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Proceedings of the Food Security Conference 2003

Challenges and Prospects of Food Security in Ethiopia

UNCC, Addis Ababa, August 13-15, 2003

Editors: Tesfahun Fenta
Osman Ali

Professional Associations Joint Secretariat

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In Collaboration With

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Acknowledgements

This is to give words of thanks to those individuals and organizations who financially and technically contributed for the success of the Food Security Conference 2003, which was held from August 13 to 15, 2003 at the UNCC, here in Addis Ababa.

A special gratitude goes to the **Action Aid Ethiopia** for sponsoring the lion's share of the cost for the conference, without which it would not be possible to undertake the conference as planned and in this high standard. Our thanks is also extended to:

- The Royal Norwegian Embassy
- Sasakawa Global - 2000
- Christian Relief and Development Association
- Ethiopian Science & Technology Commission
- Ethiopian Agricultural Research Organisation

Also, PAJS would like to give its appreciation for all individuals and organizations which actively participate in the conference.

Last but not least, PAJS appreciates the Conference Organizing Committee members and the staff of the secretariat for their unreserved personal commitment to make this conference a success.

Tesfaye Dama (Dr.)
Chairman of PAJS Board

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Cover Photo: A Farmer in Semen Shoa.
By Kidanemariam Hagos, EARO.

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Preface

Agriculture has always been and remains the mainstay in the Ethiopian Economy. The small farm unit, the most important component of the agriculture sector happens to be the lifeline for our survival and prosperity. However, unfortunately the condition of both the small farm and the agriculture sector in general is not very healthy. The food produced on the small farm is not keeping pace with the increasing rate of population growth, which is estimated to be about 3 percent per annum. At the same time, it has also has been reported that we are loosing productivity of our lands by about 3 percent per annum. Thus we need to improve annual food production by about 4 percent to meet the national demand for food.

The challenges related to the achievement of food security have been the focus of various forums organized at different levels in recent years. In this connection, a number of forums have been organized by different Professional Associations that attempted to address the issue from the respective professional perspectives. These forums have made significant contribution towards the understanding of the scope of the challenges at various levels. Working towards a sustainable solution would, however, require a comprehensive approach that addresses the various dimensions of the challenges on an integrated basis. This has provided the background for organizing the "National Food Security Conference 2003" through the active participation of the relevant professional associations under the auspices of the Science and Technology – Professional Associations' Joint Secretariat. (PAJS)

The National Food Security Conference 2003 was organized under the theme Challenges and Prospects of Food Security in Ethiopia. It is mainly aimed at discussing on the major factors attributing to food insecurity in the country and come up with concrete recommendations.

Twenty – four papers were presented under five thematic sessions dealing with different aspects of food security. The proceedings have three parts. Part one covers the opening session and part two contains the summary of panel discussion and complete document of the papers structured as per their sequence of the presentation under the different thematic sessions. Additional sources of information related to the conference organizing are presented under part three as an annex section. We strongly believe that this proceeding will serve as a useful reference material for all stakeholders that are actively engaged in the national effort for the achievement of food security.

The Editors

Part I

OPENING SESSION

Conference Programme Introduction

Tesfahun Fenta

Chairman of the Organizing Committee

Guest of Honour,
Mr. Chairman,
Conference Participants
Ladies and Gentlemen:

Welcome to the Food Security Conference 2003

Before inviting the chairman to give a welcoming address, I would like to give you a small briefing on the rundown of the program of the conference.

The conference is divided into five sessions in which 26 papers will be presented. The first day will deal with policy issues, and then in the afternoon extension, credit and finance. The next day includes crop and animal production. Natural resource and environment will be entertained on Friday morning session. A panel discussion will be conducted in the afternoon session of the last day. In fact these sessions are designed to bring together various issues of concern regarding food security and indicate measures to be taken to solve the chronic problem of food security in Ethiopia.

I hope that will give you some insight into the general set-up of the program. You can always refer to the Program Leaflet for the details. Now without taking much time from the tight program we have, I would like to invite Dr. Tesfaye Dama, Chairman of the S&T Professional Associations' Joints Secretariat (PAJS) to make a welcoming address.

Thank you.

Welcoming Speech

Dr. Tesfaye Dama
Board Chairman, S&T Professional Association Joint Secretariat

Your Excellency Ato Belay Ejigu
Acting Minister, Ministry of Agriculture
Distinguished Guests, Conference Participants,
Ladies and Gentlemen:

On behalf of the S&T Professional Associations' Joint Secretariat (PAJS), the Organizing Committee of this conference and myself, it gives me great pleasure to welcome you all to this very important and long overdue conference dealing with food security.

This conference, under the theme, *Challenges and Prospects of Food Security in Ethiopia* is organized by Professional Associations' Joint Secretariat (PAJS) in collaboration with fifteen professional societies. This is infact an intersocietal conference, the first of its kind for societies related to agriculture, which has brought together for the first time to dwell on a rather important issue that affects the survival and development of the country.

S&T Professional Associations' Joint Secretariat is an umbrella organization of over 61 professional societies in Engineering and Technology, Health, Agriculture, Social Science, Basic Science, Education, and Information Technology that are legally registered under the Federal Ministry of Justice. The Secretariat has been established in November 1997 with the technical and logistic support of the Ethiopian Science and Technology Commission, with the sole objective of rendering various services to all professional societies so that societies could be encouraged to flourish and through them professionals could contribute to the economic development of the country.

It is wise and essential to point out the opportunities and vast potentials available in the form of human resources, which is the main ingredient for development that these professional associations are packed with. It is for this reason that professional associations need to be encouraged and nurtured. It is also for this reason that this Secretariat is doing all its best to see to it that they are strengthened by removing or minimizing the problems they encounter. It is not unusual to see professional associations without shelter and as a result the respective offices becoming mobile following the work place of the prevailing president. To this effect, one of our visions is the possibility of housing all these professional associations in one building to alleviate the problem of shelters and most of all, to reach the associations with ease. In this regard, solicitations for funds from donors will be looked for and support from Addis Ababa Administration Region will be sought.

It is more than a pleasure to inform you that efforts being made by Ethiopian senior agriculturalists to establish the Ethiopian Association of Agricultural Professionals (EAAP) which is being technically supported by the secretariat office is on progress. I hope it will not be far and long to see all Ethiopian agricultural professionals housed in one big Association which will enable to discuss a wholistic issue of our agricultural problems. In this regard Ethiopian Medical association is exemplary in which others shall learn from its experience.

PAJS undertakes various activities with the active participation of Professional Associations. Just to name a few, the Secretariat had been engaged in professional certification and development of national standards. PAJS in collaboration with Basic Metals and Engineering Industries Agency (BMEIA) conducted a consultative workshop on guidelines for the certification of engineering professionals, consultants and contractors in Ethiopia. This has been finalized and at present certifications is issued to engineers to enable them practice as licensed engineers, consultants and contractors. A memorandum of understanding was also signed between Quality and Standards Authority of Ethiopia and various Professional Associations under the auspices of the Secretariat. As a part of this memorandum of understanding some national standards are in the process of being developed by different professional associations.

Workshops are also being organized by the Secretariat by involving various associations that have a stake in the subject matter while PAJS serves as a facilitator. To this end, workshops on HIV/AIDS have been conducted for the higher education communities, which included Addis Ababa University, Civil Service College, Kotebe Teachers College and Addis Ababa Commercial College. The contributions of health professional associations in these workshops were excellent.

Recently in March 2003. We have conducted an Energy Conference 2003, which was organized in collaboration with ten professionals association. It was a very successful conference in which a committee was formed to further follow up the discussions and recommendations of the conference. At this juncture I will take the chance to inform you the formation of Ethiopian Network for Sustainable Energy Development (ENSED) under the auspices of PAJS which is supposed to get a legal status soon. I hope this conference will follow the same path concerning food security.

Your Excellency,
Invited Guests and participants,

Before concluding my speech, allow me to thank Action AID - Ethiopia, for sponsoring this important conference by covering the lion's share of the cost for the conference. I will like to take this opportunity to thank the following organizations for taking a share in sponsoring this conference.

- The Royal Norwegian Embassy
- Sasakawa Global- 2000
- Christian Relief and Development Association
- Ethiopian Science and Technology Commission and
- Ethiopian Agricultural Research Organization

I will also like to thank the public and private organizations which have contributed to the success of this conference and which I also feel shows their interest and concern on the issue of the development of the country.

My gratitude also goes to all session chairmen and rapporteurs who have willingly accepted this requests made by PAJS to shoulder the respective assignments. Last, but not least, my thanks goes to the United Nations Conference Center (UNCC) administration to allow us to use this beautiful and modern conference hall.

Hoping that we will benefit from the conference, I call upon His Excellency Ato Belay Ejigu, Acting Minister, Ministry of Agriculture to officially declare the opening of this conference.

Thank you,

Opening Address

H.E Ato Belay Ejigu,
Acting Minister, Ministry of Agriculture

Mr. Chairman,
Distinguished Conference Participants,
Ladies and Gentlemen

On behalf of the Ministry of Agriculture and that of my own, I would like to extend to all of you my humble congratulations for successfully conveying this important inter-societal Food Security Conference - 2003.

Associations comprise a reservoir of individual scientists and technologists with specialized knowledge, experience and expertise that can be mobilized to accomplish specific tasks. Professional Associations play a multifaceted role in the national development effort. They constitute a vital portion of the scientific and technical infrastructure of a country. It is necessary for the association to be involved in the process of identifying research and development needs and priority areas of national development programs and strategies.

In Ethiopia, in recent years, the number of Professional Associations is on rise. Professional Associations hold their respective annual conference with a specific theme in their field of specialization. Unlike the usual practices, an organization of such an inter-societal Food Security Conference 2003, with the participation of 15 partner professional associations, which is the first of its kind is a reflection of encouraging growth of concern of professional associations in this country's development effort. The inception of Professional Associations' Joint Secretariat (PAJS), which serves as a focal point for various professional associations, in this regard, is a timely intervention, as the numbers of professional associations show a significant increase.

Mr. Chairman,
Distinguished Conference Participants,

Agriculture is the mainstay of the Ethiopian economy. It accounts for the lion's share of the total GDP, in foreign currency earnings and in the employment creation. Both industry and services are dependent on the performance of agriculture, which provides raw materials, generates foreign currency for the importation of essential inputs and feeds the fast growing population. In spite of its importance in the national economy agriculture is based on subsistence farm households, whose modes of life and operation have remained unchanged for centuries. Agricultural productivity had been deteriorating from the early seventies until 1991, rendering a good proportion of the farm households unable to feed their families and frequently dependant on food aid.

Ethiopia is endowed with a large number of perennial rivers and lakes that can be used for various agricultural development activities. The country has several climate zones suitable for various types of agricultural undertakings. More than half of the country is of highland climate (with elevation above 1500 meters above sea level) suitable for various field food and horticultural crops. Most part of the country is endowed with adequate rainfall for sustainable crop production. A survey has showed that major irrigation schemes could be developed in the semi-arid low lands for the production of high value cash crops. Quite substantial programmes could be developed in the appropriate areas to improve the livestock production potential as well.

Despite the great agricultural potential in the country, the agricultural sector is dominated by small-scale farmers following a traditional low input and low output farming technologies. The small farm unit, the most important component of the agriculture sector happens to be the lifeline for our survival and prosperity. However, unfortunately the condition of both the small farm and the agriculture sector in general is not very healthy. The food produced on the small farm is not keeping pace with the increasing rate of population growth, which is estimated to be about 3 percent per annum. We need to improve annual food production by about 4 percent per annum. At the same time, it has also been reported that we are loosing productivity of our lands by about 3 percent per annum. If one is observant of the condition of the farmer, it generally has remained unchanged over the years.

Hunger and poverty are part of most Ethiopians daily lives. Almost half of the country's population cannot produce or purchase enough food to even meet its minimum requirements. This results from a number of factors including high population growth rates, widespread and chronic poverty, low economic growth, self-defeating agricultural policies, under-developed rural infrastructure, environmental degradation, and a lack of access to improved inputs.
Mr. Chairman,

Without transformation of subsistence agriculture realizing growth and poverty reduction will be difficult. For agriculture to continue serving as an engine of growth in the coming years, through the domestic economy and international trade, there has to be progress in terms of commercialization, with more intensive farming, increasing proportion of marketable output and correspondingly decreasing ratio of production for own consumption. The complexity of the problem of agriculture in Ethiopia demands urgent integrated multi sect oral approach.

The government has designed an "Agricultural Development Led Industrialization" (ADLI) strategy which aims to use agriculture as the base for the country's overall development. Central to this strategy is the objective to enhance the productivity of small farmers and to improve food security both in the rural and urban areas. Within the framework of ADLI, the government initiated a five-year Agricultural Development Program with the objective of closing the country's food gap in the medium term. The government also introduced specific policies and provided technical and institutional support to farmers, in its drive to increase food production through intensive cultivation. These policies included fertilizer supply and distribution, improved seed supply and distribution, development of small-scale irrigation, conservation of natural resources and environment, agricultural research and extension work as well as marketing and price policy.

Since its inception in 1995/, the program has today become an integral part of the country's agricultural activities, covering all regions of Ethiopia. The program, which embraced only few thousands farmers, has now, with the latest inclusion of the millions of farmers engaged in various farming systems as direct beneficiaries of the program.

Mr. Chairman,

The concern of the organizers of this conference and all the effort directed to explore relevant issues is appreciated and is a demonstration of growing social interest in food security. No doubt that they will be able to build a rational and objective analysis of all the issues associated with Food Security to the benefits of agricultural economic development endeavour.

Finally may I take this opportunity to recognize the Professional Associations' Joint Secretariat Board Members and the conference organizers for taking their precious time to organize this inter-societal Food Security conference 2003 No doubt that they have contributed their energy as well as the necessary fund for this conference to be realized.

Finally I declare this conference open and wish you all the best in your deliberations.

I thank you.

Part II

PERSONS PRESENTED

SUMMARY OF THE PANEL DISCUSSION:

Challenges and Prospects of Food Security in Ethiopia

Chairperson: ***Ato Addis Anteneh***
Rapporteur: ***Ato Osman Ali***

Panelists:

1. Dr. Mulat Demeke
2. Ato Takele Gebre
3. Ato Zerihun Alemayehu

Food Security Conference 2003 was held in the United Nations Conference Center (UNCC), Addis Ababa, from August 13-15. Towards the end of the conference, a panel discussion was held and the following are the major points raised.

One of the panelists, Dr. Mulat Demeke, indicated that the country is entrenched in a quagmire of poverty and couldn't achieve sustainable development. He contrasted the dire situation of Ethiopia with the affluence in the developed nations by saying that hunger is alien in the latter because of their highly developed economy, whereas in this country an average of 6.6 million people face hunger every year, and this year the figure has escalated to a record high of 14 million. Further, in western countries less than five percent of the whole population are engaged in agriculture and they not only feed their country but also export or give food aid to countries like ours, whereas Ethiopia which has more than 80 percent peasant population couldn't feed itself let alone to export surplus.

Dr. Mulat gave the following five reasons that contributed to the multi-faceted problems the country is facing:

- Natural resource degradation;
- Extreme poverty due to increased population growth;
- Subsistence agriculture totally dependent on erratic rainfall;
- Problems of human resource development coupled with brain drain, HIV/AIDS; and
- Absence of international competitiveness of our industries.

He stressed that the economy ought to be propelled in the right direction, through using available resources and opportunities. Focus could be given to wildlife, tourism; and there is a need to mobilize the population as asset for development. Building human capacities and institutions that enhance agricultural production are central to improving food security.

He argued that policy and institutional failures must be corrected; that the land tenure policy may need to be reviewed, and that participatory approach be followed in policy design and institution building endeavors. Moreover, agricultural productivity should be enhanced with the use of appropriate technologies and the development of markets. Development assistance should complement and not be the driving force for the country's development.

The panelist concluded his brief presentation by emphasizing the need for coordination and networking among the various stakeholders, namely, the government, NGOs, the private sector, the academia, farmers, religious institutions and Ethiopians in the Diaspora. He also proposed the organization of a ***national forum*** to bring together the various stakeholders so as to deliberate on pressing issues and chart out the way forward to the country's development.

Ato Takele Gebre was the second to speak who lamented the sad history of the country by reminding the participants that 30 years ago the country was poor and proud, while today it is still poor but devoid of her pride and having become mendicant.

Ato Takele mentioned the country's Agricultural Development Led Industrialization (ADLI) policy and wondered how this could be achieved without transforming the prevailing smallholder subsistence agriculture to commercialized agriculture. For this to happen, he said, the farming population should decrease drastically and the land size per farmer should increase, accompanied by an increase in productivity per unit area and per unit labor. Prior to all this the degraded land, which is devoid of nutrients, should be rehabilitated with the necessary inputs.

Ato Takele also outlined the following six points as remedial measures:

a) Soil management is one big issue which requires due attention.
b) Water resource development and utilization is the second decisive issue. Here, even though we couldn't afford large-scale irrigation, he argued, we should go for small-scale irrigation and water harvesting schemes.
c) Technology is essential but policy support (input supply, credits, and marketing, etc) is necessary to make the available technology closer to end-users. Seeds, fertilizers, pesticides, etc. must be made available to farmers by involving not only the parastatals but also private sector operators.
d) More resources should be allocated for the development of infrastructure for storage, transportation, marketing, and distribution of outputs from surplus areas to deficient ones. Food based safety net programs and food-for-work schemes could enhance food security and simultaneously expand domestic markets, providing purchases from domestic production.
e) Poor farmers need to be supported; however, foreign aid must be wisely utilized and instead of free aid handout to farmers, support should be directed towards more participatory schemes like food-for-work programs. Emphasis should also be laid on the growing of vegetables, fruits, dairy farming, etc, with a view to diversify production.
f) Efforts on R&D should be further strengthened. Biotechnology issues need to be properly addressed. Africa has missed Green Revolution and Industrial Revolution but should catch up with the Gene Revolution.

The other panelist, Ato Zerihun Alemayehu, gave a briefing focused on institutionalization, coordination and cooperation of development efforts. We, in this conference hall, are fairly well enlightened professionals, he said, but we have to reproduce and multiply our knowledge, skill, and know-how so that it will bear meaningful results to the public at large. Knowledge should also reach the peasants, he asserted.

The panelist stressed that it is imperative that we should conserve our natural resources, rehabilitate the degraded environment, utilize them sustainably and transfer them to the next generation. For this to happen, institutional linkages need to be strengthened. We should also re-kindle the establishment of cooperatives in various socioeconomic spheres.

As short-term plan of action, Ato Zerihun outlined the following two points:

1) Farmers should be educated and trained; extension and other social services be facilitated; inputs be made available in order to enhance agricultural productivity.

2) We should avail an adequate threshold of infrastructure; create a sound environment for investment; provide marketing, storage and distribution facilities; empower the poor peasants and protect and enhance eco-systems. And these can be made possible only though appropriate planning and institutionalization.

The panelist wondered why just a few studies have been made about cooperatives in this country while it is important that we should focus on cooperative issues. Finally, he said, let's create the conditions to convert research into bread, i.e., into something real and useful to the society at large.

During the general discussion that ensued, the issue of gender has been mentioned. It was stressed that no development could be realized without adequately involving women on a fair ground. The way out of poverty is not feasible without considering half of the population. Gender mainstreaming, youth affairs and other societal problems ought to be properly addressed through education, participation and empowerment.

Natural resource conservation and sustainability issues need to be incorporated in the school curricula at all levels. The curricula should also include agricultural courses. Nation wide campaign must be forged in the area of awareness creation. The various media should also be aggressively involved in promulgating the pertinent issues. Environment and resource specific technologies must be implemented, not just a blanket technology for all regions. Research efforts ought to focus on available natural and human resources.

Government involvement on conserving natural resources appears limited in scope. There may be policies on natural resource conservation and/or environment issues. However, constraints are quite vivid on the implementation side, and enforcement mechanisms have, yet to be well worked out.

The extension services being undertaken by government may not suffice; it would be expedient if the private sector's involvement is sought. Environmentally sound landholding systems have also to be pursued.

One of the major problems in the agricultural research and extension system is the absence of effective farmers institutions empowered to guide, question and evaluate the system. The future development of agricultural research and extension system should be designed to serve and meet the needs of farmers. Effective coordination is essential not only to communicate research results but also to obtain feedback from farmers, which in turn puts pressure on researchers to be more responsive to farmers' needs.

The absence of security of land holding and basic service institutions such as rural education, modern storage facilities, marketing, credit and rural banking and infrastructure has a serious constraint to establish meaningful linkage between research and extension, and between farmers and extension.

Marketing strategies need to be thought through from the beginning of technology development, not later. By the same token, extension must be thought through seriously at the beginning of the technology development process to avoid loss of resources. One should also know early at the technology development stage how this technology is going to impact the poor.

The issues of water were also duly highlighted in the workshop. It was noted that Ethiopia has considerable water resources. The country has also got a natural water resource policy and a 15-year water sector strategy. It has a Ministry at federal level and bureaus at the regions in charge of water resource development functions. However, water resource development programs, particularly large-scale irrigation and dams are highly capital intensive, in which it requires $40,000 to develop one hectare and an amount of $7.8 billion for the whole country. Moreover, the fact that our major rivers are trans-boundary makes the water issue complex and political. Therefore, the viable option for the country is to develop small-scale irrigation systems and water harvesting schemes.

Strong linkages should be forged between government and professionals. The professionals' attitude towards the government should not be either a rebellion or a submission type. Rather, the relationship must be on the basis of constructive dialogue. The government ought to seek advice from professionals, associations and civil society organizations to effectively formulate policies, design strategies and issue laws and regulations.

As citizens of a country the need to have a collective vision and the culture of working together for the same cause was also highlighted in the workshop. The educated must play lobbying and advocacy roles. There is also a need to organize voluntary service whereby the veterans and other concerned nationals could contribute towards the development effort of the country. Projects must also be mission directed, and sustainable.

The fact that food security is inseparable from fuel-security was also mentioned. In this regard the need for earnest natural conservation in terms of water, soil, forestry, wildlife, and biodiversity was stressed and the fact that 'one-size policy fits all' has been argued to be a wrong approach.

In this connection, the experience of CCHABA(Comprehensive Community and Household Asset Building Approach) of the Tigray regional state in the areas of environmental rehabilitation, irrigation development, livestock development, water supply development, promotion of basic health and education services, and construction of labor-based rural access roads was commended and that other regions must take lessons from such initiatives.

The workshop also recommended that in view of the fast growing peasant population and limited land size; other non-farm activities such as agro industries need to be pursued. Moreover, other sectors of the economy like tourism; mining, industry and manufacturing ought to be thought over as alternative development avenues.

In order to effectively reflect the recommendations of the workshop a consensus has been reached to convene a ***national forum*** involving all stakeholders including senior government officials and the farmers themselves. It was agreed that such a forum should be called within six months and deliberate on how to convert the ideas put forward into practice. The Professionals Association Joint Secretariat (PAJS) should work as a focal point to organize the forum. A national taskforce composed of representatives of various institutions and renowned personalities must be formed, and it should work in collaboration with PAJS Board Members to call the meeting.

In the up-coming national forum the theme of discussion must not only focus on food security but also on feed and wood security. The forum should also critically examine the development path of the country.

Challenges and Prospects of Food Security in Ethiopia

Mulat Demeke[*]

Abstract

This study showed how weak agricultural markets, inadequate technology generation and dissemination mechanisms, lack of human resource development and poor institutions hindered sustainable increase in agricultural production and economic transformation of the rural areas. Underdeveloped output, input, capital and land markets could negate any effort aimed at increasing agricultural production and productivity. Improved agricultural technologies have yet to make a widespread impact on agricultural productivity and poverty. Agricultural development strategies have focused on food crops in all areas with little regard to whether natural potential exists and comparative advantage justifies such activities. Inadequacies in human resource development and deficiencies in the system of technology development and institutional arrangement are the major reason for stagnation of yield at about 11 quintals per ha. A sustainable and rapid increase in agricultural production would definitely entail a substantial investment in research (to generate new and relevant technology), transport and communication infrastructure, rehabilitation and conservation, irrigation and water control, human resources, etc. Ethiopia needs to intensify its agriculture and tap its irrigation potential in order to attain the goal of increasing small farmers' productivity and income. But the intensification and development of irrigation should go hand in hand with identifying profitable crops and animal husbandry, improving road and telecommunication infrastructure, strengthening research and extension capacity, designing appropriate packages of inputs, expanding investment in conservation structures, establishing a more efficient input and output market networks, and changing the land policy. A number of agricultural technologies can be imported form other countries. Genetic materials of various seeds are imported and tested for adaptability and performance. Resources can be mobilized from external sources. But new technologies and capital cannot be put into effective use unless the country's institutions are properly developed. A well-functioning public sector is characterized by: strong central capacity for macroeconomic and strategic policy formulation; mechanism to debate policies among government agencies and the public to ensure consensus; and institutionalized links to stakeholder outside the government, providing transparency and accountability and encouraging feedback. Transparent and institutionalized consultation mechanisms has given those outside of government power to restrain or even veto its actions (while preserving flexibility for policymakers to adapt to changing conditions) in many East Asian countries. Ethiopia needs to learn from what happened in other countries in building its institutions developing the critical mass of effective capacity and internal coherence to formulate and co-ordinate macroeconomic and strategic policies.

1. Introduction

As one of the largest recipients of food aid in sub-Saharan Africa, food security is a major concern in Ethiopia. The proportion of food aid in the total production amounted to about 10 percent between 1985 and 2000. The intensity and severity of food insecurity has been rising over the years. On average, some 6.6 million people were affected each year between 1991/92 and 2002/03, compared to 4.5 million between 1980/81 and 1990/91. Some 14.5 million, over two times the number in 1984/85, have succumbed to the current drought. Food production is estimated to have declined by 20 percent.

[*] Faculty of Business and Economics, Addis Ababa University

Recurrent drought, rapid population growth, exhaustion of open land frontier, war and civil strife, and low level of agricultural productivity have contributed to food insecurity in Ethiopia. A recent government document summarized the challenges facing the country as follows:

> *A combination of short-term and long-term causal factors can explain the trend towards the increasing food insecure caseload. Long-term factors, such as the interaction between environment, high population growth, diminishing land holdings, and a lack of on-farm technological innovation have led to a significant decline in productivity per household. These trends have combined with the repeated effects of drought over the years, to substantially erode the productive assets of communities and households. A loss of community assets (e.g. pasture and forest) has led to increasing environmental degradation and increased the pressure on-farm, leading to declining investment in soil and water conservation practices. More importantly, households are less able to cope with shocks because they cannot accumulate savings (e.g. livestock holdings and food stores) even in good years [1].*

The reason why Ethiopia has consistently failed to reverse the tide of famine and starvation should be found in lack of effective socio-economic development, which in turn could be attributed to inadequate strategies and policies. Previous intervention in agriculture has failed to address the real problems of the sector. Little or no attention was given to diversifying the economy and enhancing exchange entitlement of the rural population. In the absence of a concerted and meaningful effort to transform the technological and institutional basis, subsistence production of cereals using the same old technologies, with no safeguard against bad weather, has made poor farmers extremely vulnerable. Ethiopia now represents a classic case where 'Environmental assets on which most livelihoods depend are being eroded, and high population growth rates, environmental degradation and increasing poverty are mutually reinforcing each other' [2].

The objective of this paper is to review past agricultural development policies to cast some light on factors behind the environmental degradation and food security of problems of Ethiopia. The study will examine why and how weak agricultural markets, inadequate technology generation and dissemination mechanisms, lack of human resource development and poor institutions have hindered sustainable increase in agricultural production and economic transformation of the rural areas.

2. Agricultural Markets

Efficient and integrated markets ensure optimal allocation of resources in agriculture and provide adequate incentive to farmers to increase output. Underdeveloped output, input, capital and land markets could negate any effort aimed at increasing agricultural production and productivity.

a) Output Marketing

Despite some improvements following the liberalization, grain marketing systems in Ethiopia are characterized by lack of modernization, limited number of large-interregional traders with adequate storage and working capital, high handling costs, inadequate market information system, weak bargaining power, and underdeveloped processing industrial sector. Trading practices at the central market of Addis Ababa lack competitiveness and transparency. There are open auctions in the central market and prices are determined through negotiations between individual buyers and sellers.

Transport and communication system leaves much to be desired in Ethiopia. An estimated 75% of farms are more than a half day walk from an all-weather road. Inadequate roads, both within Ethiopia and between Ethiopia and neighboring countries, have inflated transport costs and impeded the viability of grain trade that would otherwise moderate extreme price fluctuations. Lack of adequate transport is also a major constraint to adoption of more productive dairy breeds.

Large inter-regional traders are small in number. Huge transaction costs and price uncertainties have discouraged investment in output markets. Small traders have limited capacity of handling large quantities for longer duration. The volume of grain marketed falls sharply in years of poor harvest and prices rise considerably. Grain prices are seriously depressed in good years. Handling and transport costs are also high due to the small quantities that farmers bring to market places (often small bags carried on head or on the back of pack animals) and the absence of grading and standards. Grain has to be unbagged and rebagged each time it changes hands, partly to inspect quality.

A good part of the margin that goes to traders comes from the inappropriate measuring instruments (under-weighing), not just price differentials. Unfair trading practices, combined with lack of accurate and timely market information and high rate of illiteracy among farmers, have widened the gap between the price paid by consumers and the price received by farmers. Since there are very few cooperatives or marketing societies, the bargaining power of farmers is weak relative to traders.

Storage problems coupled with the need to repay loans and meet other financial obligations (e.g. taxes) compel farmers to sell grain immediately after harvest. It is estimated that about 79% of farmers' annual grain sales occur immediately after the harvest season (January to March) [3]. As a result, prices drop when most farmers are selling and rise later during the year when many poorer farmers run out of stock and start buying from the market. High seasonal price fluctuation is also likely to make surplus producing farmers reluctant to make important investment in inputs such as fertilizers and improved seeds.

Market opportunities of farmers in Ethiopia have also been depressed by the low level of urbanization. With only 15 percent of the total population living in urban areas, demand for agricultural commodities produced by 85 percent of the population is undoubtedly very low. In many districts, less than 5 percent of the population lives in urban areas and is dependent on markets for its food. The vast majority of the population in the towns and urban centers also earns very low level of income (as income is derived from informal sector activities), exacerbating the demand constraints. Low level or urbanization and urban poverty have obviously reinforced subsistence production and discouraged investment in market development in Ethiopia.

b) Input Marketing

Liberalization of fertilizer market has removed price regulation and allowed private sector participation. Nonetheless, fertilizer importers and distributors face considerable uncertainty. Fertilizer import in Ethiopia is financed mainly through foreign grants and loans that are obtained at unspecified times of the year. The timing of the tender does not necessarily correspond to seasons of low fertilizer price in the world market. Optimal time of import often does not coincide with the time the grant is made available. Hidden demurrage costs at the port have increased the cost of importing fertilizer. Moreover, the amount of foreign exchange available in any one tender is too small (equivalent to lots of 25,000 tons or less) to gain from economies of scale in import and shipment.

Fertilizer distribution is marked by regional monopolies and lack of level-playing field. Contrary to the national goal of developing a free market, a few government-affiliated companies control fertilizer market. Policy uncertainties have raised the cost of investing in the fertilizer of sector and discouraged new entrants. These problems, together with the devaluation measure and removal of subsidies, have further increased the price of fertilizer.

The seed market is even less developed than the fertilizer market. Improved seeds are not always available in the open market. Private sector participation in marketing improved seeds is limited. Lack of coordination of seed supply, fertilizer distribution, credit and output marketing are some of the major impediments to technical change in agriculture.

c) Rural Credit Market

The majority of farmers in Ethiopia (over 80%) buy fertilizer on credit. But there is no effective mechanism to enforce repayment. One commonly applied measure to enforce repayment is to require all members of a service cooperative or peasant association repay all previous loans before a new loan for the current season is approved. Fertilizer sales may be suspended even when the number of defaulters is small and when the reasons for default are legitimate (e.g. crop failure). Delays in fertilizer sales often result in delays of planting time, leading to lower yields.

In order to improve credit access to input loans, the regional governments were made responsible for loan disbursement and gave guarantee for full settlement of the loan in 1996. Every year, millions of government budgets are diverted from development projects to pay for unpaid loans. Staffs of agriculture, cooperative promotion and other government offices have been forced to devote their time to credit administration.

Recognizing the need to improve the provision of financial services, the Government issued Proclamation No. 40/1996 for promoting microfinancing institutions. The Proclamation provides the legal basis for investing in medium and small banks, which specialize in catering the credit and savings needs of the urban and rural poor who are willing to undertake productive micro ventures. But interest to undertake microfinancing business has so far come mainly from domestic NGOs working closely with the regional governments. The interest to finance input loans is also limited among these institutions.

d) Land Markets

One of the main advantages associated with secure property rights is to create incentives for higher level of labor and management efforts to promote or enhance land fertility. As land becomes scarce, societies can no longer rely on long fallow periods to maintain land fertility. They must adopt fertility restoring techniques that require investment of capital and effort. This in turn requires long- term leases or land titles so as to gain from the long-term investment, mainly land improvement measures. The absence of right to transfer land through gifts, inheritance or sales could result in degradation and unsustainable land use.

The land policy in Ethiopia has remained communal or state-owned despite the growing population pressure. Tenure insecurity is believed to be the major factor behind the severe degradation and deforestation in the country. The tragedy of the commons has been in action since early 19^{th} century.

Land transaction increases efficiency in resource allocation because agents with high marginal productivity of land acquire land from agents with low marginal productivity. Property rights are required to reduce inefficiency in land use. This would also ensure efficient utilization of human or management resources. Under the existing tenure system, farmers that have the capacity to innovate and expand have limited chance to fully utilize their potential.

3. Technology Generation and Dissemination

Improved agricultural technologies have yet to make a widespread impact on agricultural productivity and poverty. Table 1 shows that improved seed is applied on about 4% of the cropped area. Only about 10% of the cultivated are treated with pesticides, while fertilizer is applied on 38% of the total area. By and large, fertilizer is used with unimproved local seeds, and this may partly explain the low yield levels in the country. Deficiency in the system of technology development is the major reason for stagnation of yield at about 11 quintalsperha.

Table 1: Use of Improved Technologies in the Peasant Sector (2000/01)

	Total crop (000 Ha)		Improved seed		Irrigated		Pesticide		Fertilizer*	
	Area	%	Area	%	Area	%	Area	%	Area	%
Cereals	7636.62	73.18	415.27	5.438	45.77	0.599	986.27	12.92	3339.73	43.73
Teff	2182.53	20.91	14.52	0.665	5.65	0.259	443.65	20.33	1146.46	52.53
Barley	874	8.38	0.9	0.103	3.68	0.421	83.52	9.556	315.39	36.09
Wheat	1139.72	10.92	53.95	4.734	1.33	0.117	395.97	34.74	746.76	65.52
Maize	1719.73	16.48	344.57	20.04	18.96	1.102	25.3	1.471	843.64	49.06
Sorghum	1332.86	12.77	1.33	0.1	15.91	1.194	25.17	1.888	131.94	9.899
Millet	346.78	3.32		0		0	9.5	2.739	143.04	41.25
Oats	40.98	0.39		0		0	3.17	7.735	12.51	30.53
Pulses@	1233.93	11.82	1.71	0.139	3.88	0.314	7.56	0.613	172.58	13.99
Oilseeds@@	561.41	5.38		0	0.29	0.052	4.12	0.734	37.42	6.665
Others@@@	306.22	2.93	1.51	0.493	9.24	3.017	5.9	1.927	129.61	42.33
All temporary**	9738.17	93.32	418.76	4.3	59.19	0.608	1003.85	10.31	3679.35	37.78
Permanent	697.19	6.68	21.51	3.085	22.5	3.227	3.64	0.522	270.22	38.76
Chat	99.02	0.95		0	6.98	7.049	2.67	2.696	35.3	35.65
Coffee	274.43	2.63	21.46	7.82	7.24	2.638	0.6	0.219	46.1	16.8
Enset	263.89	2.53		0	1.39	0.527		0	175.38	66.46
Cotton	11.23	0.11		0		0		0	1.62	14.43
Tobacco	3.99	0.04		0		0		0	1.25	31.33
Fruits	20.6	0.2	0.03	0.146	2.68	13.01		0	3.48	16.89
Other permanent	24.03	0.23		0	3.93	16.35		0	7.08	29.46
All crops	10435.37	100	440.27	4.219	81.69	0.783	1007.5	9.655	3949.56	37.85

* Fertilizer includes both chemical and natural fertilizers

** Natural fertilizer accounts for 17.5% of the total fertilizers applied

*** Natural fertilizer accounts for 88.0% of the total fertilizers applied

@ Include horse beans, field peas, haricot beans, chick peas, lentils and vetch

@@ include neug, linseed, rape seed, groundnuts, sunflower, sesame and castor bean

@@@ include fenugreek, spices, potatoes and other vegetables

Source: CSA

Agricultural research should also be geared towards bringing about broad-based technical change. Research on soil fertility management must be steeped up to reverse the decline in soil fertility due to the breakdown in traditional soil fertility restoring techniques such as fallowing and crop rotation especially in densely populated areas. In view of the massive problems of nutrient mining and land degradation, both organic and inorganic supply of nutrients must be expanded [4]. Location specific agronomic research on land preparation, crop rotation, level of fertilization and control of weed, insects and diseases could have a substantial impact on land and labor productivity. The positive contribution of improved farm implements in raising agricultural productivity should also be appreciated. The scope of socio-economic research needs to be broadened, not just on-farm verification trials, to include policy-oriented research in the area of production, processing, marketing and consumption.

An extension officer may find it difficult to persuade a farmer to adopt new inputs unless there are efficient product and input markets that render the technology profitable. Adoption to technology is enhanced provided output prices are stable, input/output price ratios are favorable, and input delivery involves low transaction costs and risk sharing. In general, technology adoption may be constrained by:

- Weak seed industry – the seed industry is dominated by a parastatal, the Ethiopian Seed Enterprise. Its capacity to produce and market improved seeds of the different crops grown under varied agro-ecological conditions of the country is very much limited. The legislation that allows private sector participation has yet to be issued.
- Poor provision of credit - regional governments control fertilizer loan and limit credit sales to the preferred companies, making the market less competitive and unpredictable.
- Unfavorable input/ output price – input prices are high while farmgate prices of output are low because of inefficiencies in the factor and output markets. Grain prices are marked by significant fluctuations due to limited capacity of inter-regional traders and poor transport. Blanket recommendations and too much load on development agents have also reduced the effectiveness of the extension system.

4. Human Resource Development

Increased productivity results from education and improved health and nutrition. According to a recent World Bank document [5],

> *Africa must solve its current human development crisis if it is to claim the 21st century. .. The crises can be solved in one generation if countries focus on the basics: nutrition, education, health and protection against increased vulnerability. .. Investment in people is becoming more important for two reasons. First, Africa's future economic growth will depend less on its natural resources, which are being depleted and are subject to long-run price declines, and more on its labor skills and its ability to accelerate a demographic transition. Growth in today's information-based world economy depends on a flexible, educated, and healthy workforce to take advantage of economic openness. Accelerating the demographic transition to reduce population growth will require education, especially of women... Second, investing in people promotes their individual development and gives them the ability to escape poverty. This again requires education and health care as well as some measures of income security.*

Increase in agricultural productivity arises not only from technical changes and physical capital accumulation alone but from improvement in human capital and institutional innovation. Capital accumulation by itself does not explain long-term growth and development. Education contributes to changes in attitudes and behavior (e.g. reduction of fertility for women). Modern attitudes and values conducive to development are largely created through education and urbanization. People holding modern attitudes are less resistant to change since they can easily see that it can be beneficial. Informed citizens identify with newer, larger entities of region and state and take interest in public affairs. The modern man's openness to new experience is reflected in his interest in technical innovation and willingness to work with people with different cultural and ethnic background [6]. High illiteracy rate, estimated at 70%, is a major bottleneck in developing Ethiopian agriculture.

High rate of illiteracy is among the factors that prevented participation of women in development activities and allowed the continuation of patriarchal practices and domination by men. About 80 percent of the adult women in the country are illiterate, compared to 60 percent illiteracy rate among men. Illiteracy has made it almost impossible to change old traditions. Cultural and religious beliefs have failed to change and adapt to the new realities. As in the old days when natural resource was bountiful, the amount of time devoted to actual work is low because of religious considerations and high leisure preference. A good part of the monthly working days are lost in many rural areas because of too many religious holidays. Surplus grain at times of good harvest is often spent to mark weddings, religious holidays, funerals and others.

All indicators of health suggest that Ethiopia trails behind nearly all developing countries. For instance, it is estimated that 64 percent of children under the age of 5 are stunted, with little chance of 'catch up' growth as they become older. Communicable diseases such as malaria, tuberculosis and diarrhea account for 60 to 80 percent of all diseases in the country. The health problems of the country are directly related to the widespread poverty, poor personal and household hygiene and lack of access to safe water. It is at a time when the health cares system of the country was unable to cope with the already existing diseases that HIV/AIDS epidemic started spreading at an alarming rate. The threat of the disease to development is unquestionable as it affects the most productive sections of the society and absorbs the bulk of the health budget, leaving insufficient resources for other diseases.

5. Institutional Aspects

As indicated above, there are several reasons behind the consistent failure to break the cycle of food insecurity and famine in Ethiopia. But lack of institutions capable of launching a sustainable development is perhaps the single most important impediment. The Imperial government attempted to introduce modern institutions into a very traditional and feudalistic system that led to dualistic economic and social structures. As the Emperor continued to rule with absolute dictatorship and the pace of modernization slowed down considerably, resentment of the non-inclusive institutions gave rise to the 1974 revolution. All institutions associated with the Imperial government were dismantled and attempts were made to establish a command system modeled along a communist dictatorship. All rural land was made state property and the farming community became entirely dependent on the government decisions regarding its basic means of survival. New entrants to the labor force were absorbed in agriculture through redistribution of land at progressively falling holding size and income levels. The administrative structure and the system of policy formulation and implementation were heavily centralized in both cases with little room for public participation. Government agencies were changed and reorganized several times. Frequent changes in public administration also meant that the system of governance lacked any permanent identity and stability. All decisions and appointments were reserved to the central government. The whole objective was to rule from the top without any consent from the public. All independent and competent professional civil servants were forced into silence, exile and early retirement under the military government. Independent initiatives by the farming community were stifled. Private sector participation in agricultural production was made impossible by the communist philosophy and restrictive land policy. Input and output marketing was also reserved to the state.

Top-down approach (dictatorial rule) did not favour the emergence of independent local initiatives and active participation. Every development intervention was expected to come from the government. The farming community continued with the same old strategy of minimizing its contact with the state. With no independent unions, associations or groupings to protect the right of farmers, government authorities at all levels were feared because of their unchecked power. Challenging government officials by ordinary citizens was largely unthinkable. They were never considered as civil servants employed to serve the community.

Since 1991, the EPRDF government has tried to build new institutions from scratch based on the principle of ethnic federalism. Many senior experts and professionals of the Derg government lost their jobs and were replaced by young and inexperienced loyalists. Autonomous regional governments have replaced centralized unitary administration and councils of people's representatives have been formed at regional and woreda levels. However, the legacy of the previous government is felt in more ways than one. Institutional stability and development failed to take root as federal and regional government agencies are merged and dismantled at frequent intervals. The planning office, for instance, changed its name from ONCCP to MOPED initially and then to MEDaC and then to MOFED, all within a span of about 10 years. The Ministry of Agriculture has been reorganized several times and its approaches to agricultural development are often dictated by politics rather than by technical problems. Boundaries of kebeles and woredas have continued to be redrawn and reformulated. Each reorganization starts with new appointment and rebuff of all previous efforts and database but only to be replaced by another reorganization a few years later. Long-term and sustainable development is not compatible with institutional instability.

In spite of the country's long history, government institutions and orientation of politicians and civil servants in Ethiopia have yet to stabilize and settle in order to focus on real problems. Ethiopia's public institutions are extremely weak even by African standards. For instance, local authorities and chief of councils lose their job in Tanzania if they fail to develop the local economy and the community required food assistance. By contrast, local authorities in Ethiopia are happy to report that the number of people requiring food aid is increasing. Public institutions and property rights are highly underdeveloped, compared to most developing countries where institutions and administrative structures are more stable and the tradition of civil service is more firmly rooted. African countries have no disruption due to land redistribution or resettlement; hence farmers are able to invest on their land.

Similar to the public institutions, the status of grassroots organizations in Ethiopia leaves much to be desired. Lack of grassroots organizations and high level of illiteracy have hindered the transition to real participation and decentralization. Collective development efforts are not common in rural Ethiopia. There are traditional organizations such as *idir* and *mahber*, but the main focus of these is on assisting funeral ceremonies. Interest group institutions such as associations and unions, development associations and advocacy groups are largely non-existent. Cooperative movements have suffered as a result of mismanagement and abuse under the former government.

6. Conclusion

The way out of Ethiopia's food security problems has been made more difficult by the failure to act comprehensively and decisively. A strategy aimed at breaking the cycle of famine cannot ignore the fact that food production is constrained both by complex supply as well as demand factors. Institutional weaknesses have further compounded the problems.
A sustainable and rapid increase in agricultural production (to exceed the rate of population growth by a reasonable margin) would definitely entail a substantial investment in research (to generate new technology), transport and communication infrastructure, rehabilitation and conservation, irrigation and water control, human resources, etc. Only a Big Bang approach

could reverse the downward trend and save rural areas from plunging further into famine and misery. Unlike many other countries, Ethiopian agriculture needs an injection of a sizeable dose of external capital to avoid Malthusian or poverty trap and increase production and productivity on a sustainable basis. Previous experience has shown that smaller investment levels that cannot produce significant results (to outweigh population growth and environmental degradation) have failed to overcome the vicious circle. The source of investment finance to get agriculture moving must be found largely in the non-agricultural sectors. The non-agricultural sector must also develop to solve the market or demand problems of the agricultural sector.

A well-functioning public sector is characterized by: strong central capacity for macroeconomic and strategic policy formulation, mechanism to debate policies among government agencies and the public to ensure consensus, and institutionalized links to stakeholders outside the government, providing transparency and accountability and encouraging feedback. Transparent and institutionalized consultation mechanisms has given those outside of government power to restrain or even veto its actions (while preserving flexibility for policymakers to adapt to changing conditions) in many East Asian countries'. Ethiopia needs to learn from what happened in other countries in building its institutions and in developing the critical mass of effective capacity and internal coherence to formulate and co-ordinate macroeconomic and strategic policies.

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The Food Security Challenges in Ethiopia

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Abstract

Ethiopia is one of the most food insecure countries in Sub-Saharan Africa. An estimated 40-60 percent of the country's population is food insecure, while 45 percent live below poverty line. The main categories of food insecure people are pastoralists and agro-pastoralists in arid and semi-arid areas, farmers in drought prone areas, small scale and resource poor farmers and urban poor. Even if there were decades of national and international funded development programmes in agriculture and rural development, sustained inflow of food aid and emergency relief operations, abject poverty, under nourishment, food insecurity and, periodical famine still characterise the lives of large proportion of the population of Ethiopia. The natural resource condition in northern, north western, eastern and central parts of the country make life intrinsically difficult. These conditions have been made worse by shrinking and degraded resource base, combined with an expanded population. The economy of the country is largely dependent on the subsistence agricultural sector and is weak, reflecting the failure of strategies and programmes to stimulate growth in the sector. The major challenges of food security in Ethiopia are classified as backward agricultural production technologies, population pressure, environmental and resource degradation, poverty, weak institutional capacity to uproot the causes of food insecurity, inadequate infrastructure and social service and inappropriate policies. Moreover, the food security challenges in Ethiopia are very wide, deep and complex in nature. They need serious investigations and understanding of the causes and consequences at grass root level in order to bring sustainable solutions through future policy intervention. Generally, it is clear that the problem of food security in Ethiopia cannot be solved within the agricultural sector alone. In other words, today the concept of food security is generally accepted as entailing not only food availability through domestic production, storage, and trade but also and perhaps more important, food access through home production, purchase in the market, or food transfer. The issue of food security in Ethiopia is complex and multi-dimensional. Attaining food security at household level may need much time. For those complex problems there must be effective solutions through time. Solving one problem of food security today is one step forward for tomorrows challenge.

1. Introduction

Ethiopia is one of the most food insecure countries in Sub-Saharan Africa. An estimated 40-60 percent of the country's population is food insecure, while 45 percent live below poverty line. The main categories of food insecure people are pastoralists and agro pastoralists in arid and semi-arid areas, farmers in drought prone areas, small scale and resource poor farmers and urban poor. Many of the causes of food insecurity are in rural areas, where 85 percent of the population and the food insecure are to be found as well as the natural resources are fragile and degraded. The agricultural production practice experienced by almost all farmers is characterized by perhaps the lowest productivity in the world. This is due to technological constraints, natural resource degradation, unskilled agricultural labour force, population pressures, very low level of institutional capacity to solve economic and social problems in the country and very limited access to domestic and international market and poverty to catch up advanced technology, information and knowledge.

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The rest of this paper dwells on the role of agriculture and resource potential for agricultural development and food security; the analysis of food security, which discusses the concept of food security and food insecurity, food production and consumption in the country; the challenges of food security that includes the main issues like population pressure, adverse weather conditions, poor agricultural production and management practices, natural resources degradation, institutional capacity, marketing and infrastructural problems; possible solutions and policy action; conclusions and recommendations.

2. The Role of Agriculture and Resource Potential for Food Security

2.1 The Role of Agriculture in the National Economy

Agriculture has always been and remains the mainstay in the Ethiopian economy. It accounts for about 45 percent of Gross Domestic Product (GDP), provides employment for 85 percent of the population, generates more than 90 percent of the export earnings and it supplies about 70 percent of the country's raw material requirement for small, medium and large sized industries that are agro-based. According to National Account estimates of agriculture, crop production is estimated to contribute on average around 60 percent, livestock accounts for around 27 percent and forestry and other sub-sectors around 13 percent of the total agricultural value added [1]. Agriculture is the main foundation of food production and hence the major contributor of food security.

Much attention has been given to identifying ways to accelerate agricultural growth. The common notion in the economic development literature is that agriculture plays a pivotal role in the early stage of structural transformation. This perception has induced economists to systematize the process of economic growth into a framework of sequential stages [2] with agricultural growth viewed as essential to induce the industrialization process [3]. Indeed, there have been very few countries that have achieved rapid non-agricultural growth without corresponding rapid growth in agriculture.

Agriculture and industry have traditionally been viewed as two separate sectors in terms of their characteristics and their role in economic growth. Agriculture has been considered the hallmark of the first stage of development, while the degree of industrialization has been taken to be the most relevant indicator of a country's progress along the development path. Moreover, the proper strategy for growth has often been conceived as one of the more or less gradual shift from agriculture to industry, with the burden on agriculture to finance the shift in the first stage. This view, clearly, no longer appears to be appropriate. On the one hand, the role of agriculture in the development process has been reappraised and devalued from the point of view of its contribution to industrialization and its importance for harmonious development and political and economic stability. On the other hand, agriculture itself has become a form of industry, as technology, vertical integration, marketing, and consumer preference have evolved along lines that closely follow the profile of comparable industrial sector, often notable complexity and richness in both variety and scope. This has meant that the development of the resources in agriculture has become increasingly responsive to market forces and increasingly integrated in the network of industrial interdependencies [4].

In addition to this, agriculture's role in economic development was highlighted by Johnston and Mellor (1961) [5], to include agriculture as a source of food supply and raw materials, a supplier of foreign exchange, a source supplier of labour for industrial employment, market for non-agricultural output and a source of surplus for investment. With these roles, one often-underplayed contribution is the strength of the backward and forward linkages agriculture has with other sectors of the economy. As agricultural production uses inputs from other sectors, such as machinery and fertilizer, an expansion of agriculture sector should result in expansion of the industries supplying these inputs to agriculture (backward linkage). As the industry sector uses agricultural output as an input, such as cereals for processed food, the increase in supply of cereals may induce an expansion in the production of processed foods that use cereals as an input (forward linkage). These linkages generally become stronger with development (Vogel, 1994) [6] and play a key role in agricultural led industrialization [7].

Indeed, the country's development strategy is expected to revolve around productivity enhancement of smallholder agriculture and industrialization based on utilization of domestic raw materials via adopting labour intensive technology. This strategy is popularly known as the "Agricultural Development Led Industrialization" (ADLI), tailored to fit the Ethiopian context. The strategy visualizes export-led growth, which is expected to serve as a propeller for an inter-dependent agriculture and industrial development. On the whole, the strategy of ADLI in the context of Ethiopia focuses primarily on agricultural development. This is to be attained through improvement of productivity under small-holding and expansion of large scale private commercial farms (particularly in low lands) which is conceived in two ways: agriculture will provide commodities for exports, fulfil domestic food requirement and supply industrial inputs; and the development of agriculture will help expand markets for domestic manufactures as a result of increased incomes of small holders.

For the vast number of farm families, whose members constitute the main agricultural work force, agriculture is not merely an occupation or a source of income; it is a way of life. This is particularly evident in traditional rural societies, where farmers are closely attached to their land and devote long, arduous days to its cultivation. Any change in farming methods brings changes in the farmer's way of life. The introduction of biological and technical innovations must therefore be adopted not only to the natural and economic conditions, but perhaps even more to the attitudes, values and abilities of the mass of producers, who must understand the suggested changes, must be willing to accept them, and must be capable of carrying them out.

2.2 Agricultural Resource Base for Food Security

a) The Land Resources

Ethiopia is endowed with abundant natural resources for agriculture. It has diverse physical feature in climate, land, etc. and comprised of 18 agro-ecological zones and 62 sub-zones having their own physical and biological potential [8].

Land is the basic resource for agriculture upon which farmers depend for their livelihood. The total land area of the country is about 111.5 million hectares of which about 66 percent is estimated to be suitable for agriculture. Out of the total land suitable for agriculture 16.5 percent is estimated to be under cultivation for the production of annual and perennial crops [9].

b) The Water Resources

Though Ethiopia's agriculture is dependent on climatic factors, mainly conditioned by availability of rainfall, there exist abundant water resources, which have tremendous irrigation potential. There are ten major rivers and lakes. The country's annual flow of water is about 110 billion cubic meters and the reserve of ground water is around 2.2 billion cubic meters. Nearly 6 billion cubic meters of water finds its way into the Mediterranean Sea annually only from river Nile. Because of this, the county is called « Water Tower » of the northern Africa. The potential for irrigated agriculture is currently estimated at 3.7 million hectares, of which only about 5 percent is under irrigation, contributing about 3 percent of the annual food production [10].

c) Livestock and Fishery Resources

The country has the largest livestock population in Africa with current estimate comprising about 32 million cattle, 24 million sheep, 18 million goats, 7 million equines and 1 million camels. There are also about 53 million poultry and 10 million colonies of bees in the country [11]. Despite the fact that the country has the largest livestock population in Africa, productivity per head is very low with milk production per local cow per lactation ranging from 200-300 kg, local mature ox weighing about 250 kg and egg production of local bird per year ranging from 40-60 eggs. This low productivity is mainly due to poor nutrition, poor health and low productive breeds of local animals. The country's fish production from inland water bodies is estimated at 30,000-40,000 tones per year. The actual production capacity is not more than 6,000 tones, which is equivalent to only 15 percent of the potential.

3. The Analysis of Food Security

3.1 Conceptual Definition of Food Security

Food security is a concept that can generally be addressed to the global, regional, national, sub-national, community and household level. The concept of food security has been developing since early 1970s. The concept on household food security in particular is a more recent development and the bulk of the literature dates from the 1980s. When we look into the evolution of food security, the initial concerns in the 1970s focused on the global, regional and national food supply or stocks (i.e., food security was conceived as the adequacy of food supply at global and national level). Such view favoured macro-level food production and supply-oriented variables that overlooked the micro-level food access.

Equating national food security with food self-sufficiency is another problem area that needs to be clearly understood. Many countries that used to be considered as self-sufficiency in food were found to be food insecure due to the fact that either lacks an efficient food system or the capacity to raise the level of food entitlement. This indicates that attaining macro-level food self-sufficiency does not ensure the achievement of household food security. That is, global or national level food availability does not guarantee food acquisition at sub-national, community and household level.

Food security is attached when all people, at all time, have the physical and economical access to sufficient safe and nutritious food to be healthy and active. Household food security, in turn means adequate access by the households to amounts of food of the right quality to satisfy the dietary needs of all its members throughout the year. From this definition, the core concept has been identified as adequacy of food supply or availability; stability of supply, without fluctuations or shortages from season to season or from year to year; accessibility to food or affordability; and quality and safety food [13].

This definition explicitly focuses on four main concepts: sufficiency (defined as the calories required for an active, health life), access to food (through production, purchase, exchange, or gift), security (defined by the balance between vulnerability, risk and insurance), quality (nutritional value and content), time (where food insecurity can be chronic, transitory or cyclical [14].

In the case of Ethiopia, there are specific sources of household food security such as food production (mainly crop and animal husbandry); cash income from different sources (mainly market based) including domestic and international trade, sales of family labour, rental income, handicrafts in rural and urban areas; reserves of food (stocks) or other assets; institutional assistance (including financial (credit) support, food aid/relief EGS, FFW and related support programmes by government, non-government organizations (NGOs) and international and national donors; remittances, and gifts; and wild food (wild plants and animals including fish).

3.2. Forms of Food Insecurity

In contrast to food security, the term food insecurity is defined as lack of access to enough food both in quantity and quality on sustainable basis. According to FAO [17], food insecurity is defined as a situation in which the individuals of a society have neither the physical nor the economic access to the nourishment they need. Food security in Africa is divided by Maxwell in to several categorise: families with little production and non-productive capital in food surplus regions; capital-poor families, but also others in arid and other marginal regions; poor cattle breeder; urban poor; refugees, homeless and other war victims.

Accordingly, household insecurity takes different forms, which require different responses or actions. The approaches may be different depending on whether food insecurity is chronic (with households almost always short of food) or transitory (resulting from temporary adverse circumstance). Food insecurity may be seasonal; a family may have insufficient food perhaps each year, but only in certain seasons.

The consequences of household food insecurity are as different as the causes in which members of households are most affected, which will vary sometimes as a result of inter-household food distribution. Households most likely to be found insecure, or at a high risk of food insecurity, are the poorest. In rural areas these may be landless households, those with such small plots of land (some times marginal land) in relation to family size as to make adequate agricultural production impossible; household with no oxen or farm animals and farm implements; sharecroppers who get relatively little of crop produced; pastoralists, fishermen, forestry workers and others who earn too little money for the needs of their families; female-headed households where the mother has many responsibilities for child care as well as farming, and poor households with a high dependency ratio or that have no or few active adults because of age, disease, disabilities or other reasons.

In urban areas also the most food insecure are the poor people, including households where there is unemployment or underemployment; single-family-headed households with dependent children, elderly people living alone; destitute and homeless individuals; and those with chronic debilitating disease or serious disabilities.

Table 3.1: Classification of Food Insecure Households in Ethiopia

	Rural	Urban	Others
Chronic	Resource poor households • Landless or land scarce • Ox-less • Poor pastoralists • Female headed households • Elderly • Poor non-agricultural households • Newly established settlers	Low income households Groups outside the labour market • Elderly • Displaced • Female headed households HIV AIDS victim families (child headed families)	Refugees Displaced Ex-solders
Transitory	Less resource poor households vulnerable to shocks, especially drought • Farmers and other on drought prone areas; • Pastoralists; • Other vulnerable to economic shocks in low potential areas.	Urban poor vulnerable to shocks, especially by those causing food price rise.	Groups affected by temporary civil unrest.

Source: Ethiopia, Food Security Strategy (FSS) (Draft copy, 1996)

Increasingly the Acquired Immunodeficiency Syndrome (AIDS) epidemic is contributing to food insecurity, sometimes because adults who were breadwinners have become seriously ill, or orphan children as young as 12 years of age have become household heads caring for younger children. In addition, where Human Immunodeficiency Virus (HIV) infection is prevalent, the disease is having a major negative impact on agricultural production, on economies and on health service (Table 3.1).

Generally, in order to provide physical access to food for consumers (households) at a grass roots level it would be necessary to establish an efficient distribution system, including processing, storage, transportation and marketing to insure the distribution of food products within a specific country, region or locality at the desire time.

3.3 Food Production and Consumption

Ethiopia is one of ancient agrarian countries in Sub-Saharan Africa. Despite the long tradition of farming, agricultural production and productivity remains much below the national requirement. The overall agricultural growth is not encouraging and due to these and other factors, food shortage has been high and chronic during the last three decades.

Ethiopia has suitable agro-ecology to grow different types of crops. The major three are cereals namely Teff, Wheat, Barley, Maize, Sorghum, Millet and Oats; pulses namely Horse beans, chick peas, Haricot bean, Field peas, Lentils, Vetch and Soya bean, and oil seeds (Neug, Linseed, Fenugreek, Rap seed, Sunflower groundnuts and sesame). In addition to food grains, the country has a potential capacity to grow fruit and vegetable crops. Coffee, cotton and sugar cane are also major crops that contribute the highest portion of export (coffee) and raw material for domestic manufacturing factories.

The rural agriculture sector, which constitutes about 9 million small holder farmers produces about 97 percent of the total crop output, including 98 percent of the coffee production and contributes on average about 60 percent of the total GDP [1].

With considerable agricultural potential, the country had been self-sufficient in major staple foods and was classified as net exporter of food grains till the late 1950s. However, since early 1960s domestic food grain production was unable even to meet the basic minimum food grain requirement of the Ethiopian people and the gap has been partially filled by both commercial import and food aid. The production of food grains registered a downward trend for several years. During 1980s, it decreased on average by 1.1 percent per annum. Sharp decline has been particularly observed during the severe drought years 1984/85 (4.46 million tons) and 1985/86 (5.0 million tons).

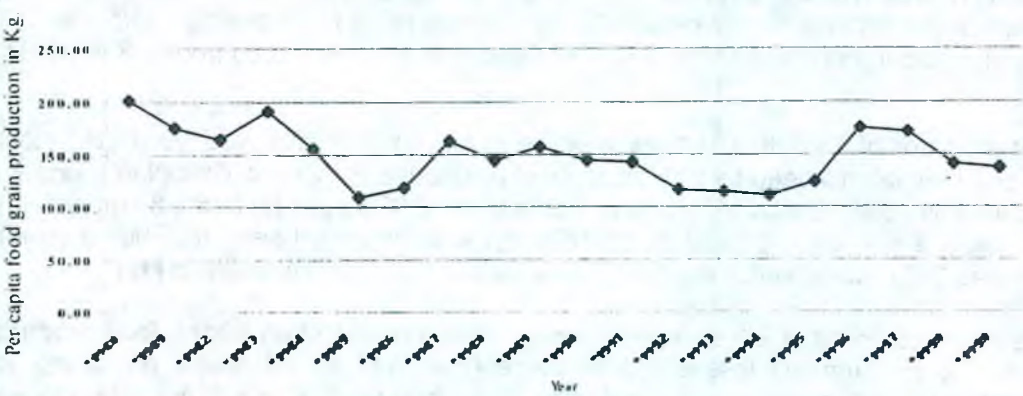
As a result, with the exception of 1982/83 (7.65 million tons) the country has been a net importer of food grains since 1981/82. In 1982/83, the best year of the decade (1980s) production of food grain increased by 17 percent compared to 1980/81 (6.54 million tons).

The total domestic food grain production raised from 6.54 million tons in 1980/81 to 10.32 million tons in 1996/97, which composed to about 57.80 percent. Even though the gross domestic food grain production had increased by half, per capita production decreased by 0.3 percent.

Annual average growth rate of domestic food grain production stood at 0.70 percent during the period 1980/81-1990/91. During this period, cereals showed an average growth rate of 0.3 percent while the growth of pulses and oil seed crops stood at 0.9 percent and 9.0 percent respectively.

When we look at the empirical situation, the National food grain production in 2001/02 as compared with food grain production of 1960/61(within a period of 42 years) increased from 5.66 to 11.61 million tons, in which annual average growth rate constitutes about 1.54 percent. Nevertheless, the per capita food grain production during the same period dramatically declined from 240.2 kg to 169.01 kg. This indicates about 0.47 percent average annual decrease.

Figure 3.1: Trends on Per Capita Food Production During the Year 1980- 1999



Therefore, domestic food supply has failed to meet the food requirement of the country. The national average calorie intake of 1954 Kcal per adult person per day is well below the recommendation of World Health Organization (WHO), which is 2200 Kcal per a day [18]. As the result, the annual deficit increased from 0.75 million tons in 1979/80 to over 4.8 million tons in 1989/90, which is more than 6 fold increase in 19 years. The situation appeared to have improved after 1994/95 but the food gap remained over 2.5 million tons even in the record harvest year 1995/96.

Here emanate the questions like What are the Major issues confronting the Ethiopian agriculture as it enters 21st century to brining sustainable food security in the country? What should be done to address these issues? And what policy actions should be taken to attain food security? All these will be discussed in the next sections.

4. The Challenges of Food Security

The challenges of food security is complex due to the plurality of elements that come into play such as supply and demand issues and technology and policy, all of which interact with the three main food security components namely food availability, food access and food utilization. Food security remains high on the agenda of the Ethiopian government; as a result there has been continued intervention in agriculture and food security.

The major challenges of food security in Ethiopia are classified as backward agricultural production technologies, population pressure, environmental and resource degradation, poverty, weak institutional capacity to uproot the causes of food insecurity, inadequate infrastructure and social services and inappropriate policies.

4.1. Technological Challenges

One of the most significant factors that cause food crisis in Ethiopia is backward agricultural practice. The use of traditional farm tool and implements, low-level use of improved agricultural inputs such as fertilizers, improved seed, and pesticide chemicals, inadequate post harvest technologies, slow the growth of agricultural production in general and of food grain production in particular.

Fertilizer consumption in Ethiopia is still very low. In 1971-75, average total annual fertilizer consumption was 7685.8 tons or 1.6 kg per hectare. Since 1971 average fertilizer consumption per hectare did not exceed 36 kg. Comparing 1971-75 average with year 2000, the use of fertilizer increased from 7685.8 to 292856.0,.in other words from 1.6 to 35.64 kg /ha.

Another indicator of inefficient farming practice is low level of improved seed utilization. A sale of commercial raw seed by Ethiopian Seed Enterprise (ESE) and Ethiopian Pioneer Hi-breed Seeds in 1994/95 was 1559.3 tons that is about 2.02 kg per ha and 1.8 kg per farmer. The situation is still not improved in 1997/98; the total improved seed distributed (sold) to farmers was 3661.7tons, which is 4.5 kg per ha, and 4.2 per rural household [19].

The present food crises in Ethiopia underscore the importance of promoting food production and reducing post-harvest losses (25-30 percent) as well as vigorously promoting food processing. The lack of enlightened problem-solving innovation in the agriculture and agro-industrial sector, and therefore the slow pace of needed technological change, has led to widespread stagnation and even decline in both crop and diversification of high quality food products.

One of the technical challenges that hinder Ethiopia is the technological capacity to use and manage clay soil and water logged land. From the total cultivated land in the country around 60 percent is clay soil. This land is not used effectively due to technological constraints.

The other technical constraints contributing to backward agricultural practices are inadequate extension service, unimproved farming implements and tools, limited use of irrigation, poor Research ↔ Extension↔ Farmer linkages and inadequate storing and processing technologies.

4.2. Demographic Challenges

One of the major causes of food crisis in Ethiopia is rapid growth of population. In 2002, the Ethiopia's population is about 67.22 million people; with annual growth rate of 3 percent, it is expected to double in 23 years. The average population density of the country is about 56 people per square kilometre.

Nevertheless, Ethiopia faces a population crisis not just because it is increasingly unable to feed a growing proportion of population from its own domestic food production but also because - and more importantly- it does not have the productivity capacity to earn wherewithal to command its additional food requirement through commercial imports. Its population raised in 2001 as compared to the average population of 1960/61-1969/70 from 26.1 to 65 million people, which is about 149.0 percent, while its domestic food grain production and total harvested cropland increased only by 70.1 and 35.72 percent, respectively. Moreover, the growing population pressure in rural areas and the limited possibility of expanding the total crop land has generally led to a reduction per capita land size available for farming. In general, due to population pressure, over cultivation, deforestation, overgrazing, declining of productive farmlands, rural - urban migration and unemployment have dramatically increased.

Households with small plots seldom produce enough grain to meet their consumption requirements. Subsistence and survival are their overriding concern. Nearly all farm produce as well as any non-farm income obtained is devoted to food. There is no surplus for investment and for input purchase. It has also been confirmed that the quality of fertilizer used per hectare is directly related to farm size. A similar relationship was also observed for improved seeds, breeds of animals and farm implements. The finding that non-users of improved inputs (fertilizer, seed, farm implements, etc.) cultivate smaller land than users seem inconsistent with the general expectation that intensification is higher on smaller farm to compensate for land shortages. It could be that farm size in Ethiopia has already fallen below the critical threshold, implying that the inverse relationship between farm size and productivity. Farmers with very smallholdings lack not only the cash to buy commercial inputs but also oxen for land perpetration.

4.3 Environmental and Resource Degradation

The wealth of Ethiopia depends on its ability to conserve and manage its land resources. It is a well-known fact that soil degradation not only results in decreased food production, but also in droughts, ecological imbalance (desertification) and consequent degradation of the quality of life. In Ethiopia the most conspicuous symptoms of negative impact of the land degradation on food production are stagnating and declining yields and high levels of poverty.

Population growth and poverty in many rainfed areas are causing serious resource degradation. Until recently, natural resources were generally abundant in these areas. Once used, farmers caused allow resource time to recover through rotation and shifting cultivation. Moreover, many of the more fragile land are not farmed at all. Today, rainfed lands frequently must support moderate to high population densities, providing not only increasing amount of food but basic essentials such as fuel wood, water and housing. In the absence of adequate increase in agricultural productivity to secure their livelihoods, farmers reduce fallow and expand into new areas, many of which are environmentally fragile and easily degraded.

Farm and grazing land in the country have suffered from the massive land degradation. The serious shortages of productive (fertile) land in the highland areas, coupled with population pressure, have forced cultivation of large parts of the steep and moderate slopes which are highly degraded because of soil erosion. The seriousness of the problem becomes apparent when one considers the fact that nearly 70 percent of the Ethiopian highlands have slopes in excess of 30°. Compounding the problem of degradation on such terrain is the current farming practice, which rarely includes terracing and other soil and water conservation technique [20].

Inadequate and erratic rainfall is also another phenomenon causing food crisis in many rainfed farming and drought prone areas. In Ethiopia, more than 95 percent of food grain production is from rainfed subsistence farm. Due to this fact, rainfall has significant impact on the agricultural sector in general and on food grain production in particular. Studies indicate that a 10 percent drop in rainfall results in decrease of cereal yields by 4 percent [21]. On the other hand, the major rivers carry vast volume of water and transport enormous quantities of silt estimated at 50 million tons annually to other countries.
Drought and desertification are closely inter-liked and mutually reinforcing, meanwhile drought is a result of weather systems (rainfall failure), and desertification is principally man-made. There are four causes of desertification, each made more acute by increasing human population: overgrazing, over cultivation, deforestation and unskilled irrigation. Development of drought resistance crop varieties, protection of the environment and increased use of irrigation potentials are thus the major challenges.

In the cause of income distribution,. a major underlying environmental degradation in developing economies is pauperisation of the rural population due to the population pressure. As supply of land suitable for cultivation becomes short relative to increased population under traditional agricultural technology, poor people are forced to cultivate fragile land for subsistence in hills and mountains, resulting in high incidence of soil erosion. Also, they are forced to cut forests for timber and fuel as well as graze animals on pasturelands, exceeding the reproductive capacity of these natural resources. It is in such an environment that dire poverty and destitution typically become a vicious circle.

4.4. Infrastructure

The increase in agricultural production cannot be substantial if not supported by adequate transport infrastructure, especially main and feeder roads that improve access to necessary inputs- fertilizer, seed, pesticide chemicals and agricultural implements. Unfortunately, the transport and communication systems in Ethiopia is far from being adequate which makes it difficult to ensure a quick distribution of agricultural inputs and efficient marketing of agricultural products. As a result, post harvest food loss reaches up to 30 percent of the total production due to poor and inadequate storage, transport facilities and other appropriate technologies.

Moreover, weak physical infrastructure and poor quality service remain one of the weaknesses of the Ethiopian economy. The country's road network is among the least in Africa with a density of 17.3 km. per 1000 sq. km by the beginning of the 1990s. As a result, vast expanse of the country's potentially productive areas lay distant from all-weather roads. Some estimates indicate that about 75 percent of Ethiopian farmers leave more than half a day's walk from all-weather roads.

With regards to social development, although encouraging signs of progress were observed over the 1990s, indicators still show the poor availability and accessibility of social services (health facilities, education facilities and services).

Generally, inadequate infrastructure and social service development such as rural road, transportation, communication, electrification, education and health services, agricultural credit and marketing services for both agricultural input and output would also be major challenges to sustain growth of agricultural productivity and food security.

4.5. Poverty

One of the root causes of food crisis in Ethiopia is expansion of poverty. Poverty is multidimensional, extending beyond low levels of income, as the World Development Report emphasizes.

According to Webb. et al [22], one route for investigating the causes of poverty is to examine the dimensions highlighted by poor people: Lack of income and assets to attain basic necessities- food, clothing, and acceptable levels of health and education; sense of voiceless ness and powerlessness in the institutions of state and society; vlnerability to adverse shocks, linked to an inability to cope with them.

To understand the determinants of poverty in all its dimensions, it helps to think in terms of people's assets, the returns to (or productivity of) these assets, and the volatility of returns. These assets are of several kinds: **Human** assets, such as the capacity for basic labour, skills, and good health; **Natural** assets, such as land; **Physical** assets, such as access to infrastructure; **Financial** assets, such as saving and access to credit; **Social** assets, such as network of contacts and reciprocal obligations that can be called on in time of need, and political influence over resources.

The returns to these assets depend on access to market and all the global, national, and local influences on returns in these markets. But returns depend not just on the behaviour of markets, but also on the performance of institutions of state and society. Underlying asset ownership and returns to assets are not only economic but also fundamental political and social forces. Access to assets depends on a large structure that defines and enforces private property rights or on customary norms that define common property resource. Access may also be affected by implicit or explicit discrimination on the basis of gender, ethnicity, race, or social status. And both access to assets and returns to assets are affected by public policy and state interventions, which are shaped by political influence of different groups.

Also important is the volatility of returns. Volatility results from market fluctuations, weather conditions, and in some societies, turbulent political conditions. Volatility affects not only returns but also the value of assets, as shocks undermine health, destroy natural and physical assets, or deplete savings.

Table 4.1: Gross National Product (GNP) per capita for Selected African Countries for Selected Years (US. Dollar, Atlas Method)

Year	Ethiopia	Kenya	Sudan	Nigeria	South Africa	SSA Average	Average for Africa
1980	120	450	450	710	2540	648	769
1990	160	370	610	270	2890	553	707
1991	120	340	560	270	3050	552	691
1992	110	330	350	290	3320	551	692
1993	120	250	300	240	3460	533	667
1994	110	240	270	220	3610	512	654
1995	110	260	300	210	3740	522	668
1996	110	320	270	240	3770	536	696
1997	110	340	270	270	3700	543	709
1998	100	350	290	260	3320	509	687
1999	100	360		260	3170	492	677
1975-85*	135	340	427	599	2133	540	638
1985-89*	162	366	656	292	2376	510	674
1990*MR	115	316	387	253	2403	530	685

Source: African Development Indicators (WB, 2001), *Annual average, MR- most Resent Year Available

Ethiopia is one of the poorest countries in the World. Annual average GNP per capita for the years 1975-84, 1985-89 and 1990s, was about 135,162 and 115 USD, receptively. This is the lowest in Sub-Saharan African (SSA), which is 540, 510 and 530 USD respectively for the same periods (World Bank 2001) [23].

The 1999/2000 Welfare Monitoring Survey also indicates that 44 percent of population in Ethiopia are absolutely poor people, meaning they are unable to lead a life filling the minimum livelihood standard. Particularly, significant deference in poverty level exists between urban and rural areas. 45 percent of the rural population live in absolute poverty while only 37 percent of urban population are found in absolute poverty [24]. Poor countries and poor people differ from rich ones not only because they have less capital but because they have less knowledge [25]. Therefore, the impact of poverty in the country results in hanger, starvation and malnutrition; incapability of using modern agricultural inputs and farm implements; incapability of using potential resources such as land and water; exposure to any risk, uncertainty and income shock; incapability to develop and use effectively infrastructure and social service and in-availability of farm oxen and farm implements.

4.6 Institutional Challenges

Ethiopia has different formal and informal institutions of which most are engaged directly or indirectly in food production, processing, marketing and consumption. Most of the formal institution in Ethiopia lack efficiency to achieve the desired policy objectives. The main constraints contributing to weak performance of institutions include: weak capacity and experience, inefficient manpower management, poor facilities such as office and office facilities, unstable organisational structure, and poor linkages within and among institutes, inadequate training, poor incentive and promotion policy. There is wide gap between federal and regional government institutions due to absence of defined effective information system network, accountability and responsibility.

In rural areas the situation of institutional constraint are worse. In most areas there is no credit institution, absence of all forms of cooperatives, weak market institutions specially input and output market, in availabilities of health centres, inadequate education and training centers and absence of information network.

4.7 Market and Marketing Challengs

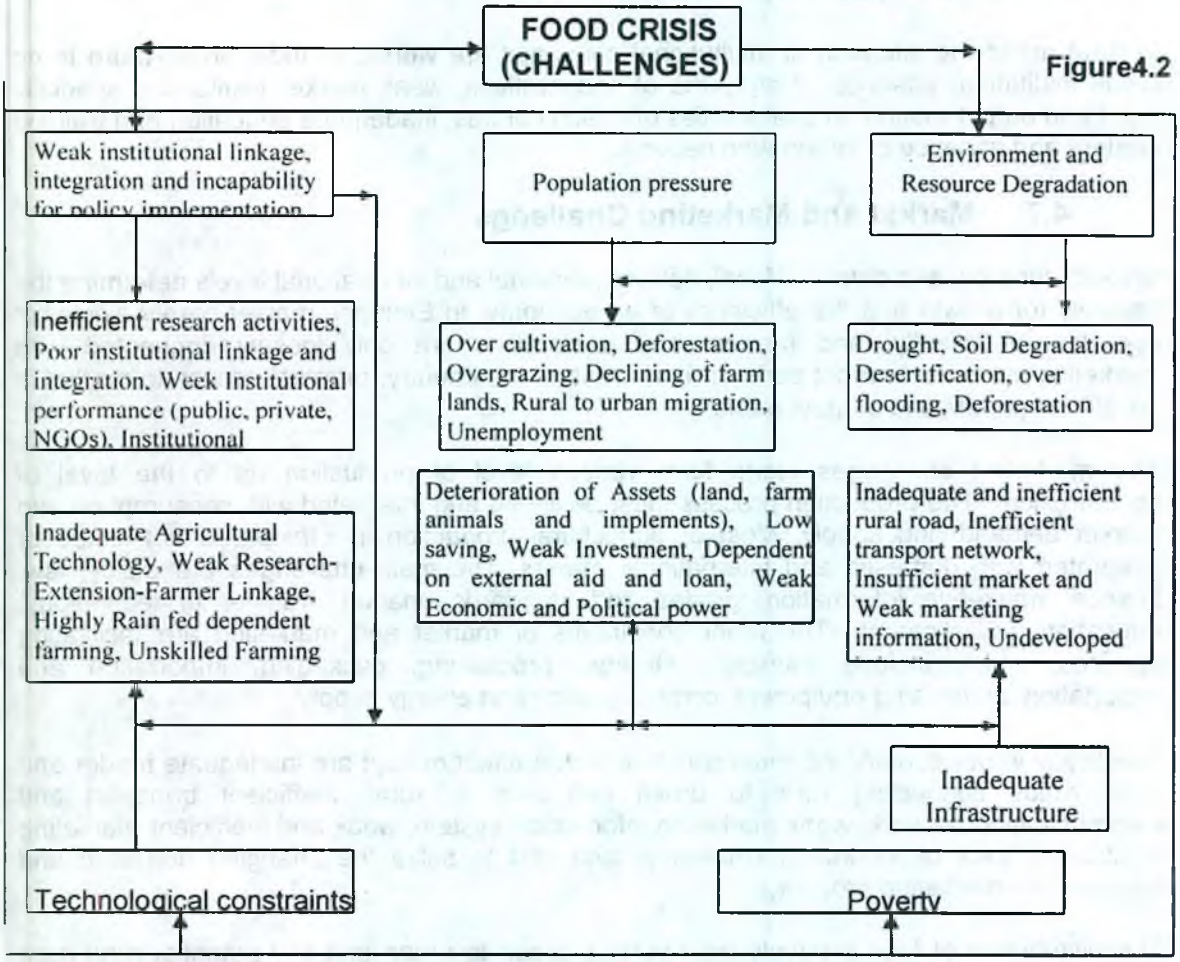
Markets for input and output at local, national, regional and international levels determine the capacity for growth and the efficiency of an economy. In Ethiopia, market barely exists, or operates inefficiently, and farmers and pastoralists are only loosely connected with marketing systems. In most parts of rural areas of the country, farmers' access to market is so difficult (inputs and outputs market).

The marketing challenges starts form various level of production up to the level of consumption. The production process must be linked and integrated with consumption and market demand and supply. Most of agricultural production in Ethiopia is not linked or integrated with domestic and international market. The main challenges are policy, law, finance, marketing information, grades and standards, market, transfer of technology, education and research. The other constraints of market and marketing are facilitating services, which include transport, storage, processing, packaging, importation and exportation, advertising equipment, communication and energy supply.

Practically in our country the main constraints that affect market are inadequate feeder and main roads connecting rural to urban and rural to rural; inefficient transport and communication network; weak marketing information system; weak and inefficient marketing institutions; lack of marketing knowledge and skill to solve the changing domestic and international marketing problems

The distribution of food products from surplus areas to urban and low potential rural area needs effective marketing system. The following illustrates the summary of this chapter.

Figure4.2



Modelling Causes and Consequences of Food Crisis

5. Possible Solutions and Alternative Policy Directions

The food security challenges in Ethiopia are very wide, deep and complex in nature. They need serious investigations and understanding of the causes and consequences at grass roots level in order to bring sustainable solutions through future policy intervention. Some of these solutions and policy directions relevant to food security are: strengthening and promotion of agricultural research; strengthen and promote the quality of extension services; develop and expand infrastructure; build institutional capacity; promote human resource development and formulate effective and sound policies; and establish effective, responsible and accountable governance.

5.1 Strengthen and Promote Agricultural Research

Agricultural research must provide appropriate and efficient agricultural technologies and farm practice that will meet the needs of the farming community. It is the research efforts that can sustainably solve the problem of food security. Therefore, one of the main policy interventions of government in this area is establishment of effective and appropriate research institutions to address the needs of the country. What are the main policy actions to strengthen and promote agricultural research?

- Establishment of adequate research infrastructure and facilities (offices, research stations, machineries, laboratory materials and equipments, vehicles, residence, information networks, computers etc.);
- Capacity building (training, experience sharing, etc.);
- Allocation of adequate funds;
- Establishment of strong and sustainable linkages among researchers, extension workers and farmers;
- Development of workable and motivated incentive (payment or reward commensurate to the result) for the researchers.

With out much question, agriculture research and technology development institutions have the responsibility to insure that they transfer results from their many years of hard work to next level- biotechnology and agro-processing to sustain food security in the country. Therefore, innovation and technological development must link with the needs of markets.

5.2 Strengthen and Improve the Quality of Extension Service

The main alternative strategic elements for attaining household food security in the country are increasing the effectiveness, efficiency, and sustainability of the extension delivery services (including financing, private sector participation, farmer responsiveness, decentralization, and gender sensitivity). In addition to this, increase farmers' access to knowledge (education), information, and communication; increase access to efficient productivity-enhancing technology; align extension to government policy particularly privatisation, liberalization, decentralization and democratisation; and create and strengthen the linkages and coordination within the overall extension services.

Moreover, diversify extension package formulation in production, processing, marketing, and family planning and home economics. The targeted beneficiaries of these packages should both men and women (gender oriented extension approach); establishment of competitive workable condition for extension and other agricultural staffs (motivation, promotion and incentive should be targeted towards work efficiency or result); create strong institutional linkages (research-extension-farmers linkages); provide adequate facilities for extension agents and other agricultural workers; and avoid frequent organizational structure changing behaviour of the institute, unless the change is supported with reasonable empirical facts.

5.3 Improve Input Delivery and Distribution System

One of the most important ingredients to increase agricultural production and productivity are timely supply of adequate agricultural inputs such as fertilizer, improved seeds, pesticides chemicals, improved farm machineries and implements and irrigation water. This can be achieved through the following:

- Create enabling environment for competitive input market;
- Encourage private investors in input production (mostly agro-chemical and farm machinery manufacturing and seed multiplications), supply and distribution;
- Establish quick and effective information and communication system;
- Establish necessary methods and standards for quality control of agricultural inputs;
- Improve feeder roads and transport network;

- Establish and strengthen rural cooperatives for input and output marketing.

5.4 Increase Investment in Irrigation

Ethiopia has abundant water resources that have tremendous irrigation potential. Despite its great potential land for irrigation, the current utilization does not exceed 5 percent of its potential. Irrigation is inventively the most appealing solution to the problem of crop production in marginal and drought prone areas of the country. In order to maximize the utilization of the country's' irrigation potential, the following policy actions are important:

- Improve and strengthen the existing traditional irrigation schemes;
- Develop small and medium scale irrigation schemes especially for drought prone and fragile marginal areas of the country;
- Encourage private investors in developing medium and large scale irrigation schemes through implementing favourable policy instruments;
- Establish effective water harvesting technologies and management system;
- Improve the quality of extension service (extension packages must integrate the components like production, storage and preservation, processing and marketing, water management and also food preparation for rural people);
- Institutional and capacity building (establishment of water associations, training of irrigation professionals and farmers- must be gender sensitive).

5.5 Investing in People

In most poor, food insecure areas of the country the two greatest potential resources are the people and the productivity of the land and water. To defeat chronic food insecurity and poverty investment will have to be both in people and productivity. Ethiopia must solve its current human development crisis if it is to climb the 21st century. Investment in people is becoming more important for two reasons.

- First, Ethiopian future economic growth will depend less on its natural resources, which are being depleted and are subjected to long-run price decline, and more on its labour skills and its ability to accelerate a demographic transition. Growth in today's information-based world economy depends on a flexible, educated, and healthy workforce to take advantage of economic openness. Accelerating the demographic transition to reduce population growth will require education (especially women education) and widely available contraceptive and reproductive health services.
- Second, investing in people promotes their individual development and gives them the ability to escape poverty and food insecurity.

5.6 Improve and Strengthen Natural Resource Conservation and Management System

Natural resource conservation and management is among the most important factors that contribute to sustainable agricultural development and food security. Renewable resources such as land, forest, water, etc. need serious attention during exploitation. Overexploitation and mismanagement of natural resources lead to deterioration and degradation of the environment that can cause drought and desertification. Some of the major policy actions that contribute to sustainable natural resources development are as follows:

- Create supportive policies for conservation based agriculture and natural resource management. It includes, formulation and adoption of appropriate land use policy, distribution of communal land (mountainous and low potential/degraded areas) to individual farmers, group of farmers, and private investors with secured property right. These will encourage the farmers and investors to integrate reforestation with food security, crop production with forestry, livestock with forestry, etc.;
- Establish effective and sustainable soil conservation and management system;
- Create enabling environment for forest development;
- Transfer productive forests to local communities, individual investors, etc. in order to reduce deforestation;
- Formulate and adopt natural resource conservation legislation.

5.7 Improve and Strengthen Emergency Prediction and Response Capacity

- Improve and strengthen the accuracy of drought and extreme events prediction, early warning system and response capacities. This can be provision of meteorological information to immediate users, establishment of computer-based prediction of droughts and floods;
- Establish sustainable emergency fund and reserve. This includes establishment of adequate strategic grain reserve stocks where necessary, organization of emergency fund collection telethon once every year.

5.8 Other Policy Actions

- Improve and strengthen national, regional and international economic cooperation and integration;
- Improve and strengthen rural credit system (allocate adequate amount of credit funds);
- Allow voluntary settlement for poor rural households from drought prone and degraded areas to potential areas;
- Promote income generating technologies and practices especially for non-agriculture sector;
- Assign competitive and qualified governance at grass roots to higher level;
- Create enabling environment for peace and stability to avoid conflict and any kind of war.

Figure 5.1 illustrates possible perspectives of food security alternative policy directions. This module conceptualises possible strategy and framework for policy action. The majority of Ethiopian population live in rural areas means that increasing agricultural production and productivity in various ways will be strategic and principal approach to solving the problem of long-term food insecurity. This means securing production, improving distribution and ensuring access to food. The promotion of technologies to enhance both crop and livestock production will play an important role through strengthening research and extension, as will the need to remove constraints to agricultural services and marketing. In a broader context, diversifying incomes within rural areas, for example, small stock keeping, artisan fisheries and domestic processing and crafts, contribute to generate incomes, which will ensure wider access to the available food.

Improved health and knowledge strengthen the human resource base, and education in particular will be essential to increase employment opportunities outside agriculture (which are accounting for an ever-growing share of rural incomes) and is vital for future generation. Better land, water and crop management can be achieved through positive synergies resulting from combined adoption of crop/plant, soil and water management practices that offer both production and conservation benefits. Land husbandry addresses the totality of the farm household livelihood system with regard to the management of inputs, outputs and land resource and aims at improving the productivity and sustainability of production system. Conservation agriculture is a farming approach aimed at making more efficient use of soil, water and biological resources. It contributes to environmental conservation as well as to enhanced sustained agricultural productivity. The main principles of conservation agriculture are ensuring the recycling and restoring of soil nutrients and organic mater and the optimal use of rainfall.

Market for inputs and outputs at local, national and international levels determine the capacity for growth and efficiency of an economy. The important thing here is improving crop and livestock marketing, better market information and improve trade and trade policy.

Development of infrastructure and services is a very important action for sustaining food security. This includes rehabilitation and construction of feeder roads, farm to market roads, railways, irrigation schemes, drainages, and river basin developments. In addition to this there should be continuous improvement in health and education services, national and regional institutional capacity building and linkages (agricultural research, training institutions, planning and coordinating institutions, extension and credit services, food standard laboratories, etc.).

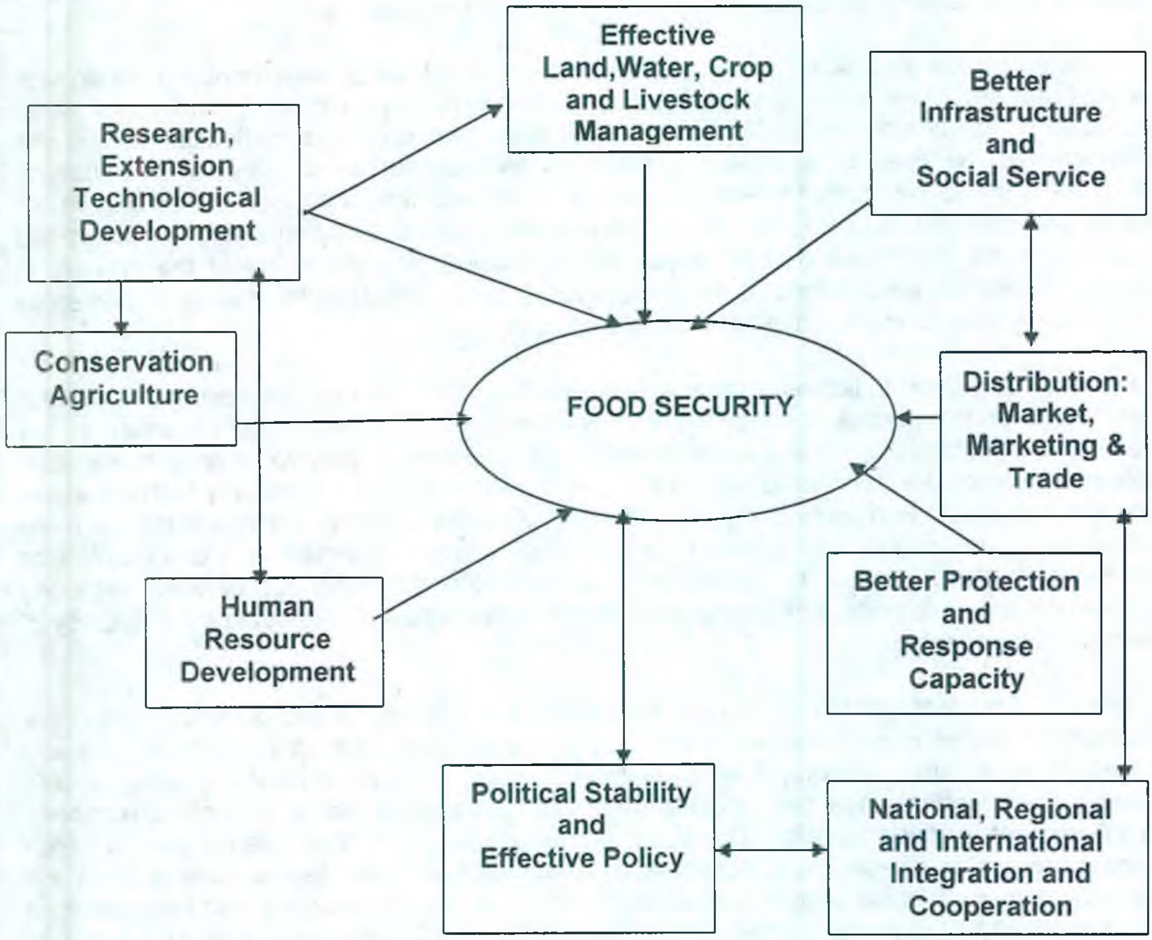


Figure 5.1: Conceptual Module for Food Security

Food security is one of the major components of food policy along with production (input-output) policy, price policy, trade policy, monetary and fiscal policy and food aid. The problem of food security cannot be solved only by the effort of Ministry of Agriculture (MOA) but it requires strong effort and commitment of governance at all level and sustainable linkages and integrations among various sectors of the economy.

6. Conclusions and Recommandations

6.1 Conclusion

Despite the resource endowment and high potential for agricultural growth and development, the population of Ethiopia live under poverty and food insecurity. Whatever the nature of the triggering event, disaster strikes because many people in the country are extremely poor and have little or no insurance in the form of food reserve or any type of asset protection. They have become increasingly vulnerable to disaster triggering events because of rapid population growth in the country as a whole and in marginal areas in particular, the increasingly degraded environment that results from over-utilisation of fragile resource and inappropriate farming practice, inability to diversify their sources of income and the difficulty of settlements to other potential areas because of policy constraints.

Even if there were decades of national and international funded development programmes in agriculture and rural development, sustained inflow of food aid and emergency relief operations, abject poverty, under nourishment, food insecurity and, periodical famine still characterise the lives of a large proportion of the population of Ethiopia. The natural resource condition in northern, north western, eastern and central parts of the country make life intrinsically difficult. These conditions have been made worse by shrinking and degraded resource base, combined with an expanded population. The economy of the country is largely dependent on the agricultural sector and is weak, reflecting the failure of strategies and programmes to stimulate growth in the sector.

Empirical evidence indicates that the opportunities for dramatic improvements in the livelihoods of the people living in the low-potential and extremely marginal areas of the country are limited. It is harsh natural environment where mere survival is an achievement. However, some opportunities to reduce the risk of famine and food insecurity in these areas are offered by modern technology, the adoption of comprehensive approach that is more sensitive to the needs and potential of the area and an increase in the allocation of resources to these areas. The approach should aim to derive synergies between restoring the natural resource base, enhancing agricultural productivity and improving the efficiency of non-agricultural sector.

Generally, it is clear that the problem of food security in Ethiopia cannot be solved within the agricultural sector alone. In other words, today the concept of food security is generally accepted as entailing not only food availability through domestic production, storage, and trade but also and perhaps more important, food access through home production, purchase in the market, or food transfer. Therefore, it is a complex and multifaceted task in which knowledge systems, education, health, energy and infrastructure development provide the framework that will allow people to broaden their economic opportunities and increase their income, which will really lead to the improvement if the social welfare of the country.

6.2 Recommandations

The issue of food security in Ethiopia is complex and multi-dimensional. Attaining food security at household level may need much time. For those complex problems there must be an effective solution through time. Solving one problem of food security today is one step forward for tomorrows challenge.

In order to accelerate the development of the agricultural sector and to achieve household food security, appropriate policies and institutional set-up have been worked out and implemented. In my point of view, to promote and accelerate agricultural development in general and food security in particular one needs to take into account the following measures:

Increase domestic food production through: **Intensification**- increased use of agricultural inputs (fertilizer, seed, pesticide chemicals, farm implements and tools) and improved breeds of animals; maximum utilization of irrigation potentials (development of small, medium and large scale irrigation schemes, improvement of traditional irrigation activities); improve soil fertility through soil and water management and diversification of crop and livestock production; and **Extensification**- maximum utilization of arable land potential; increase utilization irrigation potential; bring under cultivation water logged areas by utilizing appropriate technologies and techniques and increasing livestock and fishery production.

In addition to these, give priority for promotion of the capacity to improve service rendering in Research-Extension- Farmers linkages through: Increasing the quality of extension service by increasing Development Agent: Farmers Ratio and raising their technical knowledge and skill; strengthening Research-Extension-Farmer linkages in order to accelerate agricultural technology innovation, transfer and adoption; develop and strengthen effective marketing information system to sustain information flow through various stakeholders in order to provide information access to input-output market, credit, technology, weather condition, health education, etc.

Increasing agricultural productivity and rural income must come mainly as result of integrated work and approach of agricultural institutions and farming communities. This is the only viable way to reduce poverty, sustain food security, and protect and improve the rural resource base.

Food should be equitably distributed to all parts of the country, but often it has not been so even where sufficient food is available. More equitable distribution of food products can be achieved through: improving communication (roads, transport facilities and service) to ensure that excess stocks in one area reach another area that is short of the commodity; better marketing facilities, more market places, shops, better stocks of nutritionally valuable manufactured and preserved food in village shops at reasonable price; promoting equitable distribution within the family to ensure a fair share of food.

In Ethiopia like other developing countries, an estimated 25-30 percent of all food produced is never consumed but wasted. Measures to correct this situation can be taken on fields, households, shops and warehouses. This may include: control of rat by trapping, poison, rat proofing grain stores etc.; control of insects by use of insecticides, better food stores and airtight food containers; control of fungi and food rot by storage of food in as dry a state as possible and by use of better containers; control and protection against birds, monkeys, baboons, porcupines, wild pigs and other destructive animals.

Cutting post-harvest losses through agro processing is of paramount importance if Ethiopia is to avoid food shortage. A holistic approach should be advocated as tackling the food chain piecemeal only works to create confusion. National and regional research and learning institutions should interact with each other and with rural communities to preserve perishable commodities close to the point of production, thereby alleviating unemployment in rural areas, reducing poverty and micronutrient deficiencies, and benefiting women who are largely involved in food processing. Agricultural field workers and extension agents need to be trained in marketing, post-harvest handling, basic agro processing, and agribusiness so that they are able, for example, to advise farmers on improved storage and processing techniques. Proper food processing can ensure that nutritive values of food are maintained at the highest possible levels, that food surplus are property utilized and that food is safe to consume.

Suitable and appropriate measures are better methods of food preservation technique in the home and the village; employ better cooking methods; increase use of processes for preservation of local foods and/or for making them more palatable; ensure a supply of well-processed milk products at reasonable costs; enrichment of highly milled cereals with vitamins and irons and education on food hygiene for households. Therefore, rural based food processing can create employment and thus reduce poverty and under-nutrition in these areas.

Lack of knowledge is an important cause of malnutrition. In order to improve nutritional knowledge, the following interventions are important: nutrition education in schools, literacy class, farmers training centres and village meetings; demonstration of the preparation and cooking of food, especially food suitable for children, by nurses in health centres and clinics, by community development workers and by home economic agents in the villages and teachers in the school; encouraging nutritionally good traditional food habits and distribution of teaching materials on nutrition and publicizing of nutritional facts through the mass media at annual agricultural shows.

One of the most significant tasks to achieve sustainable food production and food security is proper and efficient utilization and management of natural resources. This includes: practical application of soil and water conservation technology and techniques; proper utilization of aquatic resources, reforestation (expansion of forest cover, special protection of degraded forests) and proper utilization of forest resources; increase the knowledge on natural resource protection and management and increase community participation on natural resource development, protection and management.

Increase the knowledge on non- farm enterprises; introduction and expansion of rural micro-business activities (credit and saving, marketing agricultural and no agricultural commodities, local transportation); encourage and improve the working condition of handicrafts and introduce small-scale agro-industries in rural areas.

Generally, for the country to achieve the objectives of sustainable agricultural development and food security, I will conclude with the following five key strategic elements: **Improvement of policy regime**: creating an enabling policy environment for entrepreneurship and agribusiness development; **Technical development and adoption**: promotion of technical progress through research and development at a firm level and strengthening research -extension-farmer linkage; **Rural infrastructural development**: establishment of rural road, water supply and sanitation, electrification, social services, and improving urban- rural linkages; **Empowerment of rural people**: increasing farmers and pastoralists participation in the agricultural and rural development process through political, administration and fiscal decentralization, participatory project and programme development and execution, and by strengthening farmers and pastoralists organization; and **Natural resource management**: improving the sustainability of production system, through effective management of land, soil, water, pasture and forests

Annex 1: Crop Production in Ethiopia- Harvested Land (,000ha) and Production (,000 tons)

Year	Cereal crop production		Pulses crop production		Oil crop production		Total crop production		Annual Changes over The base year	
	Harvested (, 000.ha)	Production (, 000.tons)	Harvested (, 000.ha)	Production (, 000.tons)	Harvested (, 000.ha)	Production (, 000.tons)	Harvested (, 000.ha)	Production (, 000.tons)	Harvested %	Production %
1980/81	5404.45	5512.20	724.94	901.80	180.56	126.10	6309.95	6540.10	_	_
1981/82	4362.31	5199.50	676.00	815.40	221.90	86.50	5260.21	6101.40	-16.64	-6.71
1982/83	4775.99	6566.80	780.06	956.30	245.77	130.20	5801.82	7653.30	-8.05	17.02
1983/84	4421.73	5715.20	737.15	701.30	231.66	104.00	5390.54	6520.50	-14.57	-0.30
1984/85	4553.81	3872.70	738.98	483.90	264.37	104.50	5557.16	4461.10	-11.93	-31.79
1985/86	4666.81	4427.80	668.24	460.60	275.36	115.30	5610.41	5003.70	-11.09	-23.49
1986/87	4642.40	6277.50	599.24	547.10	208.45	108.90	5450.09	6933.50	-13.63	6.02
1987/88	4915.14	5957.00	729.00	563.90	185.10	88.20	5829.24	6609.10	-7.62	1.06
1988/89	4848.30	5685.90	573.40	570.30	191.30	64.70	5613.00	6320.90	-11.05	-3.35
1989/90	4851.11	6138.20	627.96	674.90	220.94	98.40	5700.01	6911.50	-9.67	5.68
1990/91	4199.33	5713.30	701.92	996.68	244.00	314.20	5145.25	7024.18	-18.46	7.40
1991/92	4086.98	5713.30	683.15	970.20	234.47	305.70	5004.60	6989.20	-20.69	6.87
1992/93	7740.47	5560.30	1032.63	824.40	373.34	124.00	9146.44	6508.70	44.95	-0.48
1983/94	6107.73	7064.00	867.47	750.10	322.12	110.70	7297.32	7924.80	15.65	21.17
1994/95	6448.54	6191.20	1005.67	794.70	342.03	196.30	7796.24	7182.20	23.55	9.82
1995/96	7670.50	9265.40	1008.80	866.21	346.80	86.65	9026.10	10218.26	43.05	56.24
1996/97	7436.80	9359.15	1011.00	802.63	418.10	158.67	8865.90	10320.45	40.51	57.80
1997/98	6312.70	7197.44	1520.40	718.94	353.80	149.84	8186.90	8066.22	29.75	23.33
1998/99	6744.71	7982.99	875.38	731.98	396.22	168.87	8016.31	8883.84	27.04	35.84
1999/00	6747.47	7741.26	1044.97	959.45	424.26	190.28	8216.70	8890.99	30.22	35.95
2000/01	7636.60	9296.03	1233.90	1073.61	574.90	246.34	9445.50	10616.00	14.95	19.4
2001/02	6370.11	8706.83	1016.79	1021.22	426.13	208.14	7998.64	11360.93*		
A/Growth Rate (%)	**0.75**	**2.1**	**1.56**	**0.60**	**4.00**	**2.30**	**1.08**	**2.54**	-	-

* Includes vegetables and root crops (CSA-2002) [26] Source. Based on CSA data of various years

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Land Tenure System and Agricultural Development in Ethiopia

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Abstract

In this paper, we focus on the following issues: First, we are interested whether and to what extent land markets contribute to the dual goals of greater equity and efficiency in the rural economy. To assess whether concerns about a negative equity impact of land rental market functioning are justified, we explore whether such markets transfer land to households with lower land endowments and whether there is evidence of an "agricultural ladder" whereby it is possible for households to make the transition from sharecropping to fixed rent tenancy. To ascertain the impact on economic efficiency, we probe whether markets provide access to land for producers with higher levels of ability. We find that markets and administrative mechanisms tend to transfer land to more productive and poorer households. This would suggest that there is little reason to be concerned about potential negative effects of the emergence of rental markets as, with more and more off-farm migration and non-farm employment, the need for reallocation of land increases. A second issue to be explored, based on the identification of factors contributing to land access via markets in contrast to other mechanisms, is to compare the historical performance of land markets to that of administrative land reallocation. In addition to descriptive evidence, highlighting that rental markets have recently become quantitatively more important than administrative land reallocation, we find that reallocation appears to have been undertaken largely on political grounds, contributing neither to higher levels of efficiency nor equity. Finally, exploring factors that lead households to perceive a threat of future land loss (or gain) through administrative redistribution, we note that it is farmers who are more productive who have part-time jobs in the off-farm sector who perceive a threat of land redistribution whereas renting in land increases the expectation of gaining through land redistribution in the future. If, as is reasonable, households adjust their behavior to avoid actions that might increase the probability of them losing their land, this suggests that the danger of land redistribution is likely to retard the growth of the off-farm economy and, if realized, will also hamper agricultural productivity. This, together with the fact that it may be difficult to satisfy the expectation of those who expect to gain from administrative redistribution, suggests that a clear policy statement to reduce the scope for of land redistribution, together with proper measures to increase households' tenure security may have an important effect not only to increase tenure security and land-related investment but also to help jump-start off-farm investment and labor markets.

1 Introduction

In poor agrarian economies, land is not only a key factor of production but also performs an essential role as an insurance device and a social safety net. Ownership of land can provide access to credit which will enable households to make indivisible investments they would otherwise have not been able to undertake. Where markets for output or labor are imperfect, access to land, even if only through use rights, can help households make effective use of family labor, and improve their nutritional status [8]. The social importance of land, together

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with the fact that patterns of land allocation will affect efficiency of agricultural production, have motivated governments in countries where, often for historical reasons, access to land was highly unequal, to intervene in the functioning of markets through land reforms that aimed to equalize the ownership distribution of land. While the impact did not always live up to original expectations, reforms that gave more secure rights to households have generally had a markedly positive impact on welfare, productivity, and social peace [25,29,5].

One issue that has been subject to debate is whether, once an egalitarian ownership distribution has been attained, further intervention to maintain such equality will either be needed or even beneficial [2]. In fact, a number of arguments suggest that such intervention may be detrimental to growth and equity goals. Uncertainty about whether or not plots will be possessed in the future is likely to reduce investment incentives. Administrators may be unable to observe producers' agricultural ability and thus give land to households who are unable to make the best use of it. Moreover, the need to demonstrate a "need" for land or its "productive" use may in the longer term induce higher population growth and in a more immediate context, undermine incentives for migration and non-agricultural investment by households if they have to fear that, such activities will increase their risk of losing their land [41].

This issue is of critical importance for Ethiopia where, a decade after the government has started to individualize land rights, allow land rental, and largely eliminate the scope for land redistribution, political pressure for renewed redistribution is building up in a number of regions [31]. To decide whether to continue pursuing an interventionist stance towards land rights and land markets or to move towards abandonment of administrative controls in favor of decentralized land allocation, it will be important to know how well markets function, how they compare to administrative reallocation of land, and whether the threat of being subject to such intervention leads households to adjust their behavior. Few studies have tried to empirically explore this issue and this paper aims to contribute at filling this gap.

The paper is structured as follows: Section two reviews the literature and develops a model and an estimation strategy to analyze land rental market decisions in a framework with off-farm employment opportunities, unobserved agricultural ability and non-zero probability of losing land that is rented out. Section three discusses data sources and provides evidence on descriptive statistics as well as the distribution of agricultural ability across producers. Section four discusses econometric evidence by comparing the determinants of administrative and market-based land reallocations, assessing the factors underlying hypothetical market participation, and quantifying the gains from better functioning of land rental markets. Section five concludes with policy implications.

2. Background and Conceptual Model

In this section we first present the background on land policy issues facing Ethiopia, their historical context, and the way in which exploration of land markets as compared to administrative transfers of land can help to provide insights and policy recommendations. We use this as a basis for formulating a conceptual model that allows us to derive empirically testable hypotheses which are related to the empirical literature on the subject of land markets and land reallocation. Finally, we discuss the strategy for estimation and linking the hypotheses to the data.

2.1. Review of the Literature

In a world of perfect information and complete markets, with zero transaction costs, the ownership distribution of land will affect households' welfare but will not matter for efficiency outcomes, and everybody will operate their optimum farm size [17]. Government involvement in land markets has often been justified to counter imperfections outside of the land market in rural areas where widespread imperfections in capital and labor markets might prevent operation of land markets from bringing about socially desirable outcomes. We argue that market failures are more likely to be of policy relevance in land sales rather than in rental markets where sharecropping provides an opportunity to adjust to credit market imperfections in a flexible way with utmost moderate productivity losses.

Imperfections in rural labor markets are mainly due to the cost of supervision, which arises from the fact that, except in very limited circumstances, a wage workers' true effort is not easily observable. This implies that wage workers will have limited incentives to exert effort and either need to be supervised at a cost[1] or be offered contracts that provide higher incentives. Family members have higher incentives to provide effort than hired labor, implying that it would be advantageous for those who do not have enough land to fully utilize their family labor endowment to rent in land or for those who are relatively land abundant to rent out, rather than engaging in labor market transactions that incur supervision costs. Land markets would thus have a positive impact on improving land access by land-poor households. As long as imperfections affect only one market, everybody would still cultivate the same amount of land per capita.

Credit market imperfections can offset or even eliminate supervision cost advantages of family farmers. For example, if there is a need for up-front working capital (e.g. to acquire inputs in addition to land and labor) and access to capital depends on initial wealth, the optimal size of the operational holding would vary systematically with the size of owned holdings even if land rental markets operate perfectly. Recognition of the limitations of land markets in an environment characterized by multiple imperfections in other factor markets has led policy makers to try and impose restrictions on their unhindered operation. However, while such capital constraints are likely to be of relevance, and might be used to make at least a case in principle for government involvement, a large literature has demonstrated that adjustment of the contract terms, in particular the adoption of share-cropping contracts, provides households with an opportunity to overcome the working capital shortage at a relatively small cost. At the same time, it is well known that the scope for government intervention in land markets may be associated with a number of undesirable side-effects.
First, even if they achieve their short-term aims, such interventions are likely to reduce tenure security and impose disincentives for investment. In fact, a large literature on land tenure and investment demonstrates that higher levels of tenure security (though not necessarily formal title) will lead to greater investment by households [37,32,34,5,4,18]. While much of this literature has focused on investment that is directly attached to land, insecure tenure, i.e. the risk of losing land if specific actions are undertaken, is also likely to lead households to avoid such actions. For example, if non-agricultural development does require discrete and risky investments (e.g. migration), the threat of land loss in case such land is rented out or if the household takes on an off-farm job is likely to lead to a less than optimal level of the activity of interest.

Second, experience all over the world helped policy-makers to recognize that the mere fact of markets not leading to optimum outcomes does not imply that other mechanisms will automatically be able to bring about a more desirable outcome. A key reason is that, even in a closely knit and purely agrarian economy, it is unlikely that village leaders will be able to observe cultivators' agricultural ability. Thus, especially where producers' ability varies a lot or where the high political and administrative cost of redistribution implies that such an action is undertaken only infrequently, administrative land reallocation can lead to large efficiency losses, compared to the operation of more decentralized rental markets. This has indeed been confirmed for China [11]. The allocative inefficiencies inherent in administrative processes for land redistribution are likely to multiply if possible rent-seeking behavior by administrators is allowed for. For example, there are reports that bureaucrats may use the system for their own political goals both from China [28,38,24,9]. In Mexico, long-standing restrictions on the functioning of rental markets converted the land reform sector into a refuge of poverty and political patronage [39,21,42].

A third reason why reliance on administrative reallocation may lead to undesirable consequences is that such intervention can give rise to perverse incentives in at least two areas. On the one hand, greater involvement by rural households in the off-farm economy is widely recognized as a critical pre-condition for broad-based rural development. Insecure land tenure can undermine the ability to achieve this goal if doing so is incompatible with households' desire to maintain their land rights. While a number of studies draw this link at the conceptual level, e.g. for the case of China [41,30] there is only very weak and indirect empirical evidence pointing into this direction [15,23]. On the other hand, without restrictions on population growth, the fact that households' ability to obtain land will essentially depend on household size, could imply that the desire to obtain land is one of a number of factors that contribute to high population growth. Although the long-run nature of the phenomena at stake makes it difficult to clearly disentangle cause and effect, a study from Mexico indeed finds rates of population growth to be significantly higher where population could be used as a means to access land than where this was not possible [10]. Even though a counterfactual is difficult to construct, it may be more than merely a coincidence that, in China, the policy of land redistribution according to population size is combined with strict limitations on population growth.

While there are few examples of reforms to liberalize land rental markets, existing evidence points towards a positive effect, suggesting that the concerns of critics may be less relevant empirically than often thought. In Mexico, abandonment of rental restrictions in the constitutional reform of 1992 had a positive impact on productivity, land market activity, and equity rather than the predicted wave of land sales and destitution [40]. In China, land use rights that had been given to individuals after the 1978 introduction of the Household Responsibility System were increasingly made more secure in a process that is still ongoing. Restrictions on the scope to exchange land which are imposed at the local level have been shown to reduce the scope for efficiency- and equity enhancing land transactions [12]. Even though households' preferences over land rights are shaped by a complex set of factors [26,27], there is evidence that those who experienced more secure property rights and abandonment of administrative land reallocation approve of this measure by a wide margin [13]. An impact of more secure land rights on greater rental market activity has also been confirmed in Nicaragua [14].

2.2 A Model of Agricultural Production and Land Market Participation

We formalize these ideas using a model with household-specific ability where those who rent out land stand a risk of losing their asset to redistribution. Let the representative household i be endowed with endowments of labor $\overline{L}_i$ and cultivable land $\overline{A}_i$, a given level of unobservable agricultural ability α_i, and a vector of household characteristics and endowments X. Egalitarian distribution of land endowments, together with administrative restrictions imply that there is no market for (permanent) farm labor. Income can be derived from farming, off-farm employment, and land rental. Agricultural production follows a standard production function and is also affected by household-specific ability α_i so household i's agricultural production is given by $\alpha_i\, f(l_i^a, A_i)$ where l_i^a represents labor and A_i land used in agricultural production. And f satisfies standard assumptions: $f_{l^a} > 0$, $f_A > 0$, $f_{l^a l^a} < 0$, $f_{AA} < 0$, $f_{l^a A} > 0$ and $f_{l^a l^a} f_{AA} - f_{l^a A} > 0$. A second possibility to generate income is to devote labor time $l^o = \bar{L}_i - l_i^a$ to off-farm employment at an exogenously given wage w. Finally, rather than self-cultivate, households can rent out part of their land endowment or rent in additional land for agricultural production $\bar{A}_i$ -A_i at the competitive rental rate r. In addition, there is a non-zero threat ρ that the household's land will be subject to administrative redistribution. Taking all of these elements together, we obtain the expected utility of household i who aims to maximize current income plus future land wealth $Y+V(A)$ with $V(0)=0$, $V'(A)>0$. Suppose there exist an probability $\rho \in [0,1]$ that an household who rents out part or all of its land will lose the part or all of its land, but ρ is irrelevant to those who rent in land or stay autarky. With further assumption of linearity of future land wealth function (or $V''(A)=0$), expected future land wealth of household i can be expressed as $V[\bar{A}_i + I_{out}\rho(\bar{A}_i - A_i)]$, where $\bar{A}_i$ is the land endowment, and A_i is amount used for self-cultivation. While this expression is a constant for households who engage only in self-cultivation (or renting in of land), the ability of those who rent out land in the market to keep all of their endowment depends on ρ, households' security of tenure.

Household i will choose l^a*, l^o* as well as A_i* by solving the income maximization problem:

$$\max_{l^a, A} \; p\alpha_i f(l_i^a, A_i) + w l_i^o + (\bar{A}_i - A_i) r + V[\bar{A}_i - I_{out}\rho(\bar{A}_i - A_i)] \qquad (a)$$

Where I_{out} is a binary indicator equaling one if a household rents out land and zero otherwise, p is the price of agricultural goods, l^o is the amount of time allocated to off-farm labor ($= \bar{L}_i - l_i^a$), and all other variables are as defined above. Optimal choices l_i^{a*}, l_i^{o*} and A_i^* will solve the first order conditions (FOC).

$$p\alpha_i f_{l^a}(l_i^a, A_i) = w \qquad (1)$$

plus, for households who rent in or stay in autarky $p\alpha_i f_A(l_i^a, A_i) = r$
(2)

or for households who rent out $p\alpha_i f_A(l_i^a, A_i) = r - \rho V'[\bar{A}_i - \rho(\bar{A}_i - A_i)]$
(2)'

In the appendix, we derive the following propositions which form the basis for our empirical tests.

Proposition 1. In an agrarian economy, the amount of land rented in is strictly increasing in α, and strictly decreasing in $\bar{A}$. On the other hand, the amount of land rented out is strictly decreasing in α, and strictly increasing in $\bar{A}$. In this setting, rental markets would transfer land to "poor but efficient" producers and overall product will be strictly higher than in an economy where rental markets do not exist. An empirically testable hypothesis emerging from this is that ability will affect outcomes in rental markets but not results from administrative land redistribution.

Proposition 2. Imposing restriction in rental, represented by a probability of losing land that is rented out will drive a wedge between the amount of land rent payment received by those renting out, therefore reducing the amount of land that is transferred through markets and overall economic welfare.

2.3. Estimation Strategy

Agricultural ability: To recover agricultural ability, we take advantage of the availability of plot level data on production to estimate a production function with household fixed effects.[2] We assume that households use the Cobb-Douglas technology:

$$Q_{jip} = \exp(\alpha_i + \alpha_j) A_{jip}^{\theta_1} L_{jip}^{\theta_2} K_{jip}^{\theta_3} \qquad (4)$$

where Q_{jip} is agricultural output produced by producer i in village j on p^{th} plot; A_{jip}, L_{jip} and K_{jip} are land, labor and capital used by producer i in village j on plot p to produce output Q_{jip}, and $exp(\alpha_i+\alpha_j)$ is the efficiency parameter which has a household- and a village-specific element.[3] θ_1, θ_2 and θ_3 are technology coefficients common to all producers. Taking logs of both sides of equation (10), adding an *iid* error term, and letting q be the log of output, a, l, and k be the log of the inputs, and $\alpha_{ji} = \alpha_j + \alpha_i$ we obtain an estimable equation for production by producer i in village j on plot p as follows.

$$q_{jip} = \alpha_{ji} + \theta_1 a_{jip} + \theta_2 l_{jip} + \theta_3 k_{jip} + \varepsilon_{jip} \qquad (3)$$

Availability of multiple observations per household allows to estimate this using household fixed effects.

$$q_{jip} - \bar{q}_{ji} = \alpha_{ji} - \bar{\alpha}_{ji} + \theta(\mathbf{Z}_{jip} - \bar{Z}_{ji}) + (\varepsilon_{jip} - \bar{\varepsilon}_{ji}) \qquad (4)$$

where Z is a vector consisting of a, l, k and θ is a coefficient vector including θ_1, θ_2, and θ_3. The composite efficiency parameter α_{ji} can then be recovered for each producer. Given the fixed location of land, it is unrealistic to expect trades beyond the village level and what is relevant is therefore a producer's relative efficiency within the village. To eliminate village effects, we use a similar procedure at the village level to obtain α_j which can be used to obtain an estimate of α_i $(=\alpha_{ij}-\alpha_j)$ for each producer in the sample..

Land market participation: To identify determinants of land market participation as emerging from proposition 1, we specify a reduced form regression for transferring in or out land through land rental markets, including both cash rent and share cropping with a household's agricultural ability, its endowments of land, labor, other production factors, and available off-farm opportunities as right hand side variables. Signs on other covariates will provide evidence on the extent to which operation of markets also can satisfy equity concerns. Formally, we estimate

$$R_i = \beta_0 + \beta_1 \alpha_i + \eta \mathbf{X}_i + \delta O_i + \varepsilon_i \qquad (5)$$

where R_i is a dummy for renting or the actual amount of area rented in or out, α_i is agricultural ability as defined above, $\mathbf{X}_i$ is the vector of other household characteristics that includes educational attainments, family composition, land endowments, and total asset values, and O_i proxies for off-farm opportunities by indicating whether the household has past "migration" experience.[4] We also estimate a separate set of regressions that distinguishes sharecropping and renting so as to check whether there is a progression from one to the other, possibly in the sense of an "agricultural ladder".

Since ability cannot be transferred in markets, we expect that markets transfer land to producers with higher agricultural ability, i.e. $\beta_1 > 0$. Of the other variables included in $\mathbf{X}$ the most important prediction is that the coefficient on land endowment be negative, in line with a redistributive function of land rental markets which would lead them to transfer land to producers with lower levels of endowments. Also, while the amount of agricultural asset ownership would be irrelevant if markets for such assets were perfect, imperfections in rental markets for productive assets, especially draft animals, as variously found in the literature [36,6] would lead to a positive coefficient on this variable. To the extent that rental markets help to bring about intergenerational land transfers, the age of the household head would be expected to be negative. Finally, past migration experience will increase the effective wage rate that can be earned, other things equal, make it more likely for households to join the off-farm labor market, thus leading to a positive expected sign for renting out and a negative one for renting in [35].

Market vs. administrative reallocation: To compare determinants of market- as compared to non-market based land reallocation, we repeat estimation of equation (5) with the difference that R_i is now replaced by a dummy for whether the household has, during the last 5-year period received land through redistribution or through the market.[5] This allows direct comparison between the productivity and equity impact to be expected from land markets as compared to administrative reallocation. We note, however, that, especially if past redistribution is only poorly correlated to the scope for future land market intervention, something that seems to be the case in Ethiopia, exploring determinants of reallocations in the past will be of interest to compare between different types of allocation mechanisms but is unlikely to have a direct impact on current household behavior.

Determinants of future land redistribution: More direct inferences on potential behavioral adjustments by households in response to perceived threats of land reallocation are available from an analysis of the factors leading households to expect that they will lose land in the future. To conduct this analysis, we estimate a probit equation similar to equation (f%) where R_i is replaced by an indicator of whether a household expects to be subject to land loss or gain via administrative action in the future. Also, we include an indicator for whether or not the household head had taken on off-farm employment in 1999, a variable excluded from earlier regressions because it is jointly determined with rental decisions and therefore endogenous to current household behavior but not to future expectations.

3. Background, Data and Descriptive Statistics

The data used for this study is from the fifth round of the Ethiopia Rural Household Survey, conducted in 1999 by the Economics Department of Addis Ababa University. It covers 1680 households in 4 of the country's major regions, Tigray, Amhara, Oromia and SNNP. In addition to standard characteristics routinely included in household surveys, this survey provides information on output as well as inputs of labor, seed, purchased inputs (fertilizer, pesticide, etc.), and cultivation techniques (e,.g. double cropping) at the plot-level. This allows us to estimate a production function with household fixed effects to recover households' agricultural ability as discussed above. Moreover, information on past involvement in administrative reallocation or rental markets and on whether specific households expect to gain or lose through administrative reallocations in the future is included.

3.1. Land Policy in Ethiopia

Ethiopia has not only a very eventful recent history in which land issues have played an important role but, more importantly, also faces crucial decisions in the area of land policy and especially land markets. Historically, land tenure in Ethiopia falls into three broad periods. Before 1975, land was concentrated in the hands of absentee landlords, tenure was highly insecure, arbitrary evictions posed a serious threat, and many lands were severely underutilized. The land tenure system was characterized by great inequality which, through its impact on production and investment, not only affected productivity but was also considered to have been the most important cause of political grievances that eventually led to the overthrow of the regime [1].

Following the overthrow of the imperial regime in 1975, the Marxist government (the *Derg*) transferred ownership of all rural land to the state for distribution of use rights to cultivators through local peasant associations (PAs). The transferability of rights received was highly restricted; transfer through lease sale, exchange, or mortgage, among others, was prohibited and inheritance allowed only to immediate family members. The ability to use land was contingent on proof of permanent physical residence, thereby for example preventing migration. More importantly, tenure security was undermined by the PAs' and other authorities' ability to redistribute land, often for political reasons, something that is well documented for the case of Amhara [16].

The government taking power in 1991, though committed to a free-market philosophy, has, with three notable exceptions, made few substantive changes to Ethiopian farmers' land rights which are therefore still considered to be quite inadequate [22]. First, land was made a regional responsibility, implying that regional governments can enact laws relating to the nature of land rights and their transferability as well as land taxation. Second, the frequency of land redistribution was to be reduced; in fact Tigray declared an end to administrative land redistribution while Oromia restricted the scope for redistribution to irrigated land. Finally, rentals have been officially allowed [33] although local leaders and governments seem to have great discretion to impose restrictions on land transfers. For example, the region of Oromia allows farmers to rent out only up to 50% of their holding and stipulates maximum contract terms of 3 years for traditional and 15 years for modern technologies.

The Government's Poverty Reduction Strategy espouses the guiding principle that every farmer who wants to make a livelihood from farming is entitled to have a plot of land free of charge [19]. Even though it may conflict with this goal, the strategy also mentions a need for greater tenure security and better functioning of land rental markets. Responsibility for implementation is left with regional states which have adopted very different implementation strategies.[6] Whether the lack of a national policy on the issue is a cause for concern is very much an empirical issue of great relevance which we pursue in more detail below.

3.2 Household Characteristics

Table 1 provides key household characteristics and details on income and crop production. The average household is composed of 5 people, among which about 2 are aged less than 14 and 2.7 between 14 and 60. The average age of the head is around 50 and 77% of households are male headed. Levels of education are very low; only 40% of heads in the sample are literate, with an average of 1.35 years of formal education. However, the fact that the maximum level of formal education in any given household is 3.2 years suggests that levels of education are improving among the younger generation. All of the descriptive statistics point to large differences between regions, with Tigray being by far the worst in terms of most social indicators.

These regional differences are more pronounced for total household income which, with an average of B 2280, varies between B 981 in Tigray and B 3116 in Oromia, implying not only a relatively high level of poverty but also large regional differences in this indicator. Using the national poverty line, 36% of the households are classified as being poor, but 75% are so in

Tigray. Agriculture remains the mainstay of the rural economy, accounting for about 70% of total income. While 29% of households complemented their agricultural income with some receipts from non-agricultural self employment, only 4% had their primary job in the non-farm sector, 6% received wage income from off-farm work, and 9% worked in other woreda including those who sent home remittance and those worked off-farm in other woredas. Within the agricultural sector, income from crop production is clearly the most important, accounting for 66% of total income, although with considerable inter-regional variation (from 46% in Tigray to 75% in Oromia). The endowment of arable land held by households, excluding grazing and garden land, is very small, 1.22 ha per household or 0.29 ha per capita. Per capita land holdings are larger in Amhara and Oromia (0.45 and 0.34 ha respectively) and very low in Tigray and SNNP (0.12 ha), in line with income levels. In addition to limits on land endowments, use of modern technology remains low. While 73% of households use fertilizer which is highly subsidized, only 19% used improved seed and 31% chemicals, suggesting that fertilizer may not always be used optimally. Regional differences (only 6% and 4% of households use seeds and fertilizer, respectively, in Amhara) further exacerbate these differences.

3.3. Land Market Participation

Past and current participation in market-based or administrative land transactions, as well as expectations for the future, are summarized in table 2. We find that, with the exception of Amhara where 19% of households lost land and 11% increased their endowment through land redistribution over the last 5 years, the extent of administrative reallocation of land during this period has been quite limited – only few households in Oromia and SNNP received or lost land through the same means, bringing the total of households affected to 4% and 6%, respectively. The share of households who, over the last 5 years, increased or decreased their cultivated land area by renting in, a lower bound for activity in land rental markets,[7] was above the share of those who received land through redistribution, with 11% of households reporting to have received land and 9% that they supplied land through either rental or sharecropping.

Current (i.e. 1999) participation in rental markets is even higher. Taking fixed rental and sharecropping together, 24% of households report to currently use somebody else's land through markets (7% through rental and 17% through sharecropping). The fact that this percentage is almost equal to the share of households (20%) who report to have supplied land to the market (6% for rental; 14% for sharecropping) suggests that migration remains extremely limited and that absentee landlords are virtually non-existent.[8] With the exception of Oromia, sharecropping is more important than fixed rental, something that can be explained by the fact that agricultural production in Ethiopia, largely rainfed, is risky. The importance of sharecropping is reinforced by the fact that the area involved is much larger than for the case of rental, amounting to about half of the average per capita endowment.

Data on future expectations reveal two observations of interest. First, there is a resurgence of expectations of land reallocation through administrative means; 10% of survey respondents expect to lose land to administrative reallocation within five years. This is surprising given that land redistribution in the past decade was essentially limited to Amhara.

Large inter-regional differences in the expectation of future redistribution (ranging from 20% in Amhara to 2% in Tigray) suggest that policy decisions affecting these issues are indeed taken at the regional rather than the national level. A second finding of at least equal interest is the large discrepancy between those who expect to receive additional land and those who expect to lose land from redistribution.

With the exception of Oromia, the share of producers who expect to gain from administrative land reallocation everywhere is at least double the share of those expecting to have to cede land in such a process. Since reallocation of land is a zero-sum game, i.e. it is impossible to give out more than what is taken away from others, this implies that any redistribution that will try to satisfy expectations will lead to significant further fragmentation of holding sizes in a situation where, with given technology, the amount of land available to households is often already too small to produce enough for subsistence [31].

4. Econometric Evidence

We find that both the plot level production function as well as the participation equations provide results that are not only highly significant statistically but also in line with our predictions. Markets seem to transfer land from large and less efficient to small and relatively more efficient producers as predicted by theory and there is some indication of producers' progressing from sharecropping to cash rental with increased age and wealth that would be worth exploring further. By comparison to administrative reallocation which seems to have been driven mainly by political, rather than economic, concerns, land rental markets appear to have clear equity and efficiency advantages.

Exploration of the factors leading a surprisingly large number of individuals to expect losing or gaining land through redistribution in the future highlights that households who work in off-farm jobs for part of the time and more productive producers are significantly more likely to be concerned about losing land to redistribution. As they would adjust their behavior so as to minimize the danger of land loss, this would be expected to lead to delayed and stunted development of the non-farm economy and, to the extent that it reduces the extent of land transfers, possibly contributed to a reduction in agricultural productivity.

4.1 Market-based Land Transfers

Before discussing evidence regarding determinants of market participation, we review results from the plot-level production function with household or *woreda* fixed effects for 1334 households who have on average 4.4 plots each (appendix table 1). Parameters on main inputs are consistent with expectations. Application of modern seed, fertilizer, and chemicals all are estimated to significantly increase the value of production. Indicators for land quality are significant and of the expected sign; output from plots with "secondary" and "tertiary" land quality is about 8 % and 11% lower, respectively, than for plots with good soil quality, the default subsumed in the intercept. Plots used for two seasons produce slightly lower output for each individual season. We also note that α_i, the deviation of household *i*'s agricultural ability from the village mean, ranges between –2.27 and 2.12, pointing towards considerable scope for improvements in output and productivity through reallocation of land between producers.

To assess whether markets or administrative mechanisms contribute to such reallocation, table 3 reports results from probit (columns 1 and 2) and tobit (columns 3 and 4) equations for market land transfers where rental and sharecropping are considered together.[9] Results strongly support the hypothesis that rentals transfer land from households with low agricultural ability and relatively abundant land endowments to those with high agricultural ability and scarce endowments. We also find a pronounced endowment effect whereby households who have little land available per capita use rental markets to gain access to more land and vice versa; notably the coefficients are significant at the 1% level throughout. This clearly counters fears that liberalization of land rental markets would cause land concentration that would leave the poor without land access.

Similarly strong effects are found for ability, the coefficient of which is always very positive and highly significant in the renting in equation, implying that it is clearly more productive households who obtain land through rental. The coefficient on ability is always negative for renting out, although significant only at 10% in the tobit equation, suggesting that productivity is not the only factor leading households to supply land to the rental market. To illustrate the magnitude of the estimated coefficients, we note that, compared to the household with the lowest agricultural ability in the sample, the one with the highest ability is 23% more likely to obtain land through the rental market. Similarly, a household with per capita land one standard deviation above or below the mean is 15% and 8% more (or less) likely to rent in (out) land, respectively, than the average household.

In addition to these coefficients, factors related to households' endowment with other factors and their composition are as expected. The coefficient on draft animals, which is positive for renting in (together with other assets) and negative for renting out implies that, due to imperfections in rental markets for animals, it is easier to transfer land than animals or associated capital equipment. Having one more draft animal will increase the probability of a household to receive in land by 8%. Male headed households are more likely to rent in land while female headed ones are more likely to rent out. Younger households are more likely to participate on the demand side of rental markets; the coefficients from the probit regression suggest that the probability to rent in land increases up to 26 years and slowly declines thereafter. Once these factors are accounted for, a higher number of children below 14 years reduces the probability of renting in and increases the probability of renting out.

4.2 Administrative Land Reallocation

Table 5 compares the performance of administrative reallocation to land transfers through decentralized rental. This is of particular interest with respect to the extent to which land was transferred to households with high agricultural ability and limited land endowments, allowing to implicitly test the hypothesis that administrative transfer would be more pro-poor than independent land rental. We find that, contrary to this belief, administrative land reallocation did *not* transfer land to more efficient or poorer producers. There are not only few variables predicting households' past receipt or loss of land through redistribution; in fact, the only variable significant at the 5% level, the number of draft animals, goes in a direction opposite from what one would expect from a measure that is supposed to equalize land access among households. Ability is insignificant, supporting the notion that this variable either cannot be observed by community leaders or that increasing efficiency has not figured high as a goal of activities and policies aimed at land redistribution. Comparing this evidence to determinants of land rental (column 2) suggests that, even though the dependent variable in the recall data is less precise than what was discussed earlier, the latter shifted land to those with lower endowments and higher levels of productivity, and was thus arguably more redistributive than administrative reallocation.

Similarly, the only variable that is highly significant for loss of land through redistribution is the household's educational level and the number of draft animals. This supports the notion that redistribution is motivated more by political than economic considerations. While low ability is not estimated to have been a driving factor behind supply of land to rental markets, the positive and significant coefficient on households' land endowment, the negative coefficient on male headship, and the negative coefficient on the number of draft animals owned in the renting out equation all suggest that, historically, land markets have performed much better than administrative means in benefiting the poor and increasing overall productivity. Given that it is widely acknowledged that land redistribution was largely a political exercise, the above findings just provide empirical confirmation of conventional wisdom and are thus not too surprising. Still, if the past is any guide to the future, we would not expect future administrative land reallocation to have a positive impact on productivity or increased land access by the poor. To assess whether the scope of such redistribution may have a negative impact on household behavior through other channels, we turn to the analysis of factors affecting households' expectation regarding land redistribution in the future.

4.3 Future Land Redistribution

Factors that systematically increase households' expectation of experiencing an increase or a decrease in their land endowment through administrative measures are, to the extent that they affect household behavior, arguably more important from a policy perspective. Results from regressions with regional and *woreda* dummies, respectively, are presented in table 6.

The most significant determinant that leads households to believe that land will be taken away from them is whether or not the head has a part-time, though by no means primary, job in the off-farm sector. According to our estimates, off-farm employment increases the subjective probability of future land loss by between 10% and 15%. To the extent that households base future actions on such beliefs, the fear of losing land is likely to lead to a considerable reduction in their willingness to take on off-farm employment which could have far-reaching implications for the emergence of the non-farm economy, a factor which, all observers agree, will be of critical importance for future rural development in Ethiopia.

It is also worth noting that, contrary to what was found in China where administrative land redistribution clearly took land form larger farmers and had a negligible productivity impact [12], the regressions suggest that, in Ethiopia, it is more productive farmers who are most exposed to the threat of future land redistribution, as implied by the positive and highly significant coefficient on ability. Any redistribution conforming to these expectations would thus directly decrease overall productivity of the rural sector. By comparison, farm size, as measured by the per capita land endowment, remains insignificant. In addition, higher levels of education and a lower number of members between the age of 14 and 60, is also found to have a significant effect on the perceived probability of land loss.

While the fact that the dependent variable is a dummy precludes us from making inferences on the possible impact of such redistribution on production, we note that the increase in the probability of suffering a land loss that is associated with higher ability is quantitatively large; compared to the least productive producer in the sample, the most productive one is almost 20% more likely to lose land to reallocation. To the extent that fears of land expropriation by authorities lead households with comparative advantage in non-farm jobs to reduce their participation in non-farm employment, one would clearly expect reduced growth of the off-farm sector as a result of such high levels of tenure insecurity. Eliminating such fears would then, by increasing the scope for off-farm employment, result in a Pareto improvement.

Turning to determinants of households' belief in whether or not they will receive (rather than lose) land through administrative means, there is some indication that, within any given *woreda* it is indeed producers with less land who expect to gain in a future redistribution (column 4 of table 6). However, the fact that the number of household members between 14 and 60 years is negative suggests that these may not have the labor force to make use of the land. Also, households renting in land think they will be able to benefit from land redistribution in the future. Even though the link is less direct than for of off-farm employment, this could contribute to undermining the future functioning of rental markets in the future. From all perspectives then, the prospect of future redistribution appears to be conducive neither to a more egalitarian distribution of land nor to higher levels of rural productivity.

5. Conclusion and Policy Implications

This study contributes to the literature in two ways. First, we demonstrate empirically that land rental markets in Ethiopia work better than administrative mechanisms to reallocate land among producers. Despite some remaining restrictions, land rentals did help to further equity and efficiency objectives in ways that are superior to what has been accomplished by administrative reallocation of land. Contrary to fears that land markets might lead to accumulation of land in the hands of the rich and powerful, greater emphasis on rental markets as compared to administrative reallocation of land would provide benefits to poor but efficient producers who have few alternative opportunities of using their labor endowment. Administrative land reallocation was largely a political exercise that contributed to neither of these objectives.

Second, we document a link between higher levels of off-farm employment and lower levels of tenure security in the form of a (individual) fear of being affected by future land redistribution. To the extent that, for agrarian countries like Ethiopia, development of economic opportunities in the non-farm sector will be a critical element of any strategy aiming at higher economic growth, this suggests that land tenure could have implications that go beyond mere land-related investment. This is of policy relevance because, despite limited success of this measure in the past, support for administrative reallocation of land in Ethiopia appears to be on the increase. Even in the best of cases, and assuming considerably improved mechanisms, Ethiopia's narrow land base will limit the scope for such a measure to lead to significantly improve the welfare of the large majority of producers. Also, unrealistic expectations about the potential impact of redistribution can easily lead to an inflation of expectations that might be problematic. Finally, and most importantly, our regressions show that the scope for administrative land redistribution will affect household behavior in ways that can undermine precisely the non-farm activities on which further development of Ethiopia's rural areas depends. The scope for weak land rights to limit the emergence of the non-farm sector could be of considerable policy relevance and should be explored in more detail for other countries as well.

Taking these two findings together suggests that irrespectively of a possible need for transitory arrangements, abandoning the scope for future land reallocation could have considerable economic benefits while losses associated with such a measure appear to be mostly of a political nature. A policy statement highlighting that there will be no land distributions in the future could thus actually benefit the poor. Moreover, the evidence in favor of an economically and socially positive role of land rental markets suggests that further steps to eliminate obstacles to the functioning of such markets would be beneficial to broader rural development in Ethiopia.

In this context, it would be of interest to expand the evidence provided here in two respects. On the one hand, the data available provide an excellent opportunity to further quantify welfare implications of land rental markets not only in a static but also a dynamic perspective and to test the extent to which existence of an "agricultural ladder" has allowed households to proceed over time from being sharecroppers to cash rental and possibly towards land ownership would be of interest. Also, recent evidence suggests that allowing transferability of land in sales markets is likely to be associated with considerable investment benefits. At the same time, high risk of agriculture and the fact that sales markets are more likely to be affected by credit market imperfections than those for rental, implies that land sales markets may be more not always lead to efficiency improvements, making an empirical exploration of this issue of interest. Our results suggest that it would be useful to focus policy discussion on these issues, rather than a modei of redistribution which had very limited success in the past and, in addition, may negatively affect the development of the non-farm economy.

Table 1: Basic Characteristics of the Sample

			Region		
	National	Tigray	Amhara	Oromia	SNNP
Household characteristics					
Household size	5.04	4.72	4.31	5.11	5.81
No. of people less than 14	1.93	2.04	1.60	1.97	2.17
No. of people between 14 and 60	2.75	2.19	2.32	2.82	3.31
No. of people older than 60	0.36	0.49	0.40	0.31	0.33
Has male household head	0.77	0.51	0.73	0.81	0.85
Age of household head	49.26	51.53	50.28	48.38	48.52
Illiteratacy rate	59%	77%	63%	53%	58%
Year of education of household head	1.35	0.43	0.88	1.38	2.11
Max. years of education of household	3.21	2.45	2.39	3.08	4.51
Income and its composition					
Total household income (Birr)	2280.26	980.93	2446.17	3116.25	1360.01
Share of poor[1]	36%	75%	30%	21%	52%
Share of agricultural income in total	80%	67%	78%	86%	78%
Value of total hosuehold assets	486.05	275.62	375.10	639.05	457.96
Household head with non-ag primary job	4%	2%	5%	3%	5%
Household head worked off-farm	6%	7%	9%	4%	6%
Share with self-employment	29%	12%	25%	28%	40%
Household head migrated	9%	11%	7%	9%	10%
Crop production characteristics					
Share of crop income in total	66%	46%	55%	75%	72%
Own cultivable land holding[2]	1.22	0.44	1.49	1.67	0.58
Per capita own arable land holding[2]	0.29	0.12	0.45	0.34	0.12
Share of households used improved seed	19%	10%	6%	24%	28%
Share of households using fertilizer	73%	74%	64%	90%	55%
Share of households using pesticides,	31%	1%	4%	62%	22%
Share of households with draft animals	85%	94%	98%	92%	57%
Number of draft animals owned	3.87	4.63	6.52	3.61	1.45

1Total household income less than national poverty line (1075 Br per household)

2Excludes grazing and garden land

Table 2: Past, Current and Future Changes in Land Holdings

		Region			
	Average	Tigray	Amhara	Oromia	SNNP
Changes in land holding last 5 years					
Increased land through reallocation	4%	0%	11%	1%	1%
Increased land through rental/sharecropping	11%	1%	14%	12%	9%
Lost land through reallocation	6%	0%	19%	1%	2%
Rented/sharecropped out land	9%	4%	5%	12%	9%
Market participation					
Rented in land	7%	1%	5%	13%	4%
Area rented in (ha)	0.05	0.00	0.03	0.12	0.01
Sharecropped in land	17%	3%	35%	10%	12%
Area sharecropped in (ha)	0.12	0.01	0.30	0.07	0.04
Rented out land	6%	1%	3%	12%	4%
Area rented out (ha)	0.04	0.00	0.03	0.08	0.01
Sharecropped out land	14%	15%	24%	12%	8%
Area sharecropped out (ha)	0.12	0.06	0.24	0.10	0.04
Expectation regarding land changes					
Expects increase through redistribution	11%	13%	14%	11%	5%
Expects decrease through redistribution	10%	2%	7%	20%	3%

Table 3: Determinants of Participation in Land Rental Markets

	Probit Results		Tobit Results	
Agricultural ability	0.051**	-0.025	0.251***	-0.170*
	(1.99)	(1.53)	(2.81)	(1.87)
Per capita land holding	-0.430***	0.236***	-1.578***	1.423***
	(5.34)	(6.92)	(5.67)	(7.86)
Head's age (log)	1.983*	0.399	5.838	2.110
	(1.80)	(0.54)	(1.52)	(0.53)
Head's age (log) squared	-0.289*	-0.049	-0.851*	-0.253
	(1.95)	(0.50)	(1.65)	(0.48)
No of people < 14a	-0.029***	0.020***	-0.096***	0.116***
	(3.10)	(3.26)	(2.96)	(3.56)
No. of people 14 – 60a	-0.003	0.001	-0.012	0.015
	(0.32)	(0.13)	(0.34)	(0.42)
No of people < 60a	-0.007	-0.002	-0.065	0.023
	(0.22)	(0.09)	(0.55)	(0.18)
Max years of education	0.009*	0.002	0.039**	0.017
	(1.78)	(0.64)	(2.31)	(0.96)
Male headed	0.134***	-0.080***	0.524***	-0.370***
	(3.76)	(2.96)	(3.48)	(2.96)
Migration	0.037	0.139***	0.052	0.537***
	(0.73)	(3.61)	(0.30)	(3.42)
Value of assets	0.000***	-0.000	0.000***	-0.000
	(2.87)	(1.21)	(3.28)	(0.87)
Number of draft animals	0.022***	-0.014***	0.097***	-0.087***
	(3.49)	(3.59)	(4.53)	(4.18)
Constant	-13.812*	-5.985	-11.900*	-5.999
	(1.90)	(0.79)	(1.67)	(0.81)
No. of observations	1236	1236	1236	1236
Log-likelihood	-537.73	-418.61	-755.46	-485.52

.Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Regional dummies included throughout but not reported

Table 4: Determinants of Area Rented in/out or Sharecropped in/out

	Area rented in	Area sharecropped in	Area rented out	Area sharecropped out
Agricultural ability	0.204**	0.188**	0.070	-0.275*
	(1.97)	(2.08)	(0.63)	(1.92)
Per capita land holding	-1.520***	-1.592***	1.042***	1.170***
	(2.83)	(5.49)	(4.07)	(4.35)
Head's age (log)	0.096	6.090	1.231	0.075
	(0.01)	(1.56)	(0.23)	(0.01)
Head's age (log) squared	-0.024	-0.895*	-0.112	0.066
	(0.03)	(1.71)	(0.16)	(0.09)
No. of people<14	-0.023	-0.108***	0.095**	0.111**
	(0.44)	(3.29)	(2.03)	(2.50)
No. of people between 14 and 60	-0.007	0.026	-0.029	0.010
	(0.14)	(0.76)	(0.58)	(0.20)
No. of people >60	-0.307	0.082	-0.055	-0.039
	(1.50)	(0.70)	(0.32)	(0.23)
Max. years of education of household	0.029	0.025	-0.018	0.010
	(1.00)	(1.47)	(0.66)	(0.41)
Headed by male	0.268	0.531***	-0.137	-0.406**
	(1.10)	(3.31)	(0.78)	(2.42)
Household head migrated	-0.049	0.105	0.467**	0.531**
	(0.16)	(0.59)	(2.17)	(2.52)
Value of assets	0.000***	0.000	-0.000	0.000
	(3.43)	(0.99)	(1.26)	(0.28)
Number of draft animals	0.076**	0.091***	-0.120***	-0.062*
	(2.23)	(4.21)	(3.21)	(1.94)
Constant	-2.861	-12.200*	-4.884	-2.994
	(0.24)	(1.68)	(0.50)	(0.28)
Observations	1236	1236	1236	1236
Log-likelihood	-616.83	-301.17	-245.10	-313.76

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Regional dummies included throughout but not reported

Table 5: Determinants of Past Changes in Land Holding

	Gained land through..		Lost land through..	
	Redistribution	rental	redistribution	rental
Agric. ability	0.002	0.035*	-0.003	-0.002
	(0.44)	(1.94)	(0.60)	(0.14)
Per capita land	0.005	-0.068*	0.012	0.105***
	(0.66)	(1.70)	(1.62)	(4.20)
Head's age (log)	-0.088	0.707	0.214	-0.034
	(0.66)	(0.86)	(1.05)	(0.06)
Head age square	0.010	-0.099	-0.027	0.008
	(0.55)	(0.91)	(0.99)	(0.11)
No of people < 14a	0.000	-0.006	-0.002	0.008*
	(0.35)	(1.00)	(0.93)	(1.91)
No. of people 14 – 60a	0.002*	0.008	-0.000	-0.002
	(1.92)	(1.35)	(0.18)	(0.40)
No of people < 60a	0.006	-0.035	0.006	-0.025
	(1.43)	(1.36)	(1.09)	(1.28)
Max years of education	-0.000	0.003	0.002***	0.002
	(0.06)	(1.17)	(3.30)	(0.77)
Male headed	-0.010	0.081***	0.000	-0.050**
	(1.61)	(3.16)	(0.08)	(2.35)
Head migrated	-0.002	-0.006	-0.004	0.042
	(0.27)	(0.18)	(0.48)	(1.49)
Value of assets	0.000	0.000	-0.000	-0.000
	(0.10)	(0.94)	(0.08)	(0.04)
Number of draft animals	0.002**	0.001	0.003***	-0.008***
	(2.30)	(0.32)	(3.37)	(2.58)
Observations	1236	1236	1236	1236
Log-likelihood	-160.79	-437.45	-219.68	-307.68

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Regional dummies included throughout but not reported

Table 6: Determinants of Household's Expectations Regarding Future Redistribution

	Expects to			
	Lose land		Gain land	
Agricultural ability	0.021** (2.04)	0.044*** (2.60)	-0.024* (1.81)	-0.019 (1.52)
Per capita land holding	0.032 (1.13)	0.028 (0.61)	-0.004 (0.15)	-0.106*** (2.74)
Head's age (log)	0.022 (0.04)	-0.011 (0.01)	-0.012 (0.02)	-0.009 (0.02)
No. of people<14	-0.005 (0.94)	-0.004 (0.45)	-0.005 (0.94)	-0.006 (1.12)
No. of people between 14 & 60	-0.015** (2.52)	-0.021** (2.47)	-0.012** (2.02)	-0.018*** (3.04)
No. of people >60	-0.011 (0.62)	-0.011 (0.42)	0.005 (0.28)	0.001 (0.04)
Maximum years of education of household	0.009*** (3.39)	0.005 (1.40)	0.001 (0.45)	-0.000 (0.16)
Headed by male	0.008 (0.42)	-0.007 (0.23)	0.026 (1.31)	0.032* (1.72)
Value of assets	0.000 (0.40)	0.000 (0.08)	-0.000 (1.29)	-0.000 (0.27)
Number of draft animals	-0.004 (1.20)	-0.002 (0.45)	-0.002 (0.63)	-0.003 (0.89)
Head w off-farm experience	0.105*** (2.98)	0.152*** (2.97)	-0.036 (1.18)	-0.031 (1.04)
Area rented out	-0.030 (1.04)	-0.020 (0.48)		
Area rented in			0.039*** (2.86)	0.029** (2.09)
Observations	1236	882	1236	1194
Log-likelihood	-350.91	-288.73	-342.05	-315.20
Dummy	Region	Woreda	Region	Woreda

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 1: Results of Fixed Effect Panel Estimation of Plot Level Production Function

	Household Fixed Effects	Woreda Fixed Effects
Log of labor usage	0.169***	0.158***
	(9.94)	(12.08)
Log of cultivated area	0.457***	0.439***
	(22.08)	(27.94)
Log of value of seed use	0.023***	0.034***
	(3.33)	(5.32)
Dummy modern seed use	0.404***	0.424***
	(6.95)	(7.99)
Land quality secondary	-0.079**	-0.052**
	(1.99)	(2.05)
Land quality tertiary	-0.110**	-0.136***
	(2.08)	(3.55)
Plot used for two seasons	-0.086	-0.026
	(1.64)	(0.69)
Fertlizer used	0.067*	0.067**
	(1.89)	(2.29)
Chemicals used	0.199***	0.239***
	(4.31)	(6.23)
Observations	5839	5839
No of households/woredas	1334	18
R-squared	0.37	0.36

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Crop dummies included but not reported

Appendix 2: Proofs for Main Propositions

Proposition 1. Among the households who rent out land, the higher their ability, α, the less likely they will rent out. Alternatively, among households who rent in land, the higher α, the more likely they are to rent in.

To show this, totally differentiate (1) and (2) with respect to α, then reorganize the two differential equations into a matrix form, yielding: $\begin{bmatrix} p\alpha f_{l''l''} & p\alpha f_{l''A} \\ p\alpha f_{Al''} & p\alpha f_{AA} \end{bmatrix} \begin{bmatrix} \partial l''/\partial\alpha \\ \partial A_i/\partial\alpha \end{bmatrix} = \begin{bmatrix} -pf_{l''} \\ -pf_A \end{bmatrix}$

Solving for $\partial A_i/\partial\alpha$ by Cramer's rule, yields:

$$\partial A_i/\partial\alpha = \frac{\begin{vmatrix} p\alpha f_{l''l''} & -pf_{l''} \\ p\alpha f_{Al''} & -pf_A \end{vmatrix}}{|H|} = \frac{-p^2\alpha f_A f_{l''l''} + p^2\alpha f_{Al''} f_{l''}}{|H|} > 0 \quad \text{(for} \quad f_A > 0, \quad f_{l''} > 0, \; f_{l''l''} < 0,$$

and we know $|H|>0$ by the sufficient second order condition of maximization problem.

Similarly for household who rent out land, totally differentiating (1) and (2)' with respect to α, then reorganizing the two differential equations into a matrix form, yields: $\begin{bmatrix} p\alpha f_{l''l''} & p\alpha f_{l''A} \\ p\alpha f_{Al''} & p\alpha f_{AA} + pV''(.) \end{bmatrix} \begin{bmatrix} \partial l''/\partial\alpha \\ \partial A_i/\partial\alpha \end{bmatrix} = \begin{bmatrix} -pf_{l''} \\ -pf_A \end{bmatrix}$

Solving for $\partial A_i/\partial\alpha$ by Cramer's rule yields:

$$\partial A_i/\partial\alpha = \frac{\begin{vmatrix} p\alpha f_{l''l''} & -pf_{l''} \\ p\alpha f_{Al''} & -pf_A \end{vmatrix}}{|H|} = \frac{-p^2\alpha f_A f_{l''l''} + p^2\alpha f_{Al''} f_{l''}}{|H|} > 0$$

This implies that for all households that participate in rental markets (on either side), the amount of area operated will increase with ability.

For households renting in, the amount of land rented in is the difference between the amount of operational land and the land endowment, i.e. $A_{in} = A - \bar{A}$ (A1).

Total differentiation of both sides of (A1) with respect to α, yields $\frac{\partial A_{in}}{\partial\alpha} = \frac{\partial A}{\partial\alpha} > 0$, implying that for households who rent in land, the amount of land rented in is increasing in agricultural ability. Total differentiation of both sides of (A1) with respect to $\bar{A}$, yield $\frac{\partial A_{in}}{\partial\bar{A}} = -1 < 0$, implying that for the households that rent in land, the amount of land rented in is strictly decreasing in land endowment.

For those households that rent out land, the amount of land rented out is the difference between the land endowment and the land used for self-cultivation, or formally, $A_{out} = \bar{A} - A$

(A2). Total differentiation of both sides of (A2) with respect to α, yields $\frac{\partial A_{out}}{\partial\alpha} = -\frac{\partial A}{\partial\alpha} < 0$, which implies that for those households who rent out land, the amount of land rented out will decrease in agricultural ability. Total differentiation of both sides of (A2) with respect to $\bar{A}$, yields $\frac{\partial A_{out}}{\partial \overline{A}} = 1 > 0$ (for by assumption, individual household's operational land, A is not constrained by individual household's endowment), implying that for those households who rent out land, the amount rented out is strictly increasing in land endowment.

Proposition 2. Imposing restriction in rental, represented by a probability of losing land that is rented out, will cause households who would be better off in off-farm employment (e.g. due to low agricultural ability) to stay in farming, or $\partial A_{out} / \partial \rho > 0$ where ρ denotes the probability of losing land that is rented out.

Since this is only relevant for households who rent out land, we can prove the proposition by totally differentiating (1) and (2)' with respect to ρ, and then reorganizing the two differential equations into matrix form, which yields:

$$\begin{bmatrix} p\alpha f'_{l''l''} & p\alpha f_{l''A} \\ p\alpha f'_{Al''} & p\alpha f'_{AA} + \rho V''(.) \end{bmatrix} \begin{bmatrix} \partial l'' / \partial \rho \\ \partial A / \partial \rho \end{bmatrix} = \begin{bmatrix} 0 \\ -V'[\overline{A}_i + \rho(\overline{A}_i - A_i)] \end{bmatrix},$$

The first matrix is H, as defined earlier, and the sufficient second order conditions of the household's maximization problem imply that it is negative.

Solving $\partial A / \partial \rho$ using Cramer's rule, yields:

$$\partial A_i / \partial \rho = \frac{\begin{vmatrix} p\alpha f'_{l''l''} & 0 \\ p\alpha f'_{Al''} & -V'(.) \end{vmatrix}}{|H|} = \frac{-p\alpha f_{l''l''} V'(.) - 0}{|H|} > 0.$$

Taking derivative of (A2) with respect to ρ yield $\partial A_{out} / \partial \rho = \partial \overline{A} / \partial \rho - \partial A / \partial \rho = -\partial A / \partial \rho < 0$.

Therefore households who would be better off renting out land will be forced to rent out less or even stay autarky due to the high restriction on land transfer (note that restriction increases as ρ is getting bigger).

Footnotes

1 In agricultural production, supervision is particularly difficult or costly due to the spatial dispersion of the production process and the vagaries of nature imply a need to constantly adjust to micro-variations of the natural environment.

2 This forces us to exclude the 142 households who reported to cultivate only one plot in 1999.

3 The latter is likely to be related to infrastructure and market, soil quality, climate, and other village level characteristics

4 As noted earlier, migration in Ethiopia is very limited, so the variable chosen is if the head of the household has ever worked outside the woreda.

5 The survey does not elicit the size of area transferred either in total or under different mechanisms and only provides space for the two most important reasons of a decrease or increase in land, respectively. As there are very few households (10% of those affected) who even give two reasons, it is justifiable to assume that households either participated in rental markets or were subject to government redistribution.

6 In order to protect the user rights of farmers, their land holdings should be registered and provided with certificate of user rights. In this regard, a guarantee may be given to the effect that land will not be re-divided for a period ranging from 20-30 years. Some regional states have already stated this aspect of the land use policy and it is a step in the right direction." (Republic of Ethiopia, 2002:p 53; italics added).

7 The survey asked whether the household's land size increased or decreased durig the last 5 years and for the main reason fro such a change this implies that households who already rented in land but did not increase the amount rented would have answered negatively to this question.

8 The only exception is Tigray where the share of households reporting to rent out is much lower than the ones renting in. Given the small sample size we cannot determine whether this is a significant deviation from national trends. Further examination of this issue with a different data set would be of interest.

9 As table 4 illustrates, results from separate equations for sharecropping and cash rent provide substantively identical results.

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Gender and Food Security

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Abstract

Food security implies access to food, for men and women as well as children, at all times, adequate in quality and quantity. It also means availability, consumption and utilization by the body. Food availability is influenced in addition to food production, by distribution within the country, food losses and the number of people, all of which determine the amount of food that an individual is able to consume. It is also a function of processing, preservation and preparation. Food consumption is in turn influenced by distribution of prepared food among family members. Food distribution within the Ethiopian family provides the least priority to women after men and children. Furthermore, the body must utilize the food eaten to ensure health. Women are involved extensively in activities that impact on food security, including, almost all aspects of food production, traditional food storage, processing and preservation, as well as food preparation. Women are producers, preservers and processors of food but ill equipped and underfed. Proper methods of food storage and preservation are vital components of food availability for consumption. Traditional methods of food storage allow attacks by microorganisms, insects and rodents. This coupled with insufficient processing practices results in massive loss of food in Ethiopia. Food processing in rural households undertaken by women involves the use of technologies developed locally predominantly manual. Food consumption is also dependent on food processing and preparation facilities and access to water, fuel and grinding mills. Water is required for drinking, washing, food processing and preparation. Women collect water from a long distance. Fuel-wood is a day-to-day necessity for all rural families, mainly for food processing and cooking. Women gather wood often from distant places. They could find animal dung in the house, but poorer families may have to collect dung from open grazing fields to produce a dried cake for fuel. This takes so much of the woman's time and energy. The impact of smoke on women's health is profound. Even though fuel-saving stoves and kerosene stoves are now available, the majority of rural families do not have access to them. They are either too expensive or have not been distributed for sale to the rural community. Foodstuff mostly cereals have to be converted into flours before baking. Many rural women have to do grinding between stone grinders, a task requiring a huge amount of energy and time. The definition of food security made at the household level has enabled to effectively include all the variables that interplay in food security, and their gender dimensions. When this was done, it became possible to examine all the steps involved from production to utilization of food by the body, and see whether men or women are involved, and recommend actions to reverse the food security problem. It has been shown that, women's decision-making capacity with regards to household income allocation on family food, and the ability to decide on family planning have a significant impact on food security of the household. Efforts to improve food security in Ethiopia should therefore seriously consider all issues cited above. Women should be considered for interventions, in the areas of agriculture, education and health sectors. Education of women has an impact on food security, as an educated woman is more likely to delay marriage, practice family planning (FP), leading to smaller family size and more available food. Women's involvement in agricultural activities should be acknowledged, to better select the type and target of agricultural assistance. This should follow a proper assessment of who is involved in what activity. Improved food processing technology at household and community

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levels would ease women's workload, and greatly contribute towards the achievement of food security. There is a loud call for modification of policy direction, and a revision of the food security strategy in light of gender.

1. Introduction

Gender is a socially constructed attribute that prescribes differentiated roles, responsibilities, expectations, norms and modes of behaviour to men and women. Gender roles are the expected duties and responsibilities, rights, and privileges of men and women that are dictated by cultural factors [1]. The roles are reflected in the different activities, attitudes, and behaviour of men and women, shaped by society; influenced by religion, economy, cultural norms and values and the political system.

Ethiopia is a heterogeneous society, composed of different cultures, languages and religions, but all having a dominant patriarchal system, imposing sexual division of labour, making women responsible for all household chores, in addition to their involvement in agricultural activities. But unlike their male counterparts women are hindered from enjoying the fruits of their contribution. As a result of this gender-based oppression and exploitation, prescribed by tradition and culture, women bear disproportionate burden of poverty.

In a document on poverty reduction submitted to [2], poverty is defined as not having enough for subsistence and is consequent to social injustice, manifested by unequal power relations and gender inequality, as a result of which women suffer the most. It is characterized by subordination or absence of decision making capacity, inadequate supply of food, poor housing and sanitation services. It is caused by illiteracy, unemployment or underemployment, low and/or irregular income, and large family size. Using these indicators therefore, and [3], as well as [4], we observe that:

- Illiteracy: Female 75%
Male 52%
- Unemployment: Female 69.25%
Male 30.75%
- Irregularity of Income: Women are engaged in petty trade a lot, often in marketing of perishing goods, such as tela, Enjera, fresh vegetables
- Land Ownership: More women than men are landless
- Large Family Size: This affects women exclusively in several ways, they suffer the consequences of repeated and frequent pregnancy, child birth and breast feeding; have to work harder to feed the large family, have to eat less to ensure that others eat.

As a result of the preceding factors therefore, in Ethiopia women are poorer than men. According to DHS, 2000 [5], The population was projected to be 67 million in July 2002, surprisingly composed of more men than women. According to DHS, this could be due to the prevailing harmful traditional practices, discrimination in food allocation, early marriage, and other practices that negatively impact on girls and women's health. As a result fewer females than males survive into adulthood.

In such socio-economic context, gender-neutral development intervention affects men and women differently. Being ill equipped with skills, suffering from time constraint, and limited access to economic resources, as well as subjected to, greater cultural restrictions than men; women do not receive equal benefit from economic development. The question of women has thus become a fundamental issue for individuals, government and non-government organizations, as well as happened to be the focus of attention at national and international levels. The core of the women's question is thus, the desire to transform the socio-economic structures, which have placed them at a relatively disadvantageous position.

Ethiopia is the tenth largest and the second most populous country in Sub Saharan Africa. The country is extremely diverse, with a reasonably good resource potential for agricultural development, but one of the least developed in the world. There is intense poverty, with 44 per cent of its population below the poverty line in 1999/2000 [6]. It is estimated that, the majority of the poor are women. The majority of the population live in the highlands, engaged mainly in farming, while in the lowlands, the mostly pastoral population move about with their livestock in search of grass and water. According to MMA [7], pastoralists occupy 60% of the territory and constitute about 12% of the total population. The majority live in regions that are least developed characterized by poverty, high level of illiteracy, inadequate infrastructure particularly roads.

The Ethiopian highlands account for nearly half of the highlands of Africa. More than four fifth of the population resides in the highlands, due to the cooler climate, greater rainfall, and lower incidence of pests and diseases affecting both humans and livestock (Pender et al) [8]. These highlands account for only 36% of the country's area, and the average density in these highlands is nearly 100 persons per square kilometre, for both urban and rural residents.

The agricultural sector is the basis of the Ethiopian economy, accounting for 46% of the GDP and 90% of total exports, and employs 85% of the country's labour force. Despite its significant potential, structural food shortages have hampered Ethiopia's economic development for the past several years, [9]. Food scarcity affects millions of people. Shortfalls in food production have resulted in widespread poverty in the country.

Rural women play multiple roles in the world's agricultural systems. Ethiopian women are involved in the entire range of agricultural activities, with the exception of land clearing and preparation (tree-felling and ploughing) which are tasks usually performed by men. They are involved in planting weeding, harvesting, threshing, processing, and storing and marketing farm products. Women perform most tasks related to animal husbandry, dairy and poultry production; but this contribution is not acknowledged and rewarded.

2. Food Security Situation In Ethiopia

Food security is **consumption** by all members of the household (men, women, boys and girls),

at all times; adequate in quality and quantity, for an active healthy life. This is in a bodily health situation, where the body utilizes the food-consumed effectively. At all times for women in addition considers special circumstances of pregnancy and lactation. This definition, which enables inclusion of gender dimensions, builds on the concept of food security that considered the household and individuals, and which was forwarded by Kifle and Yoseph, [10]. According to these authors, food security is a concept that can generally be addressed at global, regional, national, sub-national, community, household and individual levels. In the past, the concern was about national, regional, and global food security issues. Household food security is a recent and welcome development, and one, which has enabled the consideration of women in food security. The concept of food security is different from food self-sufficiency. Food self-sufficiency refers to aggregate food production, which is sufficient to feed a population. A country can be food self-sufficient, but it does not mean that the food security of all its population is assured.

Food security thus involves available food, where in addition to food production, losses and the number of people should be considered, both of which determine the amount of food that an individual is able to consume. An illustrative formula is presented below:

$$\text{Available Food} = \frac{\text{Food Produced - [Food losses (storage+processing+seeds+exports)]+ imports}}{\text{Population}}$$

Maximize Production	(i) improved agricultural practices with the use of machinery, fertilizers, improved varieties of seeds, pesticides and insecticides (requiring financial investment and education)
	(ii) Healthy Work force
Loss Minimized	proper storage, preservation and processing techniques introduced; these techniques are more vital to women who are the makers of more than 90% of storage containers, are engaged in all processing and preservation activities.
Slow Population Growth	Family planning, which is dependent on women's status, requiring the possession of the knowledge, and the ability to decide as well as availability of contraceptive facilities or services.

Food security is also a function of food processing, preservation and preparation as well as distribution within parts of the country, and distribution of prepared food among family members. Furthermore, the body must utilize the food eaten to ensure health. It is intimately related to poverty, at national, community and household levels. It has been shown that Ethiopian women are poorer than the men, and thus are more vulnerable to food insecurity.

Food insecurity in many low-income, developing countries is projected to intensify, unless agricultural productivity, foreign exchange earnings, and population growth are addressed, Shapouri and [11]. For the poorest countries, an increase in agricultural production is the key to improving food security, because in these countries, import plays a small role in domestic food supply, because of limited foreign exchange availability. Sub-Saharan Africa is the most vulnerable with respect to food security. In this region, a combination of population pressure, low and declining agricultural production, and non-sustainable use of natural resources has brought about an increasing poverty and degradation. These problems are particularly severe in African highlands, including Ethiopia.

A 1998-2008 projection for food consumption at aggregate level as well as by different income groups, for 66 countries, 37 in Sub-Saharan Africa including Ethiopia, revealed that Sub-Saharan Africa was the most food-insecure, [ibid]. Sub-Saharan Africa also suffers the greatest nutritional problems. It is the only region where consumption is projected to fall below the minimum nutritional requirement for 80% of the population during the next decade.

In Ethiopia, a combination of factors has brought about a serious and growing problem of food insecurity, [6]. Drought, population pressure, environmental degradation, technological and institutional factors have led to a decline in the size of per capita land holding. Increasing urban poverty is largely attributed to limited broad based employment and income earning opportunities in urban areas. Women who make the majority of the poor are much more vulnerable to food insecurity in towns.

Women are producers, preservers and processors of food but ill equipped and underfed. The neglect of women in agriculture, education and health sectors has been and continues to be one of the fundamental causes of food insecurity, [12]. Educated women are more likely to delay marriage, practice family planning (FP), leading to smaller family size and more available food. Informal education particularly on health ensures proper use of available food, better personal hygiene, and utilization of FP services. To reverse the prevailing situation of food insecurity, there is need to recognize a few fundamental matters, with regards to women's central position in food security.

- Women's increased risk of vulnerability to food insecurity caused by poverty arising from their low status;
- Women's vital role in all aspects of the food system;
- The need to consider women in interventions to ensure food security.
- Interventions do not lie within the food production not even the agricultural sector alone, but requires a multifaceted approach involving education, employment, family planning and other related matters.

3. Determinants of Food Security and Gender Dimensions

Several sets of variables: agricultural (food production and post-harvest management of foods); food processing; and preparation; socio-economic; growth in population; housing and sanitation as well as cultural factors are all believed to have impact on food availability and consumption, Haregewoin [13]. Although the main factors influencing food security are domestic food productions, foreign exchange availability for food imports, and population growth; distribution of purchasing power within each country also play part in determining food security [11].

3.1 Agricultural Factors

a) Food Production

Small-scale (resource poor) farmers who produce 90-95 per cent of all cereals, pulses and oil seeds, and 98 per cent of the coffee dominate the sector, [10]. Women are a critical component of rural economy and are engaged in agricultural production, [6]. They contribute significantly to off-farm production/employment, cash and food crops. Women are involved in all aspects of agricultural and livestock production, except in ploughing. Nonetheless, they lack adequate access to extension services. Livestock farmers are part of the mixed farming system where crop production is the main economic activity of smallholder farmers. Livestock is also the main resource base of subsistence pastoralists in the arid and semi-arid lowlands, [12].

The agricultural economy is characterized by wide food gap, largely due to low productivity, compounded by storage and processing losses, high rate of population growth, and workload on women. It is estimated that the average Ethiopian woman has a working day of 12-14 hours, much of it spent in hard physical labour. In the peak agricultural season, women spend up to 10 hours per day in the field, [ibid]. The heaviest workload on a woman during the pre-harvest and harvest generally coincides with the period of lowest household food availability increasing the strain on her, the situation is aggravated if she is pregnant or lactating.

The process of introducing modern technologies, in agriculture inputs, planting and harvesting or storage and marketing has not been gender sensitive. Agricultural services worked with male farmers, credit could only be extended to individuals with land titles and other collateral, [ibid].

Food insecurity is getting worse all the time, because of the factors cited, and the low status of women which has led to misdirected development programmes, that does not take into account women's vital role in agriculture. With the exception of female heads of households, women have minimum role in decisions related to land distribution and agricultural production.

b) Post-Harvest Management of Foods

Agricultural production is the key to ensure food security, through making food available for consumption and/or increasing the national and household income to enable domestic purchase and importation, [14]. Production increase alone would however not be adequate, but needs to be complemented with the employment of an integrated post-harvest technology. Minimization of pre and post-harvest losses, estimated at more than 20% due to pests, outdated implements, poor on farm transport, poor storage facilities and wastage due to traditional food processing and preservation is also a crucial element in food security, [9]. Women in the rural areas play vital roles in food production, preservation and storage, and they are totally responsible for processing and preparing food.

Food Storage

> ...So Pharaoh told him [Joseph] the dream. I was standing upon the bank of river Nile, he said, when suddenly, seven
> fat, healthy-looking cows came up out of the river and began grazing along the riverbank. But then seven other cows came up from the river, very skinny and bony. And these skinny cattle ate up the seven fat ones that had come out first......The next seven years will be a period of great prosperity throughout the land of Egypt; but afterwards there
> will be seven years of famine so great that all the prosperity will be forgotten and wiped out...
> My suggestion is that... and let the officials of these districts gather into the royal storehouses all the excess crops of the next seven years, so
> that there will be enough to eat when the seven years of famine come. .... Joseph opened up the storehouses and sold
> grain to the Egyptians and to those from other lands who came to Egypt to buy grain.
>
> **Genesis 41**

The citation in the box is an experience where by careful storing seven years' production, it was possible to feed the people for an additional seven years and more, i.e. people from outside of Egypt came to purchase grain. Thus proper storage has a dominant role in food availability.

The widespread malnutrition in developing countries is not only because food production is below the target, but also due to inefficient storage and marketing practices, [6]. Post harvest losses for cereals and pulses are significant. Storage losses are major causes of food wastage.

In Ethiopia, food is traditionally stored in granaries, mud-built silos, pottery, and woven grass, all made by women, a job that is long, tiring, and hard. The woman makes these during intervals between in-door or out-door activities. A small survey done with the students of Awassa College of Agriculture [15], to find out who was involved in making containers, processing foods, and storing them, showed that except for granaries where mainly men were involved, women did all the jobs. These traditional methods of food storage allow attacks by microorganisms, insects and rodents. This coupled with insufficient processing practices has resulted in massive loss of food in Ethiopia.

Proper methods of food storage and preservation are thus vital components of food availability for consumption. Proper storage also helps to ensure household and community food security, until the next harvest, and helps producers to hold their produce until they can get reasonably good prices for them [14].

4. Food Processing and Preparation

Women are engaged in food processing, a task that is laborious and time-consuming, especially for some foods like kotcho. Traditional techniques are inefficient, tiring, labour-intensive, which do not meet the needs of the increasing population. Processing methods used are not standardized thus affecting quality. Rural women utilize this indigenous knowledge of food processing with limited technological assistance [12]. Their limited access to appropriate food processing and preservation technologies can have adverse impact on household food security of the major part of the population, [ibid].

Although women's participation in the traditional food processing is high, their participation in food processing industries is insignificant. The food products and beverages industrial group ranks first in terms of the number of establishments in the large and medium scale category. According to the statistical survey of May 1999, compared to other industrial groups, the manufacture of the food products also ranks first in terms of the number of persons engaged. Of the total number of employees engaged in the manufacture of food products and beverages in the public and private, only 19% are female. Women's low status in education, income and time constraint for self-advancement have hindered them from participating in employment in industries. They are either unaware about them or are not given the required training, priority being given to men because in most instances men would have the necessary basic education to participate in the training.

Food preparation in rural households involves the use of technologies developed locally predominantly manual, and passed down from one generation to the next. The activity requires facilities and access to household services (water, fuel, grinding mills and other processors).

Water Supply: Water is required for drinking, washing, food processing and preparation. Women collect water from a long distance, which could take hours, and/or the source, could be unclean. An intervention that brings clean water nearer to the residence has multiple influences on food security, namely: reduction of water-borne diseases, saving in energy and time for the woman; improved personal and environmental hygiene for the community.

Fuel-Wood: Fuel-wood is needed for food processing and cooking, procured mainly by women often from distant places. They could use animal dung in the house, but poor families may have to collect dung from open grazing fields to produce a dried cake for fuel. The impact of smoke on women's health is profound. Even though fuel-saving stoves and kerosene stoves are now available, the majority of rural families do not have access to them. They are either too expensive or have not been distributed for sale to the rural community. The supply of kerosene in remote rural areas could be problematic. The ever-increasing cost of electricity, has discouraged the use of electric ***mitad*** for making enjera, and this will cause more pressure to the scarce fuel wood.

Grinding Mill: Foodstuff mostly cereals have to be converted into flours before baking. Many rural women have to do the grinding between stone grinders, a task requiring a huge amount of energy and time. The introductions of grinding mills in the community will relieve the women from this difficult task.

4.1. Socio-economic Factors

The principal focus of food security policies has been to increase food supplies; little attention has been given to unequal distribution of food as a cause of food insecurity. A review of nutritional data however shows that under-nutrition is prevalent even in middle-income countries with ample supplies, [11]. In the estimation of nutritional deficits in developing countries unequal distribution of food consumption is a concern [16].

Food intake inadequacy could result from unequal distribution of food and/or lack of education and nutrition unawareness, but nutrition awareness in the absence of economic means has little efficacy, [17]. This is supported [18], who states that while women are the main recipients of nutrition education, they do not necessarily control household income allocation. They may thus be unable to actualise the education in their purchase of food for the family [11] have found the distribution of income within countries influenced the prevalence of malnutrition. They showed that in a country with great inequality in the distribution of income, malnutrition would be more prevalent, given a certain level of food availability.

Bryceson and Huntsman have shown that misallocation even more than income influences the occurrence of under-nourishment [17]. Bryceson blamed misallocation as the main cause of malnutrition in an urban situation where often the earner, usually male, spends the bulk of the money himself rather than handing it over to the woman, who is in charge of food preparation. Men are less likely than women to spend their money on food, as the family's food need is seldom their primary concern. Women tend to spend a considerable part of the cash income that they generate from marketing activities on household requirements, [16]. Traditional food distribution within the Ethiopian family after the food is prepared provides the least priority to women, i.e. after men and children.

Legal or social restrictions prevent many women from owning or inheriting land, water rights or livestock, borrowing money or making decisions regarding the use of family assets. This has a direct and detrimental impact on their ability to manage food production and food security. In comparative studies, households in which women controlled income demonstrated better levels of nutrition. Women tend to devote a greater share of their income to food and fuel as opposed to luxury items, [9].

4.2 Growth in Population

High population growth rates are the principal factors stimulating food demand, putting pressure on food supplies. Sub Saharan Africa's population more than doubled to an estimated 527 million between 1960 and 1990, and by the year 2008 will approach 800 million [11]. This rapid population growth, in the absence of increased sustainable agricultural production is cause for concern in these countries. The decision to reduce family size however will not happen immediately. A large number of factors including religious and cultural beliefs are important determinants of a family's demand for children, and to make decision about it.

With the exception of successful family planning initiatives in Botswana, Kenya, and Zimbabwe, there is no indication of a sustained decline in sub-Saharan Africa's population growth rate. The present age composition will also lead to continued increase in population growth. Between 35 and 50 percent of the regions population is 15 years or below. In Ethiopia, 45.5% of the population is below 15 years of age [5]. With such a large percentage of reproductive age population about to enter the reproductive years, population growth will likely remain high, even if average fertility rates decline. This means there is a huge challenge ahead of us. Fertility control in Ethiopia is influenced among other things by culture, knowledge, and availability of services and the status of women. Decision making capacity plays a major role, as indicated in DHS 2000, [5] where less than 25% of women stated that using contraception was mainly their own decision, while 10% cited that the husband or partner was the principal decision maker.

One of the objectives of the ICPD-POA was to raise the quality of life and to promote human development by recognizing the interrelationships between population and development. It was also to address women's limited access to reproductive health services, including family planning. The POA acknowledges that the empowerment and autonomy of women with improvement of their political, social, economic and health status is a highly important goal. It calls for the elimination of all discriminatory practices and all kinds of violence, to ensure women's ability to control their fertility. However, the majority of Ethiopian women, who have extremely limited decision-making capacity, including the control of their fertility, do not experience these rights.

The persistence of social and cultural attitudes constrains men from sharing in family responsibilities. Men are not generally engaged in the discussion on gender equality and empowerment of women either at the community or at the policy level [21].

4.3. Cultural Factors

In most developing countries, culture influences distribution of food within families with the vulnerable categories of women and children receiving the least food. Hierarchical distribution of food is a vital family variable that affects the nutritional status of women and children. In their reproductive years, especially during pregnancy and lactation, women have specific additional nutrient requirements, which determine both their own, and their children's nutritional status [16]. These extra needs are not always recognized, and women and children suffer the consequences. For instance, nearly half of women in developing countries suffer from anaemia, which affects their health, limits their activity and greatly increase the risks that they face during pregnancy and childbirth. Their babies also suffer from much higher rates of infant mortality and birth defects.

Women are often victims of food discrimination. In many households and communities, women and girls eat only the foods that are left after the males in the family have eaten. This often results in chronic under-nutrition, [ibid]. Food avoidance and taboos are also factors that inhibit women's consumption of certain foodstuff, often the most nutritious. In a study [13], vulnerable groups of childbearing women and children were expected to avoid certain foods. The greatest consensus about food taboos were found for pregnant women where 33% of the respondents said that they should avoid milk and its products, and 23% should avoid fruits and vegetables. There was no avoidance reported for adolescent boys, adult men or sick persons.

4.4 Housing and Sanitation

Water related health problems; especially diarrhoeal diseases are major contributors to malnutrition in the young, and frequent diseases inhibit proper utilization of available food [13]. Good nutrition depends on the quantity and quality of food as well as on health. Contamination by bacteria or chemicals can make foods inedible, dangerous or even deadly [16]. Diarrhoea and many other food-borne illnesses accelerate the passage of food through the digestive system, reducing the body's capacity to absorb nutrients and increasing the loss of water and body salts. Zewditu et al [22] have shown that malnutrition results from the interaction between poor diet and disease. Where food-borne illnesses are widespread, even people who consume adequate amounts of food are frequently malnourished. Often lack of adequate water and sanitation facilities for cooking cause food-borne illnesses.

The environmental sanitation situation in Ethiopia is among the worst in the world, with only 18-24 % of the population accessing clean water [23], and 15% receiving sanitation. Drinking water quality is not adequate. Forty per cent of households fetch water from open springs, 27% from rivers and 8% from protected well or spring, [5]. Eighty two per cent of Ethiopian households do not have toilet facility. Even though urban households have better toilet facilities, a significant proportion (30%) do not have any facility at all. This means therefore, even in situations where food supply is adequate, unhygienic processing and preparation of food could lead to ill-health/ malabsorption further exasperating food insecurity.

5. Gender Perspectives of the Ethiopian Food Security Strategy

The 2002 updated food security strategy addresses causes and effects of food insecurity, targeted at the chronically food insecure, where women make the majority. Focus is on environmental rehabilitation to reverse degradation, and as a source of income generation. An overall objective of the food security strategy is to ensure food security at household level, while ADLI focuses at creating national food self-sufficiency. This distinction between household food security and national food self-sufficiency indicates clear understanding of the issue by the government.

Additional factors impacting on household food security like population growth rates have also been raised with the plan to improve family planning services. But gender dimensions of family planning have not been looked into, particularly women's inability to decide on contraception use, and the limited access to information, including radio.

The gender dimension of food production has been raised, though needs more detailing out and what it is exactly that needs to be done proposed. Agricultural extension programmes addressing women's need have not been mentioned. Many and varied causal factors of food insecurity such as food distribution within family members, resource allocation on food, household food processing and preparation, have not been treated in enough details. The issues have not been identified among the essential elements of the strategy, except perhaps the promotion of appropriate technology of household based water harvesting and conservation.

Rural credit and marketing systems need to give the required attention to women who have limited access to these services. Identification of the need to encourage grain flows from surplus to deficit areas shows that one of the appropriate steps to translate national food self-sufficiency into household food security is being taken.

Moves to improve trade, processing and distribution is absolutely vital, but needs to start with the people who have been involved in the activity thus far, namely women. This has not been spelled out in the document. Women need to be addressed in micro and small-scale enterprises. The special efforts planned to assist women in finding labour saving means to prepare food and access to fuel and water seems to focus on poor female-headed households. This of course vital, but it must be noted that the problems associated with food processing and preparations affect all women, and needs to be approached as such. The instalment of grinding mills extensively is a crucial element and needs to be given priority.

Focus in institutional capacity building on the technical vocational training should be given especially to women who must be involved in food processing industries. This is only fair to both the industry and the women. Women have been engaged in traditional food processing and feeding the population. This outstanding women's contribution to the food system must be recognized. Secondly women would be much more experienced in foods, and the industries would benefit from their input.

The strategy does not address storage loss extensively enough, though mention has been made. It should have come out as one of the essential elements of food security, next only to food production.

6. Conclusions and Recommendations

6.1. Conclusions

- Women suffer extreme poverty among the 44% of Ethiopians who are below poverty line. Gender roles have created differential treatment for men and women where share of resources and benefits between the two sexes is unequal; women as a result are poorer than men. Food insecurity is a problem associated with poverty and women are thus, at higher risk of vulnerability to food insecurity. As one of the manifestation of poverty, women lack decision-making capacity on household resources allocation resulting in incomes not being allocated for food, and in women's inability to practice family planning.

- Women are involved in the entire range of agricultural activities, but not classified as farmers, hence left out in support programmes. Much of women's productive activity is localized in the informal economy and is not represented in official statistics on food supply and movement. Recognition and adequate compensation of women's productive as well as their reproductive labour is essential to maintaining their contribution to food production and food security.

- There is a tendency to focus on increased food production, while other factors are equally important and need attention.

- The definition of food security made at the household level has enabled to effectively include all the variables that interplay in food security, and their gender dimensions. When this was done, it became possible to examine all the steps involved from food production to utilization by the body, and see whether men or women are involved, and recommend actions to reverse the food security problem.

- In a country where foreign exchange earnings are limited, food produced in country would essentially be the main source of food. Increased food production alone would however not lead to food security but together with a host of factors equally important like: proper post-

- Harvest management of foods; distribution within the country; purchasing power of families; appropriate deposition of decision making power, with regards to resource allocation; ability to control fertility; and proper housing and sanitation.

- The consequences of differential treatment of men and women, the recognition of women's contribution to food security, and their vulnerability to the problem, compels us to come up with gender sensitive intervention. Food security strategies should thus seriously consider all these relevant issues, and the gender dimensions in each one of them.

6.2. Recommendations

- Women's involvement in agricultural activities should be acknowledged, to better select the type and target of agricultural assistance. This should follow a proper assessment of who is involved in what activity. Women should be provided with extension services that are responsive to their productive needs including credit. As part of the extension programme, women must be introduced to modern agricultural technology.

- The vital role women play as food producers and their contribution to health and nutritional well being of their families and communities as well as their potential to innovate and improve their productivity has to be recognized in a policy intervention that aims at achieving national and household level food security and a sustained and balanced socio-economic development.

- The amount of food lost after production is significant. Reducing such post-harvest losses can make more food available as effectively as increasing production. Women's role in food storage activities must be recognized and any intervention must consider the role of women.

- Improved food processing technology at household and community levels would ease women's workload, and greatly contribute towards the achievement of food security. A programme to develop food technologies based on the status of traditional food processing and preservation practices at the community level is crucial to the enhancement of food security. Women's indigenous technical knowledge should form a solid base for technology development activities. Since a great proportion of women are involved in food processing, there is considerable justification for upgrading their indigenous technical knowledge in the sub-sector to meet the challenge.

- Women's education is closely related to important development issues, such as their participation in productive activities, population growth, reproductive health and health status of the family, and the education including that of girls. Thus it is vital to raise the participation of women in education, skills training to promote women's employment and earnings. Improving women's education will be crucial for maintaining food security. In addition to basic education, women should be directly targeted for training on such themes as agricultural production and resource management and conservation.

- Access to family planning services is an essential component of food security. Whether or not women can control the number and timing of their children is crucial in determining both their level of nutrition and the amount of free time that they can devote to food production and preparation. Women should be enabled to exercise their fertility control rights. Reproductive health information must be made to reach them.

- Improving food safety can be achieved only by taking into account women and men's roles in producing and processing food. As women do most of the cooking in their homes, education about hygiene and sanitation needs to target them. Policies that take account of women's key roles in preparing food and collecting water and fuel can simultaneously reduce their heavy workload and improve their families' nutrition Provision of water sources and alternative sources of energy for cooking is essential. Grinding mills should be installed in communities, where women can have access.

- "Gender and Food Security" should be taken up as a theme, and a similar forum to this one created, where the issue will be addressed from different directions. This will enable deeper investigation of the issues and come up with appropriate intervention strategies. This hopefully would influence policy direction, and a revision of the food security strategy in light of gender.

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Land Tenure Links to Resource Degradation: The Case of Central Ethiopia

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Abstract

This article attempts to explore the links between land tenure and resource degradation during the present regime in two Kebele Administrations (KAs) of Central Ethiopia, located at about 65 km south of Addis Ababa, at two sequential levels. First, at a general level emphasising agrarian and rural development dynamics. Second, in the specific contexts of the prevailing socio-economic statuses of peasant households concentrating on land tenure insecurity, resource extraction from peasants and poverty. Evidences show that insecurity of land tenure is less painful to the rich than the poor, although the constraints imposed by such insecurity on tree planting and soil conservation are considerable. Peasants refrain from emphasising long-term use of land resources and concentrate on short-term gains. This 'short-term sightedness' is mainly manifested by the poorest section of the peasants. The emerging land-use dynamics such as sharecropping, land lease and sale have not been legalised and therefore the conditions under which they are practised remain destructive to land resources. Resource extraction from peasants has been both the cause of poverty and an impediment to improve production technology in turn shaping the patterns of resource uses, conservation and management. The severity of resource overexploitation stemming from resource extraction is much more pronounced in the case of the most impoverished category of peasants, providing empirical confirmation to the belief that poverty leads to resource degradation, the environment.

As a whole, many peasants express resentment about state landownership and suggest that the government should not necessarily be the owner of the land, but rather an outside actor, to facilitate and guard ownership rights and take action if necessary. State landownership is seen as a challenge to their autonomy, needs, interests and long-term conservation of land resources. The degree of this varies across peasant socio-economic categories. The convergence point as to the required type of land tenure needs to reflect varied socio-economic stances and the different kinds of uses to which pieces of lands are put, which means multiple tenure systems: private, group/communal and possibly state ownership. This in turn appears requiring cadastral survey and a restructuring of the agrarian economy.

1. Introduction

After the fall of Mengistu's government in May 1991, Ethiopia assumed a different form of government structure on the basis of a more or less ethnic-based federal state. Between 1991 and 1994 the government was in transition and the present government was formally structured in 1995 on the basis of a new constitution.[1] The constitution keeps the land under state control giving peasants only use rights. Actually then, the previous type of state land ownership and the same type of local level peasant structure persist denoted as *Kebele* Administration (KAs), replacing the previous Peasant Associations (PAs). It is often argued that the persistence of state land ownership allows the continuation of the problems of resource use and conservation and creates links to resource degradation (RD). On the basis of this, this paper intends to explore the links between land tenure and RD during the present regime, at two sequential levels; at a general level emphasising agrarian and rural development dynamics, and in the specific contexts of the prevailing three socio-economic

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categories of peasant households concentrating on tenure insecurity, resource extraction from the peasants and the expanding poverty. This article is divided into six sections. The introductory section provides a brief note on the nature of the paper. Section two gives a brief history of the land tenure and RD in Ethiopia while section three deals with background information, concepts and definitions of terms used in the article. Section four highlights the macro issues of the prevailing agrarian and rural development dynamics and its links to RD, and section five presents the micro issues of peasant differentiation and the resulting differential impact on the conservation and management of land resources. Section six concludes the paper.

2. Land Tenure Systems and Resource Degradation in Ethiopia; A Brief History

2.1. Land Tenure Systems

Ethiopia survived semi-feudal land tenure systems for decades in which landlord-tenant relations predominated. As a result of land tenure related problems, the land use issues were one of the leading questions of socio-economic and political developments of the time. It came as no surprise during the 1960's and early 1970's when the land question became bedrock of the Ethiopian Revolution tuned to the slogan 'Land to the Tiller.' The well-known radical land reform proclamation of the 1975 was basically meant to redress the landlord-tenant relations and the political system on which these relations anchored. It was a reply to the long-lived agony of the rural majority. According to article 3.1 of the Land Reform Proclamation (No. 31 of 1975), 'all rural lands shall be the collective property of the Ethiopian people.' This proclamation gave the peasants only *possessory or usufractuary* rights on the lands under cultivation and PAs, organized on 800 hectares of land, were given the power to carry out land 'redistribution', even then '... with the solicited assistance of the government ...' (article 10.1). It was on the basis of this rights and power premises that peasants had not been given the right to own land. This process, besides the close association of PAs with government and party structures, further intensified this disallowance and widened the gap between the government and peasants recreating similar conditions prevailing during feudal Ethiopia [1,2,3]. The institutionalization of state land ownership had been used as basis to design, introduce, implement and strengthen various policies intended to bring about the transformation of rural Ethiopia to agrarian socialism. State Farms and Agricultural Producers' Cooperatives (PCs) were in the forefront of the intended transformation. The ultimate objective of these policies was to extract more agrarian surpluses [4]. Resettlement and villagization schemes and State Agricultural Marketing Corporation were also planned and implemented mainly by relying on land as effective institutional strategy. However, these approaches to rural transformation were not effective. Land use insecurity, the extraction of peasant resources, the inefficiency of state and PC farms became evident eventually forcing the government to make *a reform of the reforms* in March 1990. One of the tasks of the reform was to lessen the impacts of the previous policies on the peasants by [1] providing land use security by halting the often practiced land redistribution, though land was to continue under state ownership, [2] deregulation of state agricultural and other marketing organizations, and [3] dissolution of PCs. Nevertheless, *Derg* was not fortunate to witness the effects of the reforms as it was overthrown in May 1991.

2.2. Resource Degradation

One of the formidable issues Ethiopia has been confronted with for the last several decades is the problem of RD. These problems appear to have been much pronounced in the Highlands. Paradoxically, there is still a widespread belief that the Highlands contain adequate fauna and flora, dependable soils and climatic conditions conducive to attain high levels of agricultural production although, in the course of time, the Highlands have become the most degraded area in Africa if not in the world [5,6,7]. There are adequate evidences that lands have been denuded of forests and trees, soil erosion has already reached catastrophic proportions and drought and famine have taken the lives of hundreds of thousands and millions have been hard-hit. Writers have explained the process of RD, particularly its causes, in different and conflicting ways, in part being driven by, arguably, ideological inclinations, disciplinary/theoretical backgrounds and the levels of comprehension of the intricacies involved in the process. The often-hypothesised causes of RD revolve around population growth, agricultural production practices, physical/geological forces, wars, political instability and land tenure systems, among others. As a result, there is confusion and disagreement as to the main causes of RD in Ethiopia and therefore a reliable explanation(s) on the basis of which policies are formulated has not been easy to obtain.

3. Background, Concepts and Definitions

Bruce and Colleagues' general note quoted at the beginning of section one appeals not only to polities and economies of African nations alone but also to natural resource uses and the environment as well. It even appeals more to nations where land forms the major source of the economy and provides a means of livelihood for millions. In fact, the following sources provide vivid cases about this. Everywhere, evidences indicate that landless peasants who share their harvest with the owners of the land hardly invest in land improvement measures [8]. Similarly, temporary land users cannot have the motivation to invest in activities whose benefits are likely to be realized long after they have left the holding [9]. There is a revealing illustration of the significance of land tenure in resource conservation under all circumstances [10]. Those who live at the edge of poverty would naturally prefer short-term benefits [11].

In the Ethiopian case, land tenure systems are, as mentioned above, believed to be one of the leading causes and triggering forces of RD. It is long recognized that tenure insecurity[2] creates and escalates resentments among peasants in the conservation of land resources [12,13]. It is also well-documented that land use related extraction of financial, material and human resources by the landed classes (state) from the landless tenants/peasants have been forcing peasants to intensify production and exploit land resources [14,15]. Likewise, a World Bank Mission to Ethiopia concluded that land tenure system helps assure that the peasantry will follow and perpetuate - because he/she has no incentive not to - those defective agricultural practices - lack of soil and water conservation, lack of afforestation, lack of crop rotation, lack of fodder and stock control, etc., which encourage ecological crisis [5]. These observations precisely inform the importance of land tenure in shaping resource conservation and management practices as well as environmental sustainability.

Prominent terms often employed in this article namely *resource - environmental - degradation*, *land tenure*, *peasants and households* deserve particular definitional perspectives reflecting both local situations as well as theoretical orientations. *Degradation* implies a 'reduction to a lower rank. The rank is in relation to actual or possible uses' [16]. However, a reduction in capability means different things to different people and hence degradation is a perceptual term. On the basis of this RD is simply defined as a decline in the accessibility/availability and indeed in the productive capacity of land resources (forest, soils, grasses and grazing lands).

In relation to *land tenure* – various tendencies do exist to treating land tenure and land usage as interchangeable expressions. The word tenure comes from the Latin word *tenere* which means to hold and hence land tenure is the holding of rights by individuals or groups in the ownership or use of land [17]. In the context of Africa, Okoth-Ogendo [18] defines land as 'all things that were attached to the land in such a manner as to be imbedded into it, and all things that were found under the soil' and tenure as 'the ultimate form of political control over land so held.' Bentsi-Enchill's [19] definition reads as 'land tenure systems represent relations of men in society with respect to that essential and often scarce commodity, land.' Likewise, Bruce, *et al* [20] sees land tenure as a bundle of rights held by a private or public entity in land. Admittedly, all definitions must have specific context and spatial dimension and therefore may not precisely imply the same meaning for different people. However, this paper pursues the broad definition of West [21] who states land tenure as 'socio-political relationships between man [sic] and land and between man and man in respect of land' and 'the whole pyramidal power structure relating to land: a power structure which governs access to natural resources which molds the incentives, opportunity, equity and reward patterns in land use ... which determines the shape of many socio-economic institutions and relationships in land-based societies.' This long definition portrays an array of relations between state and people and between people in using land resources and the role of political structure, which safeguards the interest of the state and the landed class invoking actions and reactions of the landless and the land insecure people as a result.

The conceptual frame of this paper falls within the configurations of political ecology, which combines the concerns of ecology and a briefly defined political economy together encompassing the constantly changing dialectic between society and land-based resources including classes and groups within society itself [16], and the property rights paradigm which handles the question of land ownership rights. Also, as Bryant [22,23] endorses, political ecology gives a fuller grasp of the relationship between ecology and political economy in dealing with the interactions between society and land resources. The smallest unit of analysis in this paper is a peasant household. For simplicity purposes, the following definitions of peasants and households are adapted. Peasants are defined as households who drive their livelihoods from agriculture utilizing mainly household labor, and engaged rather partially in input and output markets, which are often imperfect or incomplete [24]. Likewise, households are defined as a group of individuals who live on the same farm, work together and recognize the authority of a head of the household [25]. It is within this framework that this research was carried out on 171 peasant households in two villages – Bayegiche and Kersaa Lemmaan - of Kersaa and Qondaltitti district, Western Shewa Zone, of the Oromia Regional State located at about 65 km south of Addis Ababa. Database was generated through a combination of methods including household survey, literature survey, life history studies and discussions with the key-informants.

4. The Prevailing Agrarian and Rural Development Dynamics

One of the crucial issues for Ethiopia, as for any other agrarian-based economy, is not actually the change of governments and the often accompanying 'terminology' that count; rather the strategy adopted to address the agrarian question focusing on land tenure and evolving state–peasant relations and related policies. The question is, then, whether the new government initiates sensible changes to overcome or at least alleviate the prevailing agrarian and rural problems, improve the lives of peasants and contain RD. In this regard, one may inquire into the emerging elements of state – peasant relations and their impacts. A brief account of these relations is attempted in the following sections.

4.1 The Question of Land Tenure - Assessing Developments

After seizing power, the present government was confronted with a number of socio-economic and developmental problems and questions. The question of land tenure was, and is, one of the contentious issues that need to be dealt with foremost. The World Bank/IMF and other donor and lending organisations partly or even mainly imposed the economic liberalisation experiment

Ethiopia is undergoing at present, and land tenure was/is high on the agenda in the makings of economic liberalisation. Knowing that the land tenure question in Ethiopia would inevitably provoke political, economic and social problems and contradictions, as it did during the past regimes, the Transitional Government (TG) remained silent and seemed even reluctant to handle the problems of land use. Nevertheless, KAs were under constant pressure from the youth, ex-soldiers and other returnees clamouring for a piece of land. Lately, KA leaders were instructed to allot land only to the ex-soldiers even if the KA had extra land. However since land has already become a scarce resource only few ex-soldiers benefited. On the other hand, the previous regime had carried out minor reforms related to land tenure in its March, 1990 economic reform, hence the TG was pre-empted and lacked space to intervene in the existing tenurial arrangement. In the first draft of its economic policy document, the TG tended to preserve the decision on land to the government to be established after the transition period [26], which was followed by the second draft of this same document indicating that the specific form of the tenurial system would be decided by a national referendum [27]. Theoretically, it was to be decided by the public as indicated in the final draft of the constitution [28]. The successive policy documents reveal either the TG's fear of the complexity of the land tenure problems, or its desire to institutionalise existing state landownership and impose similar policy imperatives over the peasantry in a similar way, as did its predecessor.

In the early years of the present government, as it is today, there was a debate in academic and policy circles on the kind of land tenure Ethiopia may need to introduce. Some argued for community ownership rights such that rights of use and transfer reside in the individual land user, while the management and regulation of the land remains the responsibility of the community. This was referred to as *associative ownership* and its main intent is to avoid state ownership of the land and curtail state influence on the peasants and thereby safeguard and promote peasant autonomy [29]. Later, Dessalegn [30] argued for the reformation of the public ownership of land, advocating for private tenure. Others have argued in favour of a tenurial system that would allow a free and active land market [31], and the rest recommended private landownership (Ethiopian Forestry Action Programme (EFAP) [32]. Hussein [33] argued that available empirical knowledge about the existing public land tenure is too thin to provide evidence to make conclusive judgement: whether it is inferior to private tenure, and went on suggesting the need for thorough studies. Very recently, Degefa [34] documented the expectations of peasants to access land through land redistribution: that is the need for the continuation of the public ownership of land, an indication that the land q1uestion has not been resolved. On the whole the arguments appear to converge on and address the problems of tenure insecurity, fragmentation of farmlands and resource degradation processes, and attempt to suggest ameliorative strategies. Notwithstanding the above debates and the rationale behind them, and the disreputable actions of the previous regime, the present government retained state/public ownership of land and gave peasants only usufruct rights.[3] As stated in the new constitution [35]:

> The right to ownership of rural and urban land, as well as all natural resources, is exclusively vested in the State and in the peoples of Ethiopia. Land is a common property of the nations, nationalities and peoples of Ethiopia and shall not be subject to sale or other means of transfer. (Article 40.2)

This article of the constitution reiterates the central focus of the present land tenure system. Undoubtedly, the contention of the present government is, similar to its predecessor, that if individual peasants are allowed to have private ownership of land, dire necessity would force them to sell, which would turn them into tenants and repeat the agrarian structure of the pre-revolution period. This may be construed as denigrating the decision-making capacity of the peasants and downplaying their autonomy and interest. Surely, the constitution facilitates preconditions for private entrepreneurs to invest in agricultural enterprises [36], and the creation of state–peasant relations in line with the principles of market economy. As stated in the constitution:

> Without prejudice to the right of nations, nationalities, and peoples to own land, government May grant use of land to private investors on the basis of payment arrangements established by law. (Article 40.6).

This article guarantees both individual land users and investors rights to use land, although it does not mention security of use. Whatever the case may be, contrary to various programmes that displaced millions of peasants without any compensation during and prior to Mengistu's rule, the constitution seems to provide guarantee that:

> All persons who have been displaced or whose livelihoods have been adversely affected as a result of State programmes have the right to commensurate monetary or alternative means of compensation, including relocation with adequate State assistance. (Article 44.2).

Except for the addition of this explicit guarantee, the present government retains most of the March 1990 policy reform announcement made by Mengistu in relation to land tenure. This announcement allowed individual peasants to (1) make production and marketing decisions, (2) pass land to heirs, (3) hire labour, and (4) private ownership rights to vegetation, trees, physical and resource improvement structures. These rights are practised at present, and hence there is no particular issue that confers special merit on the EPRDF government, except for the right of peasants and pastoralists not to be evicted from the land (see article 40.4 and 40.5 of the constitution).

Seen in historic terms, all regimes make relentless efforts to capture the peasants, and the land question has always been at the centre of Ethiopian politics. It is through allowing and disallowing access to land that policies have been conceived, designed, planned, introduced and implemented to assign the land for various purposes. This has been made possible through evolving state–peasant relations intended to capture and control the peasants. Although the political cosmetics tend to differ, the present government retains the land tenure system of the former regime, that is, state landownership. An all-round attempt to capture the peasants indicates the continuity of one of the main characteristics of the previous regime in spite of the recent unprecedented socio-political changes that appear to abolish previous mistakes. Whether peasants become enthusiastic about the presnt land tenure policy which would guarantee only use rights and rights on its produce as Cornea [37] notes, or which ensures the flow of the benefit stream to individual private peasants as Bromley [38] puts, is a question yet to be answered. The issue at stake in rural Ethiopia remains to be one of enabling - empowering - peasants to deploy their time, energy and material resources to increase agricultural production, improve resource conservation and management and contain the agrarian problems.

4.2. The Package Approach

A notable feature of agrarian policy of the government regarding state–peasant relations is the attempt to increase the production of certain crops through the 'package approach'. This approach contains a list of seeds (improved or hybrid), and instructions concerning the time of planting, soil types, qualities and methods of ploughing, type and rate of fertiliser application and similar agronomic practices. On the basis of past performance, peasants are selected and farmland identified to plant seeds under the strict supervision of extension agents. What appears significant however is that peasants are allowed to take the seeds and fertiliser on credit, but the cost of these inputs and the interest rate is high. And uncertainties abound about the future harvest since a minor deviation from the 'scientifically recommended' operational farm requirements could jeopardise actual harvesting, which is likely to happen given the nature of peasant farm management practices and agro-ecological uncertainties and constraints. This uncertain and constraining world has reduced the accessibility of the package approach by poor households.

The experiences at the research KAs are encouraging and discouraging; encouraging because for some it is a good harvest, discouraging because for some it is a total crop failure. Since the package approach requires good land, proper ploughing and soil preparation, timely planting and the use of expensive seeds and fertiliser, crop failure becomes disastrous and unrecoverable given the subsistence (or vulnerable) nature of the peasants. On the other hand, some improved seeds are alien to the Ethiopian food traditions and an increase in production on specific farm plots at present could not generate demand and hence rewarding price. Similarly, peasants are brought close to the global marketing and pricing systems through the use of these fertilisers and seeds. Local agro-ecological conditions and the survival of the peasant households in cases of crop failure need to be adequately studied and environmental consequences should have been analysed with caution before the approach is adopted.

4.3. Land Taxation or Peasant Taxation?

Taxation also sets in another aspect of state-peasant relations. The government undermined to collect taxes and other payments during the first two years of its rule, which made the peasants feel free from any form of government obligations and therefore many became reluctant to think about it. Needless to say, it was due to the political climate of the time, which made it difficult for the government to force the peasants to pay taxes. Hence, the silence seemed intentional. Nevertheless, when asked to pay the previous two years' overdue taxes peasants felt uncomfortable, they had to pay and remain indebted, some had to sell animals and/or deplete their savings.

The procedures by which peasants pay taxes are well established. In contrast with the previous regime, which relied on land tax and agricultural income tax floating for a number of years, the present government depends upon an annually fixed amount. This fixed amount includes, implicitly, the two kinds of taxes established during the previous regime. According to the new constitution 'States shall fix and collect fees for land usufruct rights' (article 97.2), and 'States shall levy and collect taxes on the incomes of private farmers' (article 97.3). Each regional state is therefore mandated to fix the tax to be collected and hand the task down to the zones. The zonal offices in turn break down the total amount assigned to them

In to district and KA levels. Once the total amount of taxes a KA is obligated to pay is known, the executive body of the KA works out the amount each peasant pays.[5] In general, individual payments (and the sum delivered by the KA to district office) have been increasing thereby impacting on household savings. Since saving is getting more difficult, peasants are forced to remain subsistence producers with all its characteristics.

4.4 The Evolution of 'Landlord–Tenant' Relations – Land Marketing?

Slowly evolving 'landlord–tenant' relations persist in the KAs, possibly as elsewhere in the country. These incipient relations began during the revolution period and evolved over time. The land reform proclamation of 1975 abolished such feudal relations and disallowed any form of rental arrangement on land, including hiring labour. However, these relations have been practised secretively since the Revolution. The basic principles governing the operation of these practices are similar to that of the pre-revolution types in the sense that (1) agreements are oral, (2) arrangements are based on the output of the land, and rents vary depending on the contribution of each party to the production process, and (3) an element of tenant insecurity prevails. One fundamental factor that makes the current relations different from the old types is the fact that landlords are less endowed than the tenants in terms of labour availability, oxen ownership and similar resources necessary for agricultural production. In other words, the former are unable to cultivate their own land, constrained by labour shortages due to age, gender and health problems or lack of oxen and financial resources. In terms of age category, the landlords are older than their tenants which as a whole indicates a certain degree of intergenerational contradiction on the allocation and use of land. And relatively many women (elderly, widowed or divorced) are becoming landlords. Another factor that differentiates the present practices from the old types is the relations between the parties involved. Nearly all arrangements are made among closely related peasants either in kinship or strong social ties, as a mechanism to avoid conflicts and legal cases. The rental arrangements vary according to the contributions of each party, though the minimum rent is 50 per cent of the total harvest. Despite the involvement of close affiliates in this business undertaking, the prospects of tree and soil conservation have been thin due to high rates of rents and some sense of land-use insecurity.

Short-term land leases are often made for one, two or three cropping seasons. This land-use arrangement involves financial transactions, not grain sharing, and the leaser neither participates in production activities nor in decision-making processes, which makes the lessee more independent than the present-day 'tenant'. And payment is made once or every cropping season. The social background of the parties involved in land lease arrangements are similar to those involved in 'landlord–tenants' relations, as is the implication of these practices for resource use. Interestingly, the current land marketing/sale, however illegal and hidden it might be, has become an element of the dynamics of land transactions and uses. The extent to which peasants buy land in a completely uncertain situation, the price of a unit of land, the social background of sellers and buyers and the future direction of this land-use dynamics and the implications for socio-economic conditions and resource conservation and management are important subjects needing detailed knowledge and policy considerations.

4.5. Peasants' Terms of Trade

A cause of much concern for peasants is the escalating prices of goods, both for immediate consumption and farm production as the aftermath of all forms of state-peasant relations. During the previous regime, peasants had been protected from the savagery of merchants by a government-controlled pricing system in which service cooperatives played important roles. Since the economic reform of March, 1990, governmental marketing organisations were deregulated and private traders have become important actors in the whole marketing system leading to a three to fourfold increase in the prices of commodities; prices of agricultural products have not increased by the same magnitude. Pausewang [3] too, notes that peasants' terms of trade have deteriorated since economic liberalisation policy has been introduced. Expenditure items like school fees and medication have become increasing. In general, the new economic liberalisation policy has done away with the market protection and price subsidy put in place by Mengistu's regime (for oil products, fertiliser, medication and improved seeds), and subsistent peasants have been brought closer to fluctuating and rising global prices. The overall impression of the peasants is that things have changed with regard to subsidy undermining their interests.

4.6. Landholding Patterns

Comparison between aggregate and local averages in landholding patterns shows significant differences. At the national level, cultivable land per household has declined from 1.8 to 0.8 hectare in just ten years, between 1988 and 1998 [39], and an average of 0.87 hectare is registered in 1997 [40]. With a density of 1.1 people per hectare, and a 12.71 *karti* (1 *karti* = 0.25 hectare) or 3.18 hectares of cultivable land per household, the research area seems to be sparsely populated. Nevertheless, since land is not equally distributed due to variations in household sizes, fertility of the land and its accessibility, the average sizes of cultivable lands per rich, middle and poor category have been in the order of 3.8, 2.88 and 2.21 hectares, respectively. About 38 per cent of the peasant households in the research KAs are landless, and it is obvious that the sizes of these average holdings would significantly decline if this landless group were allotted lands (Table 1). Average landholdings in the research areas are far above the national average and relatively land is not scarce, if one needs to rely only on the size of land.

Table 1: Population and Household Sizes and Densities per Total and Cultivated Lands (1997)

Description	Male headed	% of total	Female headed	% of total	Total
Taxpayers	224	51	52	12	276
Non-taxpayers	166	38	-		166
Total households	390		52		442
Average size of households	7		7		7
Total population					3094
Total land size					1760
Density of people per hectare of land*					1.1
Total cultivable land					827.2
Density of people per hectare of cultivable land*					2.34

* Non-taxpayers are not included in the division of land.
Source: Research Household Survey

5. Peasant Socio-economic Differentiation and their Differential Impacts on Land Resources, the Environment

As a natural sequel to the preceding general observations and argumentation, it is fitting to analyse the consequences of turning the largest rural resource – land – into state property and in relation to recent changes in the rural milieu. Thus, in the following sections, I will attempt to analyse the effect of these processes on resource conservation and management. First however, I need to identify the socio-economic differences among peasants.

5.1 Peasant Differentiation

Peasants have never been homogenous and uniform which is rooted in social and structural forces, and their internal differentiation plays a crucial role in the ways they were, are, remain and how they make decisions. It is a socio-economic dynamics. The word differentiation signifies differences in social status and is not static, timeless, feature. Regarding this it became necessary to work out relevant, reliable, wide-ranging criteria. The first step towards that end is to make an assessment of the nature and magnitude of resources and income sources the survey households possess. Then I identified land, livestock, and household labour, and farm and non-farm income-generating economic pursuits. As Longhurst (41) notes, a better approach in this regard is to inquire about and identify selected assets and major income sources principally useful for the households. However, each of these assets and income sources entail specific constraints and turned out to be inappropriate criterion to help us carry out socio-economic differentiation of survey households. A closer examination of all these resources and income sources was required. Variations in the quality of the lands, and locations, the importance of different types and classes of animals, household sizes and the capacity to use available labour, inability of the peasants to keep farm records showing income and expenses, the significance of off-farm or subsidiary economic pursuits as much as agricultural activities, among others, were issues to examine in detail. Hence, there was a real need to deviate from the traditional practices of socio-economic differentiation. Eventually, I decided to rely on locally established valuation criteria regarding the socio-economic position of each peasant. In other words I have depended on the *value judgements upheld in the community*. KA executives, key-informants, knowledgeable and elderly people were consulted. However, this differentiation exercise on the basis of value judgements is supported by information/data on resource endowments and sources of peasant households. In addition to real assets and income-generating activities examined, these information/data included the capacity of peasant households to use own seeds, buy fertiliser and pay for schooling and medication, rented land and labour or lease in or out land (see Table 2). These are principally meant to complement the perceptions and value judgements of the peasants. Size of resources and income sources overlap and create difficulties for comparisons of peasant households. With this understanding and a series of discussions held with the bodies identified above, I ultimately differentiated survey households into three categories namely the rich, middle and and poor. This method is supported by Scoones (42). As depicted in Table 3, at present about 45 percent of survey households are perceived to be rich followed by middle, 36 per cent, and poor, 19 per cent, out of 171 survey households.

Table 2: Resource Endowments and Sources of Income for the Three Socio-Economic Categories of Peasant Households (1991–1997)

Resources/Sources of Incomes	Rich	Middle	Poor
Land (ha)*	1.5–6.25	0.5–5	1–3.75
Household size**	2–9	1–13	1–9
	(1–5)	(1–10)	(1–5)
Oxen	2–4	1–3	0–2
Food availability	Sufficient	depends on weather	Deficient
Schooling fees	Pay	depends on income	few pay
Inputs – seeds	Yes	yes/no	No
– fertilisers	Yes	No	No
– medication	Yes	yes/no	No
Arrangements	hire labour	rent in land	rent out land
	rent in land	lease out land	lease out land
Subsidiary Incomes		Firewood & charcoal	casual employment
			firewood & charcoal
			local brew

* Only fields under cultivation are taken into account.

** Figures in parentheses refer to available household labour. Also, household size and number of oxen are related to the 1997 production year.

Source: Research Household Surveys, Key informants and KA Registration Books.

Table 3: Socio-economic Categories of Peasant Households (1991–1997)

Category	Households	
	Number	%
Rich	78	45
Middle	61	36
Poor	32	19
Total	171	100

Source: Research Household Surveys

The following sections will take up the three socio-economic categories of peasants and analyze the consequences of the present land tenure system and the extent to which each category exploits and conserves available resources. I concentrate on assessing and measuring the attitudes, perceptions and reactions of the three socio-economic categories of peasant households to land tenure, including land-use insecurity, resource extraction and the expanding poverty and how these have been shaping, effecting and crystallizing the interactions between the peasants and available resources such as farmlands, grazing lands, woodlands, and trees and how these interactions impact on resource base, the environment.

5.2 How do Rich Peasants Manage Resources?

The largest proportion of the survey households consists of – relatively – rich peasants. This category is dominant in terms of size and economic status. Although individual variations as reflections of specific household characteristics are the rule rather than the exception, the rich have the capacity to influence the decision-making parameters on many contours of community practices and actions, including agricultural production and resource conservation and management.

In relation to the perception of the security of the present land tenure this category appears to hold two diverging points of view. On the one hand, there is a feeling of better security as compared to the past regime, though not different from the last two years, and there is a pervasive need to capitalise on this *felt security*. Therefore, some still *hope* that the government will continue endorsing private ownership rights to land. This perception of hope about the security of the land is advanced by the most comfortable group of this category (comprising about one-fifth) having fertile and adequate land as well as better income. Others holding relatively infertile and inadequate land as compared to the above still feel uncomfortable with the existing landholdings. They appear to advocate a broader view of the patterns of land redistribution among peasants and point out the inequality of holdings. Specifically, they express sympathy to the landless youth that depend on their parents' land or sharecropping arrangements with other peasants. But they are not prepared to give up some of their land or ready to accept new land redistribution. On top of this, there is a general concern that the government may reinitiate rural cooperative societies in which, as the experiences of peasants show, land becomes the first asset to be pooled and put under common ownership and management. Not truly aware but wary of the nature of these cooperatives, these peasants seem to believe that the future is gloomy, and they have little faith in the security of land use and investments in resource conservation and management.

On the other hand, learning of the consequences of the new land redistribution programme launched in Amhara Regional State in 1997, which induced feelings of hostility and insecurity among the peasants in the region, rich peasants in general expect the inevitability of land redistribution. Current KA leadership consists of landless youth. Their discontent and expressed need for redistribution once and for all has inculcated more land-use insecurity among those who hold relatively adequate land.

Nevertheless, over 88 per cent of this peasant category has already planted Eucalyptus seedlings, 513 plants per household, around homesteads. This is an initiative of an NGO called Farm-Africa.5 Some peasants have also established small-sized Eucalyptus 'woodlots.' This tree 'plantations' make homesteads greener and livelier than the surrounding areas; particularly farmlands and grazing areas. In a manner comparable to how the people of Guinea have created 'forest islands' around their settlements in the savannah (43) so peasants in the present research area have created tree resources around homesteads which, over a longer period, will mean more people, more trees around homesteads. As many respondents suggest, tree planting around homesteads is not affected by the existing land tenure insecurity and the purpose of these trees is not actually to rehabilitate the forests, soils and the environment, but is only meant to supply wood products for construction and firewood. Only a few indicate that they have installed soil conservation structures on farmlands located very close to the homesteads.

Rich peasants are particularly worried about the rising cost of land tax, credit, and interest. The latter is related to improved/hybrid seeds and fertiliser provided by the government as part of the current package approach. Respondents indicate that the prices of these farm inputs as well as the rates of interest have been increasing overtime. Although most peasants in this category avail themselves of the new rural policy, they are uncomfortable with the package approach which in case of crop failure offers no dispensation from paying land tax, credits and interests and hence can be disastrous, given the low level of savings of the peasants particularly to those who are economically more vulnerable.

Land tax is levied on the basis of estimated annual crop production. However, these estimates are superficial in that they fail to reflect the actual quantity of production. Often, the total cultivable land under the jurisdiction of a given household is counted to estimate total production, but the whole area is not necessarily under cultivation, nor is all land equally productive. The leaders of the KA assess and estimate the quantity of grain produced by the peasants. Individual peasants are seldom consulted, and what peasants are reporting is seldom considered acceptable. In some situations there could also be underestimation of the taxes. In all cases, existing procedures of pre-collection tax assessments are unrealistic and ineffective, and peasants feel that they are paying more than they should. Occasional contributions to the KA and other organisations are another dimension of the process of resource extraction from peasants. Hence, about 67 per cent of this category feels 'very strongly' about this extraction, while 21 per cent feel only 'strongly'. The rest do not feel the pain of this resource extraction.

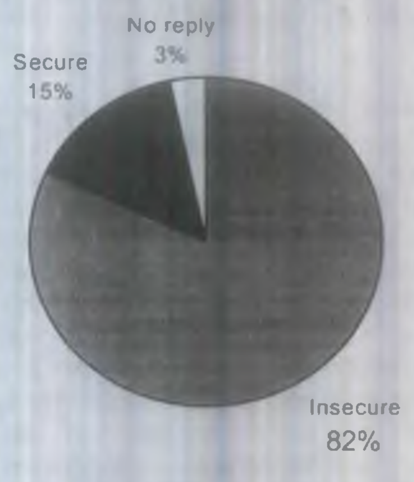
Another interesting characteristic of this rich category pertains to its involvement in sharecropping arrangements, leasing in and buying lands. These are new but steadily growing tendencies in land-use patterns and hidden transfer of land-use rights carried out between some of the rich and the poor peasants. About 22 per cent of the peasants have entered these newly emerging local resource-use dynamics which is actually an outcome of already established socio-economic differences among the peasants. What matters is not so much the growing differences in socio-economic status and the problems of polarisation that may evolve over time, but the immediate implication of this process to resource conservation and management. The newly evolving land-use dynamics are prompted by the economic necessities of the rich and poor peasants, necessities that they have to meet by producing more in a short period of time. Up to now no conditions are placed on the use of land resources in the case of leasing in land. As a result of short-term needs and actions, trees, bushes and soils have been already subject to over-exploitation and degradation.

Those who belong to this category have the impression that resource conservation is something they can afford only after a better standard of living is attained. About 90 per cent of these peasants believe that conservation of resources is like saving money: to save you have to either impose austerity measures or produce more than you consume. Given subsistence-orientated peasant production, imposition of restraints on consumption will have a negative effect on health and hence is not appealing, and production has not yet exceeded consumption. Either way, they cannot put away savings and are unable to make necessary efforts to plant trees and protect soils, meaning they do not engage in resource conservation undertakings. Peasants understand resource conservation as meaning saving in the literal sense: put money in the bank and get interest on it. As the local saying goes *jiregni manaa yo baredee kan alaas ni bareeda* (improvements in domestic conditions will surely bring improvements to the fields) (Keloo Dogdaa, 69, January 20, 1997, Kersaa Lemmaan KA). The problem is however whether improvements in living standard can precede improvements in the ways resources are being used. Besides improvement in income and living standard, land use insecurity is mentioned time and again and the question of lack of a clearly defined future ownership of land resources as a by-product of state landownership is consciously related to the complex issues of resource conservation.

5.3 How do Middle Peasants Perceive Land Tenure and Resource Conservation?

In terms of sheer size the 'middle' category of peasant households constitutes about 36 per cent of the survey households and is dominated by young peasants. This category is intermediate between the rich and the poor and shares some basic features of both categories. It also exhibits specific characteristics. Compared to the rich, these peasants are more susceptible to insecurity of land tenure, although they feel that it is more secure now than during the previous regime. But mindful of the hardships faced then they simply do not trust the present government; they are suspicious and pessimistic. About 82 per cent of them give such responses; while about 15 per cent *hope* that land under cultivation will remain theirs (see Figure 1).

Figure 1: Responses of the Middle Peasants About the Present Land Tenure (1991–1997)



Source: Research Household Surveys

Fearing the problems of tenure insecurity, this peasant category urges for a clear definition of private ownership of land and duties attached to it. Knowing that this demand is unlikely to be met they are reluctant to improve the land they are entitled to use. None of the members of this category has made attempts to introduce soil conservation structures, although they acknowledge the problems of soil erosion. The recent move to plant trees around homesteads, as many appear to endorse, is only to attain self-sufficiency in wood supplies for construction and firewood. Whatever the intention behind tree planting might be, one-half of them have planted Eucalyptus seedlings, with 74 plants per household.

Over 57 per cent of this peasant category expressed bitter feelings about what they must pay the government in the form of land tax, repayments of credits and interest rates on farm supplies. This is not surprising since those who have doubts about the security of the present land tenure will feel strongly opposed to any financial charges related to the use of such land.

Credits and interest on farm supplies are the most important expenditure item to which all middle peasants object. Increments in production resulting from the application of these farm supplies, for instance fertiliser, rarely offset the costs. At times production increments counterbalance the cost and the net gain is close to nil. These peasants hold that, even if under good farm management one may be able to obtain some return, the returns are far from spectacular. Another peasant outcry is the fact that farmlands to which fertiliser has been applied become used to this external input, so that if fertiliser is not applied these farmlands *ni gataatu* (abort), and result in low production. Hence, fertiliser has to be bought and applied at whatever price. Similar price rises are observed on improved/hybrid seeds. It is obvious that most of these farm supplies are imported and their prices reflect global prices. In the long run, the action and inaction of peasants may be shaped and reshaped by this process of incorporation into the global economic order. The environmental implications need to be seen as an integral part of it, simply because this category combines coping strategies that include the expansion of crop production and the sale of firewood and charcoal obtainable only through the exploitation of shrinking farmlands, grazing, woodlands and tree resources. This is more urgent in view of the fact that over 75 per cent of this category has not been able to raise the level of agricultural production sufficiently to meet household needs, concomitant land taxes, other financial obligations and ever-increasing prices of consumable commodities. Nearly a tenth of them have to survive declining farm production. Soil erosion, continuous cultivation of farmlands and lack of fertiliser are also major constraints on production.

5.4 Poverty and Resource Conservation

As per socio-economic differentiation the composition of poor peasants is about 19 per cent of survey households. One of the striking features of the poor peasant category originates from the perceptions of the nature of the present land tenure system. In spite of government's intension that state landownership will safeguard the interests of the peasants in general and the poor in particular, the peasants in this category are uncomfortable with the present land tenure system. This is a reflection of their short-term needs to draw as much benefit as obtainable from the land. In essence, changes in survival strategies from farming to non-farm activities as practised by poor households lead to less concern about the insecurity of future cultivation and use of the land. On the other hand, the economic motivation to lease out and/or sell land allotted to them implies greater insecurity, because there is no legal framework to do so, particularly in case of land sales. Moreover, since this possible (though illegal) way out preoccupied these peasants there seemed to be no interest whatsoever to plant trees and conserve the soil. It is observed that just 25 per cent of them have planted a few tree seedlings (27 trees per household), meant only for firewood. None of the members has attempted to control soil erosion, which is not surprising given the socio-economic positions of these peasants and the resulting short-term economic imperatives. Instead, survival strategies such as sale of wood products and the preparation of local brew have become important.

There is no doubt that the immediate economic needs of this category of peasants take precedence over the long-term use of the land. Thus, tree planting and soil conservation activities are perceived and interpreted in the context of these immediate economic needs. Tree plantations and soil conservation projects take some time to mature and cannot yield realisable gains in a short period of time. Thus, there is little or no attempt to undertake this activity in the real sense of conservation. It is held that available 'trees and soils' need to be exploited to improve one's standard of living. The implication is that if the living standard does not improve (and for most poor peasants it does not), nobody takes initiatives to plant trees and conserve soils. Contextually this is similar to the decisions of other categories, particularly the rich, who undertake this project precisely because their living standard has in fact been improving (44). The obvious conclusion is that a deteriorating living standard – impoverishment – has a negative impact on conservation and management of land resources.

Another interesting feature of this poor category of peasants is the explicit or implicit reactions towards land taxation and other financial obligations. Explicit, because they feel that these obligations are too much to bear, and implicit, because they do not fully engage in the actual business of farming like most other peasants and feel that they should not be subject to payments. On both counts any financial demand is met with negative reactions, making about 88 per cent feel 'very strongly' about such demands. Decisions to enter sharecropping arrangements, to lease out or sell land, etc. are partly rooted in these economic exigencies making them vulnerable to minor internal and external shocks.

The proportion of the poor peasant category which is still involved in crop production as a leading survival strategy is low (22 per cent). Respondents say that their level of agricultural production has been steadily declining. The main reasons for this downward spiral of crop production include lack of oxen, soil erosion, lack of fertiliser and seed, outbreak of crop diseases, drought and shortage of labour. Except drought (and partly soil erosion) all factors relate to lack of household entitlements and thus their poverty. In the face of this, it is not surprising to note that living standards have never improved, forcing poor peasants, in search of feasible coping strategies, to scavenge for available resources. Understandably, as a result of the continuous exploitation, land resources have diminished and become scarce. For instance, at present to gather a bundle of wood takes much longer time and is much harder than it used to be. The prices of firewood and charcoal however have not increased in proportion and reflect neither its scarcity nor the labour expended to fetch it. In this struggle for survival a new strategy has evolved in several households of this category, whereby whatever wood is fetched has to be used for brewing. Generally speaking, both off-farm income-generating activities, sale of wood products and local brew are combined into a 'vigorous' survival strategy. On the other hand, the use of a large portion of wood by the peasant households has created a fall in the supply of wood products in the nearby town of Lemmaan unleashing a new wave of other 'town' scavengers for this same resource base. Many poor residents of the town have taken initiatives to collect and sell firewood although KA leaders seem to be intimidating them.

6. Conclusions

This article attempts to explore the links between land tenure and RD during the present regime. The exploration portrays quite clearly that the same types of (1) agricultural and

rural development policies, particularly state landownership pursued by the military regime, i.e. state landownership as part of the 1990 economic reform policy, (2) local-level peasant organization, and a host of problems associated with these policies and structures have continued into the present.

Specifically, insecurity of land tenure has persisted, affecting peasant households in their decisions regarding resources. Although insecurity of land tenure is less painful to the richest than the poorest, the constraints imposed by such insecurity on tree planting and soil conservation are considerable. Insight into these variants in impacts was gained through the socio-economic differentiation of respondent peasant households into rich, middle and poor categories. Peasants refrain from emphasising long-term use of land resources and concentrate on short-term gains. This 'short-term sightedness' is mainly manifested by the poorest section of the peasants and in stark contradiction with the principle of sustainable use of resources. Moreover, the emerging land-use dynamics such as sharecropping, land lease and sale, have not been legalised and therefore the conditions under which they are practised remain destructive to land resources.

Similarly, unmitigated resource extraction from peasants has been both the cause of poverty and a constraint to making any improvements in production technology which in turn influences the patterns of resource uses, conservation and management. The severity of resource abuse and/or exploitation stemming from resource extraction out of the peasants varies along the three socio-economic categories of peasants and is much more pronounced in the case of the most impoverished segment, providing empirical confirmation to the belief premising that impoverishment of peasants leads to further degradation of the environment.

The present land-tenure regulations contain a loophole with respect to leasing or renting land. Also, no conditions are stipulated on the basis of which both parties involved in sharing the benefits of a given piece of land could negotiate on appropriate resource-use patterns and legalise their agreements and/or arrangements. Thus, these land-use patterns, including hidden land sales, have been operating in a *legal vacuum*, to say the least. Such arrangements were also practised during the socialist time without any legal framework. The present practice is certainly reminiscent of the past. Of crucial importance however is the mismanagement of the nearby trees, bushes and soil. The dire need to extract as much return as possible from farmlands in a short period of time, inherent insecurity in the use of farmlands despite the fact that only close associates take part in the transactions, conscious decisions made by land-hungry parties to evade the responsibility of conservation works and the opportunity costs of different enterprises elsewhere – all these are major factors leading to overexploitation of resources under such arrangements. Lack of a legal framework and its effect on resource use has to be seen in relation to the prevailing state landownership.

As a whole, in response to the question on how they feel about the present land tenure, many peasants say that they are not in favour of state ownership and suggest that the government should not necessarily be the owner of the land, but rather an outside actor who both facilitates and guards ownership rights and takes action if necessary. State landownership is seen as a challenge to their autonomy, needs and interests. The degree of this varies across various peasant categories. The convergence point as to the required type of land tenure needs to deal with the survey and identification of these varied socio-economic stances and the different kinds of uses to which lands are put, which at the end of the day allows multiple tenurial systems to prevail encompassing private, group/communal and possibly state ownership. This in turn appears requiring cadastral survey and a restructuring of the local agrarian economy.

Notes

1 This constitution is termed the Constitution of the Federal Democratic Republic of Ethiopia (FDRE) (1994).

2 In the Ethiopian context, tenure insecurity can be understood as the short and/or long-term lack of land use and landholding rights, as a result of traditional land redistribution systems, landlords' intentional decisions and government land use policies.

3 This policy is disqualified as 'superficial, stereotyped, and does not reflect the experiences of the peasantry regarding access to land, tenure insecurity or land transactions' (Dessalegn 1994:8).

4 According to the information obtained from Bayegiche KA, a peasant who obtained the lowest harvest during the 1996/1997 production year paid birr 30 while his counterpart who was in the best position paid birr 145.50, and the total amount of tax paid by the KA was birr 12, 000, birr 300 more than the previous year and birr 500 more than what they paid two years earlier.

5 Farm-Africa is an NGO operating in the research area. Its main objective was to conserve forest, wildlife and soil resources.

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Agricultural Extension Programme in Ethiopia: Retrospect and Prospect

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Abstract

The gap between food needs and availability being a multi dimensional issue in Ethiopia, a number of intertwined and interrelated factors have been responsible to the continuing deterioration in the food security situation of the country since the past three decades. Among the basic factors contributing to food insecurity are the policy environment be it at the macro or sector levels and the efficiency and appropriateness of the institutional structures put in place to implement policies, strategies and programs. Policy reform introduced to transform the economy from state domination is generally on the right direction. The overall development strategy, Agricultural Development-Led Industrialization /ADLI/, is to be acknowledged as agriculture is the dominant sector of the economy. To complement the ADLI strategy, the national agricultural extension programme has been launched since 1994/1995 with the aim of attaining self-sufficiency in food production. The extension package programme assisted small-scale farmers to improve agricultural production and productivity through the dissemination of research generated agricultural technologies and improved practices. Nevertheless, the realization of the objective of closing the food gap in the medium term would depend on overcoming, in particular, the problem arising from the unreliability of rainfall in many parts of the country which is the main cause of food insecurity in the country. To overcome the formidable challenges facing agricultural development, strategies have been set to speed up the transformation of agriculture from subsistence to market orientation. Thus, to increase food production in the reliable rainfall areas, the diffusion of modern technology packages within smallholder agriculture is considered as important. In moisture deficit areas, addressing the issue of food security is the major strategy where the primary solution is to be found within agriculture. In these areas, moisture conservation practices are central for enhancing agricultural development activities. As the major agricultural activity of the pastoral area is livestock, agricultural development will make this fact central to all its other activities. Efforts are underway to bring about changes in agricultural development. Thus, package development has been initiated and the process is underway at all levels. These packages are integrated around major activities such as water harvesting, coffee, dairying, agro-forestry, and are implemented at household levels. Farmers Training Centers (FTCs) are assumed to play significant roles as centers for skill training and demonstrations for the diffusion of these technology packages to all farm households. Generally, the challenges facing agricultural development would require a multi-facetted approach. Concerted efforts need to be made to overcome constraints associated with environmental, institutional, infrastructure, socio-economic, technological and human resources development.

1. Introduction

The gap between food needs and availability being a multi dimensional issue in Ethiopia, a number of intertwined and interrelated factors have been responsible to the continuing deterioration in the food security situation of the country in the past three decades.

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Among the basic factors contributing to food insecurity are the policy environment be it at the macro or sector levels and the efficiency and appropriateness of the institutional structures put in place to implement policies, strategies and programs.

The policy reform introduced to transform the economy from state domination is generally on the right direction. The overall development strategy, which is agricultural development-led industrialization, is in principle on the right direction as agriculture is the dominant sector of the economy.

Agricultural Development-led Industrialization /ADLI/ is central to agricultural development with the aim of transforming the country's economy from agriculture to non-agriculture sector. Agriculture is expected to play a leading role to enhance its contribution to economic growth on both supply and demand sides (SDRP, 2000). On the supply side, the sector provides food; export products and industrial raw materials. While on the demand side it stimulates industrial expansion by providing market for domestically produced goods and products.

To complement the ADLI strategy, the government has launched and implemented the national agricultural extension programme since 1994/95 with the aim of attaining self-sufficiency in food production. The national agricultural initiative which is also known as package programme followed the new extension system known as Participatory Demonstration and Training Extension System (PADETES) for its implementation. The extension program adopted package approach to development where all essential components which include information on agricultural technologies and improved agricultural practices, agricultural production inputs and credit are provided to beneficiaries as a complete set. Similarly, conducting economic size on-farm demonstrations is an essential part for programme implementation.

In general, the extension package programme assisted small-scale farmers to improve agricultural production and productivity through the dissemination of research generated technologies and information.

However, the transformation process of smallholder agriculture from subsistence to market orientation requires overcoming the formidable challenges confronting agricultural development in Ethiopia. Such challenges, among others, include environmental, technological, institutional, infrastructure, socio economic and human resource development.

2. Strategies

The scope for increasing food production at a significant rate per year appears feasible in the light of the potential impact of widespread adoption of improved farm technologies. On-farm demonstrations conducted in different parts of the country have shown that crop yields per hectare could double or even triple with the introduction of new technologies and improved agricultural practices. Nevertheless, the realization of the objective of closing the food gap in the medium term necessitates the need for designing different strategies for different agro-ecologies and farming systems.

The strategies include the following:

- To increase food production in the reliable rainfall areas, the diffusion of technology packages within smallholder agriculture is considered as important. In these areas technical opportunities for raising farm outputs are reasonably well understood and there are generally good yield responses to the use of improved seeds and inorganic fertilizers. The opportunities for improving livelihoods in such areas will tend to come from shifting where market permits from production of grains for subsistence purposes towards labour intensive cultivation of high value commercial crops and increased diversifications into livestock.

- In moisture deficit areas, addressing the issue of food security is the major strategy where the primary solution is to be found within agriculture. In these areas, moisture conservation practices are central for enhancing agricultural development activities. In addition, the use of drought tolerant crop varieties, high economic value crops and animals is given due consideration.

- As the major agricultural activity of the pastoral area is livestock, agricultural development in these areas will make this fact central to all its other activities. Strengthening livestock marketing is also an important part of the food security strategy of pastoral areas.

3. Current Interventions

Cognizant of the fact that strategies must be complemented with appropriate interventions, several initiatives are underway. Such initiatives, among others, include the following:

Package Development

The package development has been initiated and the process is underway at all levels. The packages developed include those to be implemented by existing farm households utilizing existing technologies and management skills of these farmers as well as those to be implemented by educated and well-trainined farmers and they are of high-level technologies.

Efforts are also under way to integrate packages around major activities such as water harvesting, coffee, dairying and agro-forestry. These packages are to be implemented at household level and would be made available as menu to be chosen by the end users themselves.

To be more problem and area specific, socio-economic surveys have also been conducted with the objectives of satisfying the needs of target groups. Following the survey, farmers have been classified into different recommendation domains based on their situations.

Agri-Technical Vocational and Educational Training and the Establishment of Farmers' Training Centres

Farmers Training Centers (FTCs) will serve as centers for skill training and demonstrations for the diffusion of these technology packages. The establishment of FTC is part of the agricultural, technical, vocational and education program and it is expected to speed up the rural transformation process to market orientation. To ameliorate the objectives of the FTC the Technology Vocational and Education Training (TVET) has been operational since

2000/2001. The main objective of Agri-TVET is to create and develop human resources and institutional capacity that would have desirable impact over the medium and long-term capacity building strategy.

Reformulating the Existing Extension Approach

The need for reformulating the existing extension approach becomes apparent due to the following objective realities:-

- The current decentralization process necessitates, more than ever before, real participation in the overall extension process.
- The advancement in science and modern technologies in agriculture has demanded well-trained and skilled manpower and the extension approach we follow should be training based and should also utilize different communication media to transfer technologies.
- The extension approach should as much as possible suit the needs of different agro-ecologies and target the household as a focus and must ensure graduation after piloting the different packages for some years.
- The extension approach should be client oriented, agro-ecology based and demand-driven.
- There is a need for transforming agricultural extension programme from piece meal approach to integrated.
- Integration of activities as well as institutions is considered to realize the envisaged transformation process. In this regard, Research-Extension-Farmer linkages should be given high priority.
- The extension approach should also acknowledge the transformation of smallholder from subsistence to market orientation, the utilization of local resources and appropriate technologies as well as use of environmentally friendly technologies. (Whether developed locally or imported and adapted for wider use).
- The extension approach should focus on transfer of technologies and human resource development. Monitoring and evaluation should be built into the system.

Along this line, efforts are underway to reformulate the existing extension system based on the aforementioned objective realities.

Water Harvesting

The dryland of Ethiopia are suffering from desertification, loss of topsoil and overgrazing. The exhaustion of water resources has been going down over the years and more erratic rainfall situation becomes apparent. Cognizant of this fact, the extension programme pays special attention to the promotion of water harvesting technologies and efforts are underway at all levels.

Conclusion and Recommendations

It is agreed that food security in Ethiopia is first and foremost the responsibility of Ethiopians themselves and is an achievable objective given the enormous natural and human potentials of Ethiopia, and that the country could attain a sufficient level food security through rational, judicious and clear-sighted use of these immense potentials. In this regard, it is of paramount importance to give attention to the conservation and wise utilization of the natural resources.

The problem of crop production and food supply instability in the country is associated with almost absolute reliance on rainfed agriculture, despite the country's high potential for irrigation development both from perennial rivers and water harvesting. It is therefore important to efficiently use our water resources through all means of efficient water utilization methods. Water harvesting is one of the major interventions for increasing agricultural production and productivity.

External assistance can never play more than a supporting role in the development process. The responsibility for the achievement of the development objectives rests on the people themselves. It is therefore essential to build the capacity of the farming population in order to enable them to decide on their own development agenda. It is believed that for agricultural development to occur, the knowledge and skill of farmers must keep increasing and changing.

The institutional structures, such as extension service, devoted to supporting the small-scale farmers have been especially weak and inadequate. High priority must be accorded to strengthening these institutions, but this should be aimed at enabling them to provide support for the organizations developed by small farmers themselves at the community level, rather than imposing rigid, centrally controlled structures on them. In this regard, one has to recognize that for agriculture to be business oriented, there must be a market for the product and a price for them high enough to repay the farmer for his cash costs and his effort in producing them. This, among others, calls for strengthening the organization base of the farming communities.

Agricultural development requires that local availability of supplies and equipment be available at many local points on sufficient quality to meet the needs of every farmer who may want to use them. One window-shopping should be acknowledged and private business institutions should be encouraged to fill this gap.

Most research systems in developing countries including Ethiopia are organized to serve farmers operating in more favourable and homogeneous agro ecological conditions than those in resource-poor farming contexts. Resource-poor farmers' access to research information is restricted, their ability to articulate their needs is poor, their capacity to tolerate risk is limited; and the pressing concerns of their daily existence make it difficult for them to focus on long-term technological change. In order to overcome such challenge, there is a need to develop a greater capacity to facilitate effective interaction amongst researchers extensionists and farmers. This, among other things, requires the development of strong links with research, technology transfer agencies and farmers.

Agriculture extension service to farmers has not been adequate in terms of coverage and providing quality service. Frontline staffs are too overburdened to do a good job, especially given the low level of operational budget support both to monitor and supervise extension demonstrations programme and to receive in-service training. In this connection, overall support is required especially for grass root extension agents in order that they will do the job as per required.

Finally, it is important to recognize that increasing agricultural production of the country is a complex task. It is complex because it requires to fulfill conducive environment for overcoming challenges facing agricultural development. Such challenges relate to environmental, technological, infrastructure, institutional, socio-economic and human resources development.

ɘference

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Agricultural Input System and Public-Private Partnership in Ethiopia[1]

*Belay Simane**

Abstract

The role of agricultural inputs in increasing production and productivity has been very evident during the last four decades of research and extension works. Despite considerable efforts by the Government and non-government institutions to promote improved seeds and fertilizer, consumption by farmers remains one of the lowest in the world. The average national fertilizer consumption is only 25 kg/ha of nutrients. Area covered by improved seed is about 28 percent. However, fertilizer and improved seed use have shown a significant increase during the last six years. There are several pests in Ethiopia that cause losses of significant magnitude both at pre-harvest and post-harvest stages of crop production reaching up to 50 percent yield losses. Despite such high yield loss in the country, pesticide use by the smallholder farmers is extremely low. Currently all chemical fertilizers are imported by public and private importers/wholesalers and distributed to the smallholder farmers via private retailers or farmer cooperatives with pronounced assistance from Regional Agricultural Bureaus (RABs). Improved seeds are mainly produced locally and the bulk of it is distributed through RABs and a limited quantity through farmers' cooperatives. Pesticides are mainly imported and handled by private importers. Pesticides for field and storage pests are distributed to smallholder farmers through formal and informal retail outlets. Much of the inputs are supply driven rather than the actual demand of the farmers. This system should be replaced by a well-organized and coordinated marketing network that would target the supply of inputs to the smallholder farmers under one roof at the grass roots level. Although the fertilizer consumption has shown a tremendous increase over the last 6 years, the change in the quantity used per unit area has been much less impressive, one of the lowest in sub-Sahara Africa. Moreover, it has also been stagnant or declining and fluctuating over those years. These phenomena indicate that the increase in the total quantity of fertilizer consumption observed over the last several years was coming from area expansion and not intensification. Seed marketing study indicates that the size of the available seed market of certified seed in the country can aim at ranges from 0.75- 1.0 million quintals. On the other hand the penetrated market size is about 200,000 quintals per annum. Ethiopian Seed Enterprise (ESE) has been the major parastatal seed company producing and distributing improved seeds of various crops. Although the private sector is getting attracted into the seed business, its share in seed production and marketing is far below expectation. The slow progress of the formal sector in the supply of improved seeds to the Smallholder farmers led to the designing of Farmer Based Seed Production and Multiplication Scheme (FBSPMS) in order to produce and distribute improved seeds of self-pollinated crops within the farming community. Insecticides, herbicides, and fungicides are the major categories of pesticides imported and used in the country for various purposes. The average annual import of pesticides is about 1100 tons for the last seven years. The country is by and large dependant on imports to meet its requirements and these are mainly undertaken by private trading companies although AISE is also involved in the importation of a limited quantities of pesticides. Presently, there are about 20 active private traders dealing with import and to a very limited extent retailing of pesticides.

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To ensure the availability of the required agricultural inputs (like seeds and fertilizers) at the right place and time and to create favorable environment for both private and public sectors, the government of Ethiopia has set up the National Agricultural Input Authority (NAIA). Policies and strategies and law enforcement mechanisms regarding fertilizer, seeds and pesticides have been developed and are being implemented. However, the Agricultural inputs supply system is still not competitive enough to ensure farmers an easy access to fertilizers, improved seeds and pesticides under one roof and along with advisory services. The present agricultural input distribution network mainly comprises of cooperative outlet, with little private sector participation, and the required inputs are made available in big towns only. The public-private partnerships in the Agricultural Input System are not significant. The major problems identified with the poor performance of the private sector in the development of a competitive and efficient agricultural business are lack of physical capital (infrastructure, machinery and equipment), financial capital, and qualified human resources. In order to attract private investors and improve the public-private partnership, the public institutions need to have predictable and transparent management, proper expertise for the technical departments, and good track records in their performance with competitive strategic business plan. Well-developed agricultural input supply system is essential for increasing agricultural productivity and rural family income. Nevertheless, the agricultural marketing channels and support services are not well developed in the country and found to be a major drawback to achieve the development objectives. In order to influence the use of inputs by smallholder farmers, the inputs must be taken to easily accessible, trusted outlets close to the farmers, or at least within their zone of mobility. This could be achieved through the establishment of stocking points/distribution or storages/wholesales at strategic locations and retail outlets within farmers' zone of mobility. Healthy and competitive input production and distribution network should be developed with the active involvement of both the private and public sectors. Favorable policy environment and adequate incentives to attract the private sector in the agricultural input business are also essential.

Introduction

Ethiopia's primary development objective of the Government is to attain relatively fast, broad -based and more equitable economic growth with macroeconomic stability. An additional and equally important objective is relative price stability to protect the poor from the ills of inflation and thereby encourage saving and long-term investment. Several policy reforms have been made in order to establish healthy and competitive environment by involving the private and public sectors, even though there are several problems in the implementation.

Despite an abundant potential of arable land the level of production and productivity in Ethiopia is low to meet the minimum 2100 Kcal/Head/Day of the highly increasing population, the export and local agro-industry requirements. The area under crops as well as overall production has remained stagnant for several years. The crop productivity has also remained low at an average of 1.2 tons for food grains, 0.87 tons for pulses and 0.45 tons for oil crops as compared to relatively much higher yield in many cases obtained at research stations and demonstrations in the farm fields [2]. This low performance, among many others, is partly attributed to the very low use of improved agricultural inputs.

Efficient and rational use of agricultural inputs is the most cost effective means of increasing agricultural production and productivity. This is even more important in Ethiopia in view of increasingly limited available arable lands, declining soil fertility and an ever-growing population. These facts increase the importance of promotion and use of improved inputs together as a means to intensify food production.

Despite considerable efforts by the Government and non-government institutions to promote improved seeds and fertilizer, the use of these inputs by farmers remains one of the lowest in the world. The average national fertilizer consumption is only 25 kg/ha of nutrients. Area covered by improved seed is about 28 percent [1]. However, fertilizer and improved seed use have shown a significant increase during the last six years. There are several pests in Ethiopia that cause losses of significant magnitude both at pre-harvest and post-harvest stages of crop production reaching up to 50 percent yield losses. Despite such high yield loss in the country, pesticide use by the smallholder farmers is extremely low.

In recent years, the agriculture sector has responded positively to reforms aimed at enhancing market incentives and private sector initiatives. There has been progress in production and productivity of the traditional agriculture through provision of modern inputs such as fertilizers, seeds and pesticides through the extension package program. The program also expanded to cover wide areas as opposed to the past efforts, which were contained to limited areas. Evaluations of this program have demonstrated productivity increase of major staple food crops by at least twice or 2-4 times on participant farmers' fields (Table 1).

Table 1: Comparison of Yield (qt/ha) of Major Cereal Crops Between Traditional Extension Package Demonstration Plots (EPDP) and Research Stations

S.No	Crop Type	Traditional	EPDP*		Research Station	
			Yield	Percent Change	Yield	Percent Change
1	2	3	4	5=(4/3x100)-100	6	7
1	Tef	8.24	14.8	80	22	167
2	Wheat	12.23	28.6	134	51	317
3	Barley	10.00	21	110	41	310
4	Maize	17.86	46.25	159	71	298
5	Sorghum	12.63	26.8	112	45	256
	Average	12.20	27.5	120	46	270

* Extension Package Demonstration Plots.
Source: [1]

The definitions of agricultural inputs greatly vary in different countries. Agricultural inputs are improved seeds, fertilizers, pesticides, improved farm tools (farm tools and irrigation equipment and materials), improved beehives, improved breeds of poultry, dairy, small ruminants along with the processing equipment and tools locally produced or imported and a number of other inputs believed to be fundamental inputs to increase agricultural productivity. For the purpose of this discussion, I took the very narrow but widely used definition of agricultural inputs *viz:* fertilizer, improved seeds and pesticides only.

Improved seeds, fertilizers and pesticides together constitute a package to increase production and productivity of yield; and they are made available under the current extension intervention program. Establishing a composite input distribution system so that a farmer can get all the needed inputs for crop production under one roof has been evident in many developing countries. The new five-year Agricultural Development Plan requires convergence in the availability of quality seed, fertilizers and pesticides, as one without the other cannot give optimal returns. Ensuring their timely and adequate availability, their quality, sound marketing practices, availability of credit, problems of remote locations and semi-arid areas are common problems to all the inputs. This called for the establishment of the National Agricultural Input Authority (NAIA) by proclamation (No 288/2002), responsible for the establishment and implementation of an agricultural inputs supply system that ensures adequate, timely and quality inputs supply right up to the grass roots level [4].

The objectives of this discussion paper are to:

- To discuss the status and prospectus of Agricultural Input System in Ethiopia,
- To examine the public-private partnership in the production, and marketing agricultural inputs.

Fertilizer Supply System

Fertilizer is a strategic commodity for the agricultural sector. The fertilizer supply system begins with import operation and goes through distribution and sales activities until it reaches the end users (farmers). As shown in figure 1 the fertilizer supply system involves various public and private organizations at Federal and Regional levels [7].

The fertilizer system starts with the estimation of the annual fertilizer demand by the NAIA and regional governments. Based on the approved annual fertilizer demand and considering the leftover stock, the NAIA sets the total import requirement and estimation of foreign exchange.

Once the foreign exchange is availed, the NAIA prepares the annual fertilizer import schedule (which is periodically reviewed) and communicates to the National Bank of Ethiopia to proceed with the allocation of foreign exchange for fertilizer importation. The Fertilizer Foreign Exchange Facility Committee (FFEFC) is the responsible organ for bid document preparation, tender floating, evaluation and awarding. After the award of tender to the successful importer, the importer then starts processing the import operation, which essentially includes opening of L/C, fertilizer shipment and inland transportation.

Fertilizer is imported in bulk and bagged at the port of entry during which the Quality and Standards Authority conducts the inspection activities. The fertilizer after being inspected and bagged at the port, the inland fertilizer transportation and distribution activities are the sole responsibilities of the respective importers.

Although various policy and reform program measures were taken by the government to establish a competitive market environment, the fertilizer supply system is not strong enough to ensure timely and adequate supply of fertilizer at a competitive price. The major problem, among others, is its huge capital requirement. The fertilizer business is capital intensive in terms of counterpart fund payment at the time of L/C opening, collateral, working capital for local fertilizer distribution and so on. For example, to handle a 25,000 MT of DAP fertilizer, it requires about 65 million Birr. The number of importers has decreased from seven to three now due to this problem alone. The procurement modality with in the country is an open competitive bidding and some times through negotiation between the regions and importers. The existing fertilizer distribution channels are the following:

- Directly delivered to the end users through the importers own outlet (marketing centers);
- Through the agricultural cooperatives unions and/or primary cooperatives to farmers;
- Through the private dealers and/or commission agents to the end users
- Through the Regional Agricultural Bureaus.

During 1996-2001 adequate fertilizers supply, that exceeded actual consumption, has been ensured and this has significantly contributed to enhanced fertilizer use in the country (Table 2 overall, fertilizer consumption has shown a significant increase during the period 1996-2001). The total fertilizer consumption (DAP + Urea), which was about 220,430 tons in 1997, has reached a record level of 297,907 tons and 279,602 tons in 2000 and 2001, respectively. The increase in the annual Urea consumption is quite significant compared to DAP, which might be attributed to the extension intervention program.

Although the fertilizer consumption has shown a tremendous increase over the last 6 years, the change in the quantity used per unit area has been much less impressive (about 25 kg/ha), one of the lowest in sub-Sahara Africa. Moreover, it has also been stagnant or declining and fluctuating over those years. These phenomena indicate that the increase in the total quantity of fertilizer consumption observed over the last several years was coming from area expansion and not intensification.

Table 2: Fertilizer Supply and Consumption in Ethiopia for the Years 1996-2003 (tons)

Year	Supply			Consumption				
	DAP	UREA	Total	DAP	UREA	Total	Carryover	%
1996	311,044	95,576	406,620	209,883	43,269	253,152	153,468	66
1997	215,413	108,766	324,179	168,623	51,808	220,431	103,748	47
1998	334,261	151,395	485,656	193,395	87,976	281,371	204,285	73
1999	322,856	145,768	468,624	195,345	94,919	290, 264	178,360	61
2000	235,996	157,092	393,088	197,345	100,562	297,907	95,181	32
2001	258,151	106,529	364,680	181,545	98,057	279,602	85,078	30
2002	208,000	160,424	368,424	155,941	76,329	232,270	136,175	59
2003	160,294	111008	271302	159974	106202	266176	0	0
Average	246,601	132,064	378,557	186,011	78,989	223,533		

Source: [8]

The Seed System

Improved seed is the most cost effective means of increasing agricultural production and productivity. This is even more important in Ethiopia in view of increasingly limited available arable lands, declining soil fertility and an ever-growing population. These facts increase the importance of promotion and use of good quality seeds as a means to intensify food production.
The seed sector is a very complex chain of events that aims to supply seed of high quality in adequate amount, at the right time and place, and at reasonable prices. Seed quality refers to both the genetic quality and to the optimum physical, physiological and sanitary condition. The country has got a well formulated seed industry policy and development strategy as of 1992 to enhance a successful national seed industry system.

The policy and strategy address issues to create enabling environment for both formal and informal seed systems. The purpose of the seed policy is to facilitate and regulate the production and marketing of quality seed. Proclamations, guidelines and seed standards issued in line with the NSIP and Strategy are conducive for the development of a sustainable seed system [3]. The national seed industry has registered some achievements in the promotion and development of improved varieties. Private entrepreneurs are getting attracted into the seed business in many parts of the country, which is vital for reliable, sustainable, competitive, and cost-effective seed system [6].

However, healthy and competitive seed industry by mobilizing both the public and the private sector is far from reality. Some of them need conceptualization of issues in order to build a sustainable seed system. Others need capacity building. Because many stakeholders are involved and it follows generation system, seed production planning is also complicated and sometimes it is very difficult to plan and coordinate. The most important work of NAIA, therefore, will be how best can all the institutions involved in the seed chain get organized effectively and know clearly who should do what in the seed chain.

In order to improve the use of improved seeds and attain fast and sustainable development, the seed system will follow basically the two approaches, developmental and commercial concepts. In practice, these two extremes in seed policy result in very different seed-supply organizations.

- **Developmental**: seed plays a crucial role in agricultural development and, therefore, could be offered at affordable prices in order to increase the adoption rate of new technology and to increase national food production.
- **Commercial:** seed production is a productive operation that should be run as a business. Investment in purchasing good seed is recouped by the individual farmers and subsidies would only distort the system.

The seed system in Ethiopia basically consists of two components-The formal seed sector and the farmers seed system (informal). There is also a third component, which is equally important- emergency seed programs, often implemented by NGOs and other relief organizations.

The formal seed system covers from variety development to marketing of seeds as presented in Figure 3. Present development policies are generally adequate to address problems related to sustainable seed supply. However, lack of coordination of all sector activities is a common feature. The future strategy for NAIA is to change all the weaknesses to opportunities as presented as follows.

Every certified seed lot is derived from a particular lot of breeder seed via a known number of generations according to the nomenclature of Organization for the Economic Cooperation and Development (OECED) system (Table 3). In order to maintain the genetic identity and purity of each seed lot, a strict generation system is used. Therefore, quality control and certification process is undertaken as the major component of the seed system. Seed laboratory testing will be decentralized using the central National Seed Testing Laboratory (NSTL) and the newly constructed eight Regional Seed Testing Laboratories located at different strategic locations of the country.

A great deal of effort and resources has been spent in food crops for potential areas. As far as its endeavors in seed sector, high value crops, export crops and crops for marginal areas require more focus and a more applied approach.

Table 3: Summary of Seed Classes and Responsible Institutions

Generation	Seed Class	Responsibility
1	Breeder	Research institutions/**Breeders** are responsible for producing this category from nucleus material.
2	Pre-basic	A second-generation of breeder seed. The Research institutions/**Seed Units** should be responsible to make enough quantity available. • Quality control
3	Basic	➢ Production of enough quantity of basic seed of all crops including **Hybrid Maize** should be the responsibility of ESE. ➢ EARO should make an agreement with ESE regarding the patent right of **Inbred Lines of Hybrid Maize** ➢ Quality control is compulsory and it is NAIA's responsibility.
4	Certified-1	1. **Private sector**: production of marketable and profitable crops. 2. **Public Sector**: ➢ Crops that are not produced by the private sector (Developmental aspect), ➢ Profitable crops like hybrid maize to supplement the private sector ➢ Quality control is compulsory and it is NAIA's responsibility.
5	Certified-2-4	Basically produced by **Cooperatives through farmer based seed multiplication scheme**. • It is applicable only for Open-pollinated crops. ➢ Quality control is compulsory and it is NAIA's responsibility.

Variety Release and Registration

Variety release guidelines are available for field and horticultural crops. Conditions for release, supporting documents for application, evaluation procedure, amendments and forms are included in the guidelines.

Existing variety release and evaluation is done by a standing National Variety Release Committee (NVRC) and various ad-hoc technical committees drawn from different institutions. However, it has been acknowledged that this system has enormous limitations to plan and coordinate the activities as planned due to various assignments of the committee members. Experiences in other countries show that it is possible to carry out the variety release by contracting independent institutions or building capacity of the regulatory body, like NAIA. However, considering the overall capacity and capability of NAIA and universities, the current system would continue for some years to come.

The registration system of high value crops imported and produced locally by commercial farmers for export will be simplified in order to speed up registration of new varieties and to allow quick entrance into commercial production.

Seed Quality Control

A complete formal seed quality control system will be enforced comprising the following:

- ***Inspections:*** involving inspection of field, processing plants, stores and markets;
- ***Seed testing***, involving sampling, variety and germination analysis, purity analysis, moisture analysis, seed health and vigor testing, and
- ***Certification***, labeling in order to confirm the origin and variety purity of the seed lot and is compulsory for all crops, and

Seed Promotion and Extension

More focus and a more popularization of new varieties should be carried out as soon as new varieties are registered. Variety Gazette and public media will be exploited as much as possible. Educational campaigns should be carried out through demonstrations, field days, and both public and private seed farmers should aggressively exercise study visits. Workshops, seminars, radio, television and newspapers will also be used.

Seed Processing and Storage

Seed processing involves operations such as cleaning, grading, dressing and packaging. There are more than sufficient processing plants in the country for the quantity of annually produced seeds (almost in all regions). Seed processing plants are expensive and most of the private seed producers cannot afford to own their plants. Therefore, it is anticipated that the private seed producers could use the existing plants of ESE and Regional Institutions with reasonable service charge.

Seed Production Planning and Coordination

Planning a seed production program requires a business approach. It should start with an assessment of market demand and be followed by an analysis of expected returns and risk factors before final allocation of resources. Because of the generation system, seed production planning becomes rather complicated. Changes in demand cannot be met immediately by appropriate changes in production because certified seed production depends on the availability of registered or basic seed.

Excessive production of basic seed in a declining market for certified seed of the particular variety can amount to substantial wasted expenses. Also, holding stocks of lower generation seed to meet any sudden increased demand is often costly. 20% of the expected demand should be kept as a security stock at all levels. All regions and private seed farms should submit their demand one year before in order to properly plan and coordinate.

Seed Marketing

Seed marketing study of November 2000 commissioned by ESE indicates that the size of the available seed market of certified seed in the country can aim at ranges from 0.75- 1.0 million quintals. On the other hand the penetrated market size is about 200,000 quintals per annum.

The market consists of four elements: the producer, the product, the customer and the competitor. The general factors that give a good starting point for seed marketing are:

- Definitions of consumer needs and consumer purchasing power,
- Definition of geographical distribution and collection of information on potential customers,
- Definition of the profitability of the crop, and
- The pricing structure

These variables need to be optimized in order to establish a sustainable private seed farm. Marketing activities should include the establishment of marketing strategies, market research, market communication, pricing, and distribution network.

The Pesticide Supply System

Insecticides, herbicides, and fungicides are the major categories of pesticides imported and used in the country for various purposes. The country is by and large dependant on imports to meet its requirements and private trading companies mainly undertake these. Presently, there are about 20 active private traders dealing with import and to a very limited extent retailing of pesticides. The locally established pesticide processing plant is also formulating different types of insecticides by importing their active materials and solvents from abroad. The plant has got a capacity to formulate 1500 tons of dust and the same quantity of liquid pesticides every year.

Generally, the level of pesticide use by the smallholder farmer is very limited among the major reasons being lack of awareness about their importance, high costs involved with their use and absence of an effective pesticide-marketing network. On the other hand, farmers are frequently suffering from significant magnitude of crop losses due to the occurrence of a wide range of pests the outcomes of which sometimes could be catastrophic. Some of these losses can easily be avoided by making available to the farmer preventive pesticides such as seed treatment chemicals and storage insecticides through an appropriate marketing channel (Fig 3).

Considering the need of pesticides as important inputs to increase productivity and the hazards associated with pesticides, NAIA will follow the following pesticide registration, importation and supply system.

Pesticide Testing Procedure

A series of experiments vis. initial, advanced and verification are conducted before a candidate pesticide is recommended for registration. Newly discovered pesticide products go through all three stages of testing. However, known pesticides often come in different trade names, and products with change in trade name only could be recommended either for advanced testing and verification or directly for verification.

NAIA will designate a new National Pesticide Registration Committee composed of relevant professionals from different institutions (advisory committee). Documents are first reviewed and evaluated by a technical committee and then NPRC verifies the assessment of the technical committee to approve the registration. For wide spectrum pesticides, if tested and proved to be effective against a specific pest species on a particular crop then the product should be eligible for use on other crops if recommended by the concerned supplier with full responsibilities.

Import of Pesticides

Considering the need of pesticides as important inputs to increase productivity and the hazards associated with pesticides, the country is following the IPM system. NAIA will issue import permit to pesticide companies upon request once a pesticide is registered. Trade, quarantine and other laws of the country are mandatory to all pesticide companies in the process of importation.

Table 4: Volume of Pesticide Imports in Metric Tons (1995-2001)

Year	Insecticides	Herbicides	Fungicides	Others	Total
1995	494.0	675.0	238.0	7.5	1414.5
1996	441.5	467.7	22.5	12.7	944.4
1997	368.4	577.4	27.0	44.6	1017.4
1998	550.3	297.8	41.0	10.0	899.1
1999	320.3	801.4	97.8	3.9	1223.4
2000	160.7	805.8	46.8	2.6	1015.8
2001	446.2	803.8	32.0	57.5	1339.5
2002					
Average	397.3	632.7	72.1	19.8	1122.0
Percent Share	35.4	56.4	6.4	1.8	100.0

Source: Ministry of Agriculture

There is a rapid increase in herbicide and a slow increase in fungicide imports between the year 1995 and 2001 (Table 4). The increase in herbicide imports is mainly due to an apparent moderate increase in smallholder demand for use on wheat and tef crops. On the other hand, import volumes of insecticides, which in the past used to exceed those of herbicides have not shown changes due mainly to the formulation locally of certain insecticides.

The local pesticide formulation plant, Adami-Tulu Pesticide Processing Share Company, has started to formulate pesticides since 1999. The plant has the capacity to formulate 1500 tons of dust and the same quantity of emulsifiable concentrates every year. The average annual pesticide production by the plant is 338.06 tons; of which 201.75 tons are agricultural pesticides and the remaining balance are pesticides for malaria control. Major pesticides formulated by the plant include Malathion, Endosulfan, Diazinon and Fenitrothion.

Most of the imported as well as locally formulated pesticides in the country are consumed by state and privately owned commercial farms. Previously conducted assessments of pesticide consumption indicate that large-scale farms consumed 80% of the total pesticides while the smallholders' sector which accounted for 95% of food production received the remaining quantity of 20%.

Quality Control

Considering the hazards associated with pesticides the government has already put in place a legal system for the control of the importation, production, sale and use of pesticides.

Imported pesticides are inspected at point of entry by NAIA inspectors before releasing for use. Sample is collected for further laboratory test if the inspector has any doubt on the imported pesticide. The PC is not allowed to sell or distribute the sampled batch until final notice is given from NAIA.

Private-Public Partnership in Agricultural Input System

Development of a well-organized public-private partnership in product development and utilization is vital for reliable, sustainable, competitive, and cost-effective economic development. NAIA believes that a quick response to farmers and agro-industries needs in countries like Ethiopia can be rendered through implementation of appropriate PDP. PDP can also play a mutually beneficial role in transferring agricultural technologies, including biotechnologies. Since the fall of the command economy, the private sector is entering into agricultural business; however, their involvement in the agricultural business is below expectation. The major problems identified with the poor performance of the private sector in the development of a competitive and efficient agricultural business are:

- Lack of physical capital (infrastructure, machinery and equipment),
- Financial capital, and
- Qualified human resources

Noting the contribution of the public sector in effectively multiplying and distributing agricultural inputs at a competitive price to farmers, it is necessary to underscore the fact that partnerships between public and private sectors in the Agricultural Input System are beneficial and have the potential to guarantee sustainable Agricultural Input System. There must be well-formulated backward and forward public-private partnerships for sustainable development. The public-private partnerships in the Agricultural Input System are not significant. There are no business plans and agreements that are legally binding to both the public and private sectors. In order to attract both national and foreign private investors, the public institutions, which are dominating in the economy of Ethiopia, need among other things the following improvements:

- Predictable and transparent management:
- Proper expertise for the technical departments, and
- Good track records in their performance with competitive strategic business plan

Conclusions and Recommendations

The overall assessment of the agricultural input system in Ethiopia reveals that a considerable effort and progress has been made to establish a sustainable system. The input law and regulations are fairly suitable in most respects for the development of competitive input supply. The private sector is getting attracted into the system, even though it is below expectation. Nevertheless, the agricultural input supply and marketing are not operating efficiently and farmers do not have easy access to inputs at affordable price. There are several factors that need the attention of both the public and private institutions to take immediate actions in order to develop efficient agricultural input system. Among many others, the following are the most important that require immediate action.

- High input prices and low grain prices are disincentives to input marketing
- Weak entrepreneurs and dealers knowledge about input marketing and supply
- Weak farmer's knowledge about inputs and financial capacity
- Poor infrastructure and information network
- Poor performance of the private sector in the development of a competitive and efficient agricultural business
- Poor public-private partnerships in the Agricultural Input System.

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Figure 1: Fertilizer Supply System

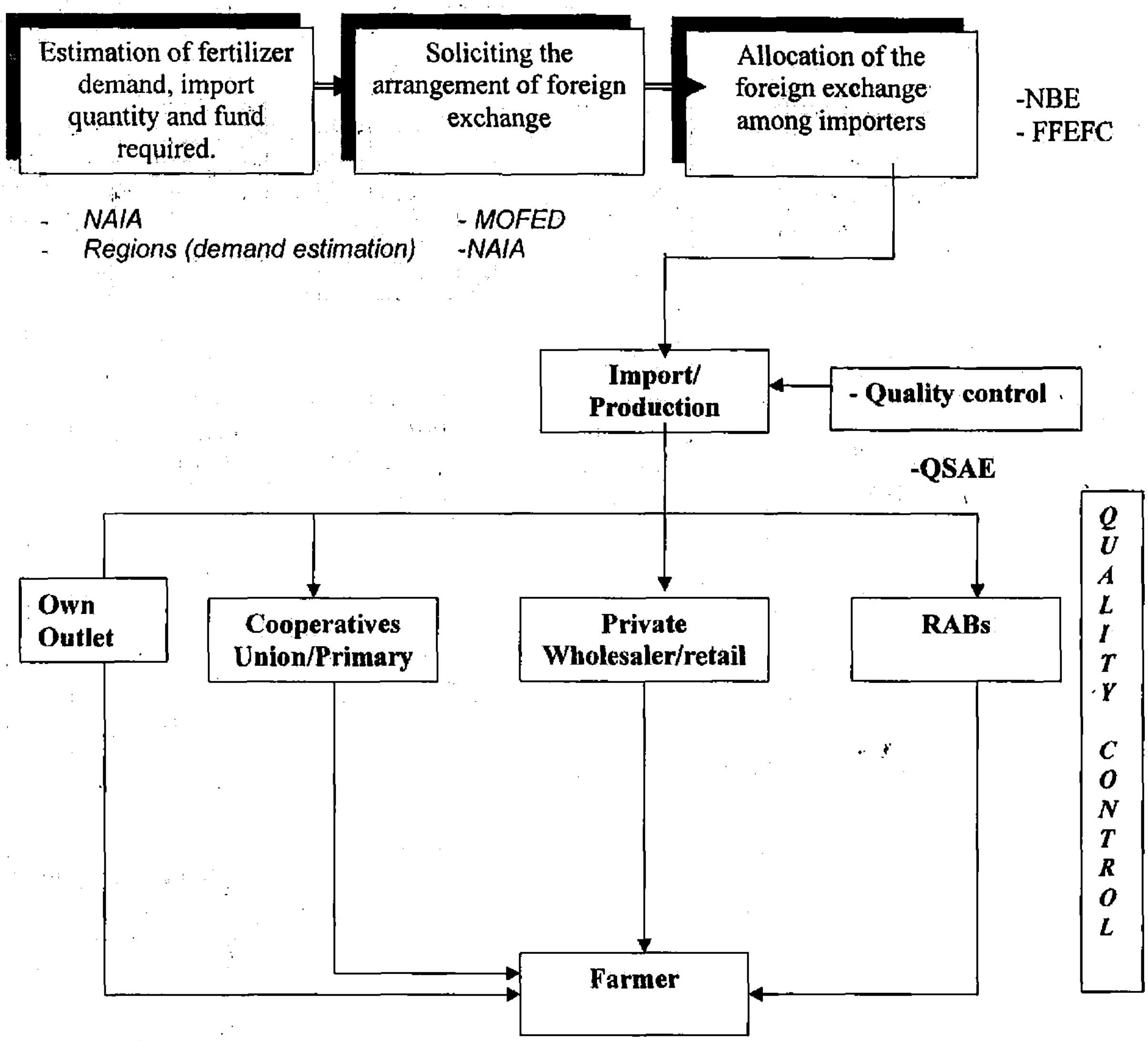


Figure 2. The Seed Supply System

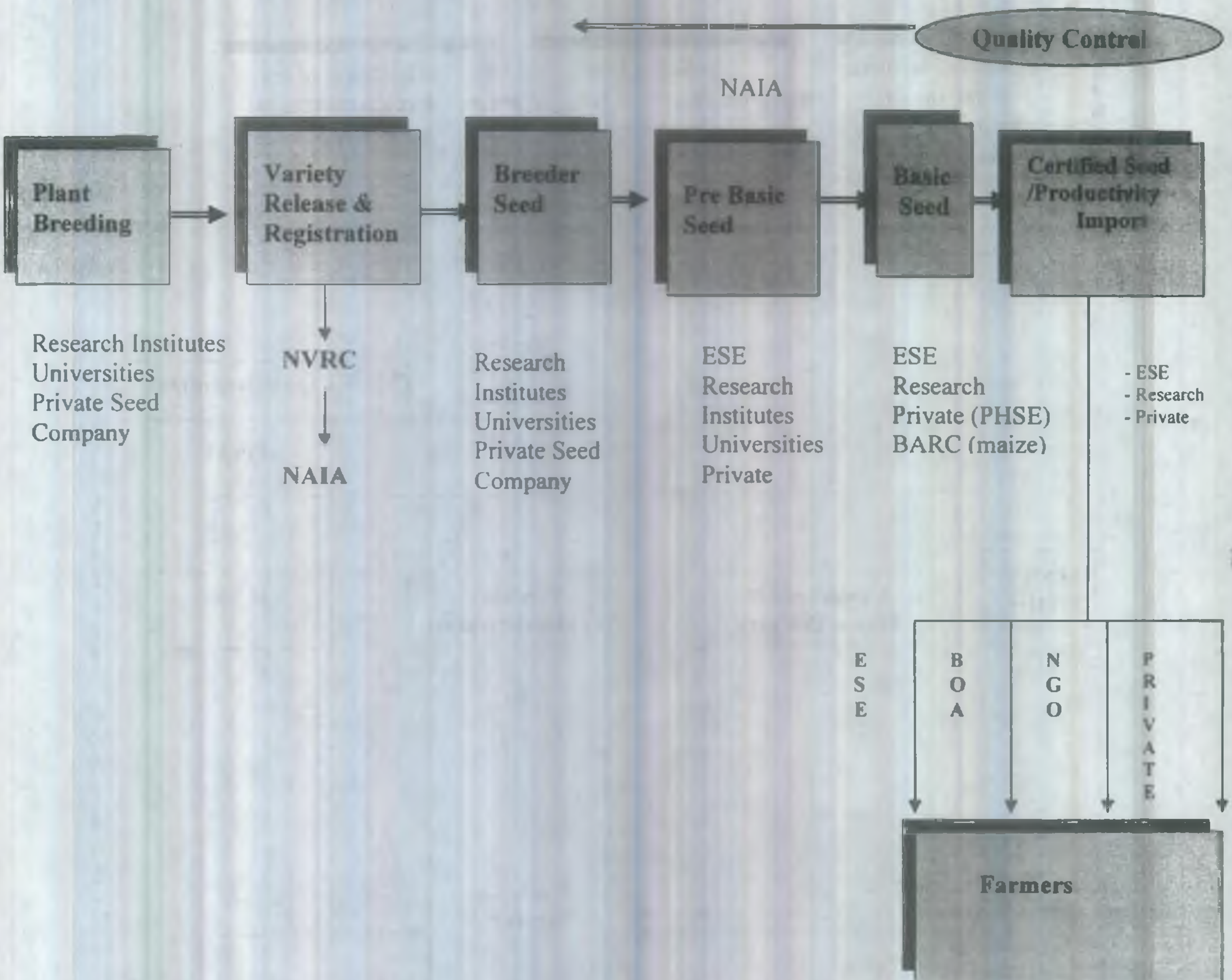
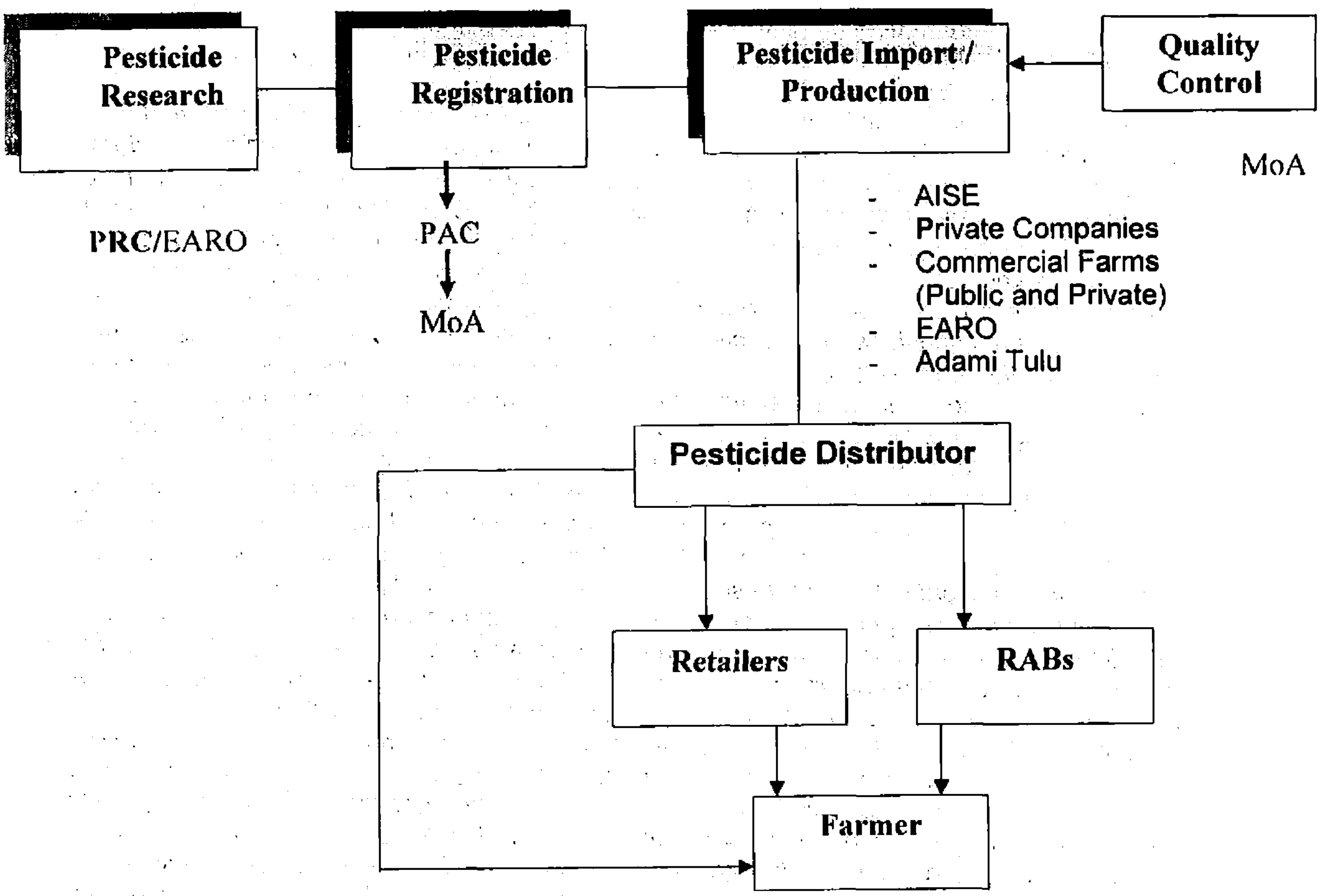


Fig. 3. The Existing Pesticide Supply Structure



Models for Private and Public Extension Cooperation; as Applicable to Ethiopian System

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Abstract

The study on the extension activities of the private sectors in farm production and marketing was conducted during the year 2001/ 02 in the Karnataka state of India. In the study, investigating the roles of several actors was the key objective. Starting from the term itself, extension can mean different thing to different people within different situations, but in common it can be described as the process of assisting farmers to become aware of and adopt improved technologies to increase their production efficiency, income and development of life situation in general. As a principle, extension recommendation must be relevant to the conditions of the client regardless of the methods used. This in turn necessitates the condition that extension must understand the characteristics of target farming system and the factors that impinge on these systems. According to this study, given the increasing tendency for the government to look for ways of increasing efficiency and effectiveness in transfer of technology and decreasing their expenditure on agricultural extension, supplementing sectors such as private firms and NGOs were found to have significant role in the system. Appreciating the role of public and private sectors, the study recommends appropriate adjustment of the public roles to the current demand of farming communities. Accordingly, three basic models for cooperation of public and private sectors were identified to help agricultural development of developing countries. These models are; 1) Government efforts: this appreciates integrated extension through effective communication and farm approach, 2) Government - Private firms - Individual efforts: under this, some form of commercialization of extension service is recommended, 3) Government-Private firms-Group efforts: in this model the use of farmer associations is most appreciated. In the analysis of private-public interaction in execution of research and extension programs, public sector was found to have comparative importance in basic research, whereas private sector could effectively and efficiently perform the input delivery activities. Cooperatives on the other hand showed comparative advantage playing significant role in marketing services. Hence, if government encourages these sectors, the service would be more effective and helping. Therefore, the models described in this paper provide wide scope for increasing efficiency and quality of the services given to farmers. It also gives sufficient opportunities for the policy makers to redesign the system through encouraging involvement of private sector in areas where they show comparative advantage. The finding of this study, with its recommendation towards improving extension policy is believed to shed light on the right direction for possible improvement on the existing public extension services.

Introduction

Most developing countries in general and sub-Saharan Africa in particular continue to suffer from food deficits and poverty despite a wealth of natural resources. Nearly 70% of the population of Sub-Saharan Africa lives in the rural areas and is engaged in agriculture.

Therefore, it is on the agricultural front that efforts to alleviate poverty and achieve food security must be concentrated [1]. In the agricultural sector itself, agricultural extension

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shares the greatest portion of responsibility. Further, the backbone of extension endeavors is the transfer of agricultural information that is aimed at enhancing the productive capacity of farmers. The adoption of improved technologies in farming activities is becoming crucial for countries in order to meet the challenges of rapidly expanding population and decreasing availability of productive lands. Moreover, the recent trend of shifting from the resource based to technology-based system of agriculture underlies the demand and supply of agricultural information [2]. To this end, some type of approach is crucially demanded towards solving the overwhelming problems of the world in agriculture. This approach, according to [3] is a system approach. According to the authors agricultural development in broader sense depends on a system of related functions. As a component of the system, producers, input suppliers, marketers, researchers and governors are all related and need to involve in the system in varying degrees of responsibility.

Agricultural extension service as a transfer of technology was the domain of the public sector all these years. However due to globalization and liberalization, there is a change in the public extension approach wherein the private sector is involving itself in educating the farming community. In the background of the latest development, there is a search for new paradigm of extension system to maximize its effort by combining the strengths of private and public sector potential for extension services. In this context, there is constant wrestling with several concerns like what should be the role of public and private sector in agricultural extension [4]. Experiences of various countries indicated that the provision of extension services varies between countries as well as over time in a given country. But in general, the future extension endeavors will be to transform agriculture from subsistence level to commercial operations.

In agricultural development process, technology gradually changes from public good to becoming an increasingly private good [5]. And private sectors are emerging, for provision of extension service as one of the strong complimentary and/ or supplementary sector to the public services in many parts of the world [4]. The borrowed inferences from world agriculture may not drive to replace the public extension system but provide complimenting role model for strengthening the existing public counter part. Hence, in order to think for change and reform of the prevailing extension system, it is imperative to know the specific role of private sectors in the system and their special area of importance. This demarcation of roles enables to design appropriate model for private and public sectors extension service providers. This paper, thus, explores the diversity inherent in Ethiopian extension systems comparing to the experiences of India and tries to suggest a few reform models of extension and also examines the way in which the models are applicable to the different situations in the coming years.

Methodology

An ex-post-facto research design was used for the study in order to identify the major and complementing activities of private sector extension service providers. Dharwad, Belgaum, and Haveri districts of Karnataka state, India, were the target areas for the study. The areas were purposively selected because of the following fundamental reasons. In one case, the districts are potentional for diversified crop production; secondly, large number of private sectors involved in the extension services and supply of agricultural inputs were found operating in the areas widely. Furthermore, seed producing private companies are operating in the area since the last 10 years involving farmers on contractual mode. As a result of this, available private firms have been selected taking into account the legal registration of the private firms, jurisdiction of their operation, year of experience in the business and renewal of investment license.

In an attempt to measure the extent to which the private sectors perform the extension activities, those activities that are performed by extension personnel under normal condition (by public sector) were identified and scrutinized. To effect this, preliminary survey was made in the selected districts and as much activities as the private companies perform were identified from different sources. Among the activities identified, those, which are found to be common extension activities, were examined. This was to make the condition suitable for comparing the functioning of the different private firms. Finally, the activities were ranked by the respondents using pair wise matrix. Following the matrix ranking, test for relevance and reliability of the ranking were applied using Kendal's Coefficient of concordance (ranking correlation). The correlation result was further tested for consistency of the ranking using the Chi-square formula. Based on the tests, frequency matrix was constructed to calculate frequency score for each activity.

Result and Discussion

The result of this study reveals three basic models for cooperation of public and private sectors. Using this opportunity and relating the case with the extension experiences and systems of Ethiopia, this paper tries to indicate the major activities of private sectors in agriculture, their relative importance, and areas of development that demands effective partnership of the public and private sectors for quality service in extension. At the end it suggests appropriate model for reform and improvement in the existing system. It is inevitable for the government to utilize private extension services on commercial or contract basis. They serve well competing with each other since they cannot survive unless they impress the clientele and achieve good results. Speaking the Indian context, one has to consider on how to demarcate the benefit of extension as "private and public". A controversial argument from the public extension systems to private either as a substitution or complementing each other provoke today's professionals to study the world extension systems and borrow experiences for conceptualizing the privatization of extension system. Even if the time is not ripe for complete privatization of extension, especially in developing countries like Ethiopia, some sort of partnership with public sector is most demanding.

Formative Experience of Ethiopian Extension System

The genesis of agricultural research and extension as well established institution goes back to the 1950s. The institutions were modeled to emphasize the integration of training, research and extension. The extension wing was later transferred to the administrative control of Ministry of Agriculture (MoA), thereby marking the beginning of government funded and public oriented extension service. Since then, a number of methods, approaches and strategies have been under implementation aiming at improving the life of the rural community. The Integrated Rural Development Project IRDP (1967), Minimum Package Programs MPP I-II (1971), IAR/EPID joint programs (1974), IAR/ADD joint programs (1980) and the Peasant Agricultural Development and Extension Project (PADEP) (1985) can be cited among the development projects implemented so far. However, the impacts of all these development interventions were not that much significant in terms of improving the life of the target people in general and the mode of farming and productivity in particular [6,7].

Moreover, the national extension programs (through MOA) and extension package program (through SG_{2000}) are the recent development interventions that have began to penetrate into rural areas using participatory approach. In this recent approaches too, greater emphasis was given to the production aspect which can be called as "*production extension*" and resulted in increasing the production using the improved varieties of agricultural crops and improved management practices.

The current national extension system-Participatory Demonstration and Training Extension Systems (PADETES) is designed and framed in order to appreciate the participatory learning. However, it indicates only the general statement and directives envisaged by the central government [6]. On top of this, the present package program to extension seems to exert its energy on transfer of technologies to boost agricultural production for food self sufficiency. Nevertheless, the advancement in technology promotion is hampered by lack of farmers' organization, private sectors' involvement, village level information center and agricultural marketing agent *(public or private)* in the system.

In spite of the achievements, strengths and/or weaknesses of the national extension system, some controversies on how an extension organization should be organized ever existed. The persisting question is whether extension is to be organized functionally by agro ecology, by commodity based on enterprise, or income generating potentional. The question of accountability also exists whether the extension agents are answerable to the community? to the government? or whether it should go in between; what should happen when the community adopts the technologies, increased production and fails to market it? what if the farmers reject the extension programs? and the like. Attempting to answer these questions, create a burden to the sole public extension services in the country. At this point, one can analyze whether the Ethiopian extension system is complete or if some gaps are observed hindering the achievement of the national goal. In general, in Ethiopian extension system, lack of clear responsibility and accountability, partiality of the system (*as it lacks marketing aspect*), lack of professional and skilled manpower (in extension), and absence of effective communication channels as well as village based cooperative societies are commonly observed lacunas.

In review of the extension systems of developing countries, [8] reported that even if the public extension services were not without success, currently, its efficacy is disappointing in transfer of technologies. On the other hand, globalization and mechanized system of production called for the involvement of private agribusiness firms. This was believed to increase the effective delivery of the extension services on one hand and reduce the burden of the public sector with respect to financial deficit and resource limitation on the other hand [9].

Activities Performed By Private Firms

Many of the private firms (agro-input dealers) perform some extension functions, which could also be viewed as one function of marketing. Surprising to see in private sector that the marketing officers are the ones who also oversee the extension related activities. In agreement to the report of Schwartz [10], private extension is generally not a stand-alone activity, but will be providing certain activities under some conditions. Among the major activities listed in table 1, input supply, farm/ home visit, and group meetings were found to be the top three in the score to which the private firms are affiliated in their business. Among all, input supply stood the highest in frequency score indicating that it was the primary task of private sectors providing extension services. This might be because of their aim of profit maximization.

Comparative Advantages of Key Actors in Research and Extension

It cannot be said that a given single sector could efficiently operate in a given system; rather it demands the cooperation of different actors with clear definition of roles in the system. To this end, table 2 gives a picture of the opinion of private input dealers providing extension services on the role to be played by the actors in the research–extension system.

♦ Research Work (for Development Technologies):

Towards the activity of basic research for the development of technologies, 55.00 per cent of the respondents indicated that it should be undertaken by public sector (government institutions), and other 15.00 per cent responded, as it should be carried out by the private research stations. The rest 30.00 per cent appreciated the joint activity of private and public sectors in this particular activity. As most of the private firms indicated, basic research was to be undertaken by the public sector (Universities, research); but that does not mean there would be no attachment with other sector like private companies and non-governmental organizations. The rest 30.00 per cent of the respondents indicated that depending on the nature of research (basic or adaptive), public and private sectors can participate in several ways.

♦ Provision of Training on Improved Technologies:

Training to farmers, agricultural experts and even private input dealers is indicated to be the most determining. In this case, of the respondents 40% expressed the importance of public sector in conducting training. This might be because of sufficient manpower resource in public institutions, as well as the major concern of government for education. On top of that, because of their profit-orientation private firms might not equally benefit all farmers if training is to be their sole mandate. A report of [11], on the training and education of farmers was in consistency with this finding that the basic education is usually the responsibility of the government, but professional training can be undertaken by private sector, or by collaboration of both public and private sectors. But in determining the training needs all the stakeholders should be involved.

♦ Agricultural Input Supply:

In this particular role, 65.00 per cent indicated that the activity could be efficiently performed if at all given to private dealers. But others (30.00%), looking at the need of intervention of local people's representatives in some cases, indicated a joint venture of private firms and cooperative societies. The private firms could be good in input supply scheme as indicated by majority of the respondents. This correlates with the market-oriented business of the firms and the competition under which they are operating. However, other proportion of the respondents still appreciated the interference of public government hence; the investigation recommends the keen involvement of government in input supply scheme while encouraging private sectors to share the greatest portion for effective and efficient delivery of inputs.

♦ Advisory Services:

Relatively, more number of the respondents (45.00%) appreciated the joint activity of all actors in the system; other 35.00 per cent have an opinion to the fact that the activity needs to be done by private sector. This went in line with the need of training, as most of the farmers were not educated and hence, frequent advisory services are most demanding. Farmers' initiation to keep on using improved technologies depends on the understanding they had about the production systems. Hence, joint services have been appreciated in an attempt to reach as many clients as possible. In agreement with this finding, [12] noted that more often, the fertilizer companies conduct demonstrations on fertilizer use, and arrange soil-testing facilities with provision of technical services.

♦ Marketing Services:

Increasing production per se cannot change the life of farmers if attractive market is not available for their produces. This shows that the issue of marketing is the most decisive factor which deserves due attention. In the study, 20.00 per cent of the respondents indicated their opinion as the marketing services need to be mandated to the public sector. Private sectors also provide marketing information, and help farmers in creating market to their produces. But their services are limited to their client farmers only. The opinion of 30 per cent of the respondents is towards the joint collaboration of all sectors in arranging markets for farmers' produces. Hence, for better marketing system establishment of cooperatives at village level and encouraging private sectors is the greatest responsibility of the public government.

♦ Supervision/ Follow up (During the Cropping Seasons):

The opinion of 45.00 per cent of the respondents was that the activity of supervision goes in line with the credibility of the service providing body. The study indicated effective performance of private firms in this particular activity. This is because of the fact that supervision is a season-based activity when framers need guidance for the particular cropping season. The private input dealers were supervising their respective clients in order to encourage them. This had connection with the customer-ship of farmers with the dealers. But the joint activity as indicated by 25.00 per cent of the respondents might be appreciated because of the common motive of different sectors extending services irrespective of the type of farmers.

A general analysis of public-private interaction in the funding and execution of research and extension related activities were indicated in table 3. As depicted, the public sector was given greater accountability in case of certain activities such as research work, manpower training, and local resource management (enforcing the regulatory policies). Where as; for input supply, advisory services, and on-farm supervisions, private sectors were believed to have more comparative importance. Still the importance of NGOs and cooperatives as well as their joint venture was found to have significant impact in the research-extension systems. Table 3 clearly shows the interaction of different stakeholders and their comparative advantage in funding, executing and supporting in research and extension systems. The general discussion on the interaction of the different actors in technology Development and transfer programs could be summarized as the following modes of interactions.

Consultative Mode: for activities such as problem identification, prioritization and other technical challenges, consultative interaction of all sectors would be demanding.
Collaborative Mode: this is especially in funding and execution of programs, be it research or extension activities.
Contractual Mode: this entails private funding of the public research and extension program, public research services to private sector on cost recovery basis.

Client Mode: this is providing basic and strategic research support to the private sectors
Supervisory Mode: Indicates the aim of ensuring competition and quality of services and enforcement of regulations.

Need for Collaboration of Public and Private Sectors

Analyzing the world experience in the role of private sector and the comparative advantage of private and public sectors in research and extension vis a vis the experience of Ethiopia, one can judge whether collaboration of the sectors is demanding. To appreciate partnership between public and private sectors in extension system or not, depends on the role differences that have been observed in between and the consequences of these differences. An extension service is a comprehensive activity including various duties as delivery of pure information (*technological software*), technology embodied information and pure material inputs (*seeds, fertilizer, chemicals and implements*).

The study indicated that each of the sectors in the system has an advantage in particular situation. Similar finding by [13] indicated that private sectors are playing a predominant extension role for particular inputs, particular outputs and for particular farmers in particular area. In Ethiopia, the extension system that has been operating for decades has not created an opportunity for the involvement of private sectors. However, the modern agricultural system demands a move towards strengthening the private/ public extension systems, which is of utmost importance to peep into the future. This vision may be quite new to the country, but reviews and experiences indicated that there is potential for involvement and effective collaboration of the different sectors.

In the context of defining the role of different stakeholders, there is constant wrestling with several concerns like what should be the role of public and private sector in agricultural extension? Whether there is efficiency gained from private sector delivery? what are the welfare implications for a small farmers and rural poor? what kind of extension messages could be dealt by the public vis-à-vis private extension system? [4]. Moreover, greater use of scientific technologies is another challenge in today's world of agriculture; the issue attached here is the question of efficiency and cost effective production, processing and marketing. To this end, effective performance in the system could be attained by establishing strong partnership between the public and private sectors involving in the transfer of technologies [14].

Model for Effective Cooperation

Review of the past and present situation of Ethiopia, relating to the case of India where the role of private sector is becoming significant gives a wide range of experience and used as a background to suggest some form of models for cooperation.

1. Government Effort (GE-Model)

The public government has been the sole extension service provider irrespective of the farm size and socioeconomic status of the farmers. The main objective is to improve the productivity of agriculture focusing mainly on food grain production. But to ensure efficiency in farming, government should formulate and incorporate the required policy and legislation in this regard. To help the formulation of appropriate policy, this model puts forward some form of mechanism to design an integrated extension approach.

Integrating Experience and Expertise: in farm production, the various stakeholders including scientists, extension agents, and farmers have wider range of experiences to share and consolidate. Hence, enhancing the linkage between these stakeholders enables to integrate their experiences and achieving their common vision.

Integrating Schemes and Resources: involvement of various development departments, NGOs and supporting agencies is a detrimental factor so as to channelize and integrate the resources in a complementary manner avoiding the duplication of activities and sporadic use of resources. Several organizations are seen in Ethiopia performing similar duties with no clear role model. Hence, this model initiates the government effort to act in this regard.

Integrating the Enterprises: this approach enables the development workers of various organizations and the farmers to discuss together and decide on the most appropriate and profitable combination of enterprises in accordance with the needs, priorities, resource and agro-climatic conditions of the area. Here, government plays significant role in designing potential area and potential commodity approaches. This, for one thing increases the land use efficiency, and on the other side ensures the market oriented production.

Integrating Agro Based Industries and Marketing: the concept of identifying potential commodity for a given area and promoting its large scale adoption would pave the way to the establishment of agro based industries on private or cooperative basis. This further could be integrated with the more profitable network for marketing value added products.

Integrating Cost Effectiveness with Accountability and Quality of Extension Work: The conventional approach of technology dissemination "the T&V system" has considered farmers as contact group. The emphasis was to reach as much farmers as possible, but this approach has created lack of accountability in the system and left the farmers as a forced user of technologies. If some sort of accountability is given to the extension service providers, the services will be more of "demand-driven" in nature in these days when there is a possibility for "farmer paid" extension service.

2. Government, Private Firms and Individual Efforts. (GPIE-Model)

Government per se is not an end by itself; it is one means to an end. This model appreciates the combined efforts of the three. The model suggests to recognize private commercial firms in areas where they show comparative advantage. Rather than complete reliance on the government, encouraging the involvement of such private firms would make the extension services *need based* and *market-oriented*. Here the private extension experts offer their services individually, in partnership with others or as a company. It is to be noted that each agent, firm or any service providing company need to be officially registered. In this model the extension advisers and licensed firms are more accountable to their clients. Since a farmer is free to obtain advice from any registered adviser (private firm), the competition that exists among the private sectors enhance the quality of services and increases the level of accountability of the private firm to their clients.

3. Government, Private Firms and Group Efforts. (GPGE- Model)

This is the third model for private and public cooperation in extension, which appreciates the use of farmer associations (groups). Farmers with similar farming enterprises or similar problem groups together form an association to act on their common problems. The public and private extension support either directly or indirectly helps the association in planning and executing of various activities of the association. In the analysis of private-public interaction in execution of extension programs (table 3), cooperatives were found to havecomparative advantage and plays significant role in marketing extension services. This indicated that the services that cooperatives are providing for the member farmers would be more effective if the cooperatives are supported by the government. Furthermore, the farmers organized in groups could employ extension agents as their farming experience becomes market oriented and client demand-driven. Hence, government has a role to play in making this model functional. Under this model, two extension approaches are feasibly recommended.

- **Potential Area Approach (PA-Approach):**

By its nature an extension project involves considerable cost, it can only be justified if it can induce improvement in productivity and increase farm profitability [7]. Thus feasible changes need to be investigated. On the other hand, in an attempt to improve the extension services, controversies on how the system should be organized existed. According to [6], there are cases where extension is organized functionally by agroecology (pastoral extension, irrigation extension, highland extension), or commodity wise based on enterprise (crop extension, livestock extension, coffee extension, forest extension...). This approach is recommended under the ***GPGE-model*** believing that it will keep in pace and strong the cooperation of public and private sectors together with the farmers. Besides, it improves the land use efficiency of the farming community as it paves the way to the potential (market demanded) commodity approach.

- **Potential Farmer Approach (PF-Approach):**

The potential area approach is believed to give rise to the potential farmer approach (PFA). Exploiting the potential areas initiates the farmers to concentrate their farming business on the commodity (crops, livestock) that yields better and have market demand. This further leads to commodity specialized farmers (potato growers, cotton farmers, coffee growers, etc.). The existence and strength of this specialization, however depends on the potential of the local as well as national markets. If good market services accompany the PF-approach, the specialization to commodity farming will produce the commercial oriented farmers. Generally, it is believed that policy makers/ designers do have wide scope to reform the existing Ethiopian extension system taking into account the three models described in this paper.

Conclusions and Recommendations

The study on the extension activities of private sectors related to the Ethiopian extension systems indicates the possibility of improving the existing public funded extension services of the country. The review of Ethiopian case shows inadequacy and incompleteness of the system. This situation demands necessary adjustment of the system, which is believed to happen through incorporating the best contributions of private firms. As a remark, various models might have been used in one form or the other, but in extension systems in general the control of clients over the system is almost nil. Therefore, the models described in this paper provide wide scope for increasing efficiency and quality of service by promoting the controlling power of clients on the system. It also gives sufficient opportunity for the policy makers to reform the existing extension system through encouraging private sector's involvement in areas where they show comparative advantage. Developing strong policy in this regard in turn create favorable condition for integrating public and private sectors as well as farmers' groups and associations in the days to come.

In attempting to go for reform, the potential area approach and potential farmer approach can most widely be used to improve the farmers and their farming. While advocating this form of approaches, due attention should be paid to the resource poor farmers which are much dependent on the public government services, and the remotest areas ("rural vacuum") which the private input dealers could not reach because of limiting factors.

Finally, this study gives the following key recommendations to be used as a tool in extension policy design.

- Private sectors can perform extension activities through multiplication and distribution of improved seeds, supply of fertilizers and chemicals. Hence, public government need to be realized of this burden and emphasis on other issues of development. Still it can share the function of input delivery in case when some sort of subsidy is thought for poor farmers.
- A contractual arrangement between private seed producers and farmers is a good start in fostering contractual mode of interaction, hence, this needs to be encouraged.
- Government assistance is needed in exploring marketing opportunities as agricultural production is increasing.
- Seed training on massive scale for farmers, extension workers and private sector (including NGOs) staffs is needed.
- Farmers should be assisted in developing effective marketing of the seeds and their produces in order to ensure sustainability. In this respect, governments need to provide assistances in such areas as improved marketing and utilization, reasonable pricing of farm inputs and fair product pricing.
- Government needs to support the private sector operators and encourage them for investment on agro based industries in rural areas (near the raw material sources)
- Public funded research should also emphasize the development and adaptation of technologies of immediate output taking into consideration the current national issues; food security and marketing issues.

Table 1: Extension Activities Performed by Private Operators

Activities performed	Respondents	Frequency Score
Agricultural input supply	95%	60
Farm /home visit	45%	47
Meetings/ group discussion.	35%	44
Office calls	25%	40
Method demonstrations	20%	39
Credit service**	25%	36
Farmers training	25%	37
Result demonstrations	20%	38
Field day/ Farmers' day	25%	38
Video shows/ Audiovisual presentations	10%	30

** Credit services extended to farmers directly or indirectly on certain circumstances.

Table 2: Responses Towards the Roles to be Played by the Different Actors

ACTIVITIES	Response Towards the Key Actors (%)				
	Public Sector	Private Sector	NGOs	Cooperatives	Joint
Research work	55	15	0	0	30
Man power training	40	15	15	5	25
Agricultural input supply	0	65	0	5	30
Advisory service	10	35	5	5	45
Supervision / follow up	15	45	15	0	25
Marketing services	20	15	5	25	35

Table 3: Public–Private Interaction in Funding and Execution of Activities in Research –Extension System

Activities	Public Sector	Private Sector			Joint venture	Example
		Private for profit	Private for no profit (NGOs)	Cooperatives		
Research Work	F* E*	E	F		S	Development of new varieties, production technologies, etc.
Manpower Training	F* E*	E P	F E		F* E	Education and training on frontier areas
Agricultural Input Supply		F* E*		E S	E	Hybrid seeds, chemicals, fertilizers, Farm implements, etc
Advisory Service	E	E* P			E*	On what to produce, which variety to use, how to do ect.
Supervision /Follow up	E	F* E*	E		E	To transcribe how well farmers are doing and recommen best suggestions
Marketing Services	Pg* E	E		E*	E*	When to sale, how much, to whom, through which channel, where to sale, etc. Also creating market facility for their produces
Local Resource Management	Pg* E*	S	F E*	S	E*	Allocate of resources, how much of a given resource (eg land) for which crop.

Note: F: Funding, E: execution, P: Payment for services; Pg: planning; S: Supportive
* indicates strong comparative advantage

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The Role of Cooperatives in Enhancing Food Security

*Zerihun Alemayehu**

1. What do we mean by a Cooperative?

In 1995, the International Cooperative Alliance (ICA), the apex organization that represents cooperatives worldwide, defined a cooperative as:

"An autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise."

This definition emphasizes that cooperatives are independent of government and not owned by any one other than the members. Members are united voluntarily, and should be free to join or leave. Cooperatives are distinguished from shareholding firms by their democratic nature, with voting rights being assigned by a person rather than by size of shareholding.

Finally, the definition emphasizes that they are enterprises, and not charities, NGOs, or branches of government.

Values

Cooperatives are based on the values of Self-help, Self-Responsibility, Democracy, Equality, Equity And Solidarity.

Cooperative members believe in the ethical values of: Honesty, Openness, Social Responsibility and Caring for others.

The cooperative principles on which they are based reinforce this definition.
The principles are guidelines by which cooperatives put their values into practice.

1st Principle: Voluntary and Open membership
2nd Principle: Democratic Member Control
3rd Principle: Member Economic Participation
4th Principle: Autonomy and Independence
5th Principle: Education, Training and Information
6th Principle: Cooperation Among Cooperatives
7th Principle: Concern for the Community,

The way to explore the contribution of cooperatives to fight against poverty is through three notions.

* Cooperative Commission, Addis Ababa.

Opportunity means that poor people have the chance to lift themselves out of poverty and all other forms of deprivation that go with it. On the supply side, opportunities are created when economic growth is stimulated and markets are made to work for poor people. On the demand side, the poor must have the capacity to take advantage of the opportunities, and this means building self-confidence through education, training, and self-organization like cooperatives.

Cooperatives have a contribution to make both on the supply and demand sides. Because they tend, through natural extension of primary societies to federate into larger bodies, national and international markets can be opened up.

Empowerment "The expansion of assets and capabilities of poor people to participate in, negotiate with, influence, control and hold accountable institutions that affect their lives." It means expanding the freedom of choice and action to shape one's life. In the development process, it means that wherever possible, poor people should have as much control as possible over the resources being invested, and over the decision-making process. It has been recognized for a long time that without the participation of the target groups it is difficult to make development projects effective. It is also true that where people are individually powerless there has to be strong local organization of one kind or another. The cooperative movement has relied on the strength that comes from acting collectively to empower individuals. It is likely that whether we call them cooperatives, community associations or farmers' organizations, they will have cooperative characteristics which means that they are member based organizations set up for economic aims.

Security means taking measures to reduce poor people's vulnerability to risks. Risks can occur at the micro or macro levels affecting individuals or the entire country.

Cooperatives can help to reduce the risk to individuals through pooling risks at the level of the cooperative enterprise.
Typically, as soon as cooperatives become large enough they offer their members insurance.

How can Cooperatives play a significant role in the development effort of the country?

Cooperatives especially in the agricultural areas can serve their members in an organized manner in providing agricultural supplies and bringing their produces to the market.

The common interests of the members are clear, all farmers need inputs that are better in quality and reasonable in price and they need marketing to save them from being exploited by middle men who take most of the profits.

It has been proved by researchers that out of ten reasons for rural poverty, the three that are most amenable to action are infrastructures, agricultural inputs and marketing.

In the years to come the main challenges before cooperatives are supposed to be food security, poverty alleviation and social services. The relevance of cooperatives in improving the livelihood of their members is linked to their abilities to respond effectively to the needs and aspirations of its members. The strength of a cooperative lies in its ability to cultivate a feeling of trust and confidence among its members and strong commitment to continue to retain this feeling.

The food security strategy of Ethiopia emphasizes the need to realize the Agricultural Development Led Industrialization (ADLI) strategy, the means to get the country out of food in secured situations.

It is pointed out that, "The adoption of ADLI presupposes productivity enhancement of small holder agriculture and industrialization, based on utilization of domestic raw materials via adopting labour- intensive technology. It is believed that the development of agriculture helps expand market and increased incomes of small holders.

The importance of cooperatives in carrying out coordinated and comprehensive development efforts is evident in Ethiopia where farm holdings are small, application of modern technology is very low and production is mainly of subsistence nature with low marketable surpluses. Thus strengthening the organizational level of farmers will be given high emphasis.

A 'cooperative union' is taken here as a case in point to vividly illustrate the role of cooperatives in enhancing food security in specific area of Oromiya region. It is called Meki-Batu cooperative Union.

The Meki-Batu Cooperative Union, which is located in Eastern Showa Zone, about 130 km away from Addis on the way to Shashamanne is set up of 12 primary societies.

This area used to have been facing a deep-rooted, vast and multidimensional problems. As a result of low agricultural performances the people had been leading miserable life, exposed to severe food shortage and hunger.

A sound and sustainable community based organization became eminent. A cooperative which is owned, used and managed by its members was believed to play a significant role.

It was a matter of choice either waiting for emergency food aid and become dependent of donors or make a collective effort and create irrigation cooperative union and become master of one's destiny.

In the case of Meki-Batu the second choice was the best choice. Lake Ziway served the union for irrigation purpose?

The Union was formed in December 1999 embracing 16 Primary cooperatives out of which 12 have been registered (legally certified).

The Union is having a membership of 636 farmers (552 men and 84 women).

At present the members of this Union cultivate over 496 hectares of land.

Major Objective of the Union

The major objective of the union is to enable its members get an opportunity to free themselves from hunger and produce marketable produces in a sustainable manner

Services Provided by the Union:

a. Supply of Agricultural inputs:-

b. Improved (high yielding) varieties of maize & assorted vegetables seeds,

c. Agricultural machineries for ploughing, dicing & ridging members' land on rental basis for food security program;
d. Marketing members'= produces;
e. Provision of credit;
f. Provisions of market information
g. " of transport & storage facilities
h. " training to members

In its Food Security Programme support, the union focuses on crop production activities. Through credit facilities and other technical support from the cooperative Promotion Bureau of Oromiya a variety of crops production activities are being performed.

Maize, Onion, Cabbages, Potatoes, Papaya, Tomatoes and soybeans are some of the items produced. Some of the items are marketable and especially vegetables from this area satisfy markets in Addis and Nazreth cities.
Some of the factors that guarantee the sustainability of food security in Meki-Batu Union are the provision of Credit and Market information as well.

Transport and storage facilities are also consistently provided by the union. There is training programme for ordinary members, committee members, manager and the staff of the union. NGOs like self-help Development International and VOCA/ Ethiopia are so much helpful in enhancing the overall capacity of the Union members.

Conclusion

Cooperatives are not only business organizations but also social ones. One of the cooperative values is social responsibility. In their principles they are concerned for the community.

Cooperatives in general advocate for equitable use of natural resources so that the next generation will hope to have a future.

The Union has become a key factor to help farmers to stay in farm business.
Marketing, transporting and storage of farmers produce ensured members to adjust timing of sales, control product flow further up the marketing system which can ultimately bring in greater financial rewards to individual members.

The benefit of the Union spreads beyond members in the sense that the individual consumers get quality produce for reasonable price. Additional income generated by the union finds its way back to union's employees salaries.

All primary societies, unions and the future higher types of cooperatives are supposed to tackle poverty, ensure food security and do away once and for all with uncertainty of daily life in the rural areas of our country.

Attaining Food Security with Integrated Approach to Agricultural Development

P. A. Chadhokar[*]

Abstract

Food insecurity problem in Ethiopia has become almost a regular feature in recent years and this year it is at its worse. The estimates over the last decade indicate that on an average annually around 4-5 million people regularly need external food assistance which amounts to about one million tons of additional food to bridge the gap between domestic supply and the demand which keeps growing every year. Unfortunately this has been happening in spite of various efforts being made to improve food production. Presently we are producing annually about 10-12 million tons of food from as many hectares of land under cultivation and to make the country self sufficient in food we would need to produce extra one million tons for the present. Although we have been blaming insufficient rains for limiting the production potential of our lands which is true to some extent but the problem appears to more complex and it is directly related to the poor health and inefficient management of the basic components of agricultural development. As far as agricultural development is concerned the three most important components are the soil, the water and the farmer. Unfortunately we have not been using and managing these components responsibly and efficiently. As a result they have lost their capability to contribute towards improved food production. Most of the productive lands in the Highl`ands have been affected by soil erosion, diminishing their capacity to provide effective depth, plant nutrients and water essential for plant growth. In absence of effective water conservation and harvesting measures, most rain water is lost as runoff and the farmer who is our bread winner still remains the most neglected, least respected and least supported member of our society. With all our efforts to improve agricultural production we have reached only thus far and this is not enough and we have to do more than and better than this. The average small farm in Ethiopia is a complex integrated agricultural system and the present approach has not been effective in improving the capacity of this system. Therefore, in order to build food security we must improve the efficiency of the soil, the water and the farmer by providing necessary support and this would be possible by following an integrated holistic multidisciplinary and participatory approach in a coordinated manner. This integrated approach when it is followed in the form of an integrated watershed development approach brings about an overall improvement in the ecosystem with definite improvement in agricultural production and income on the individual farms. An integrated watershed development approach includes a holistic multidisciplinary coordinated approach based on the socio economic problems of the community, where the community is an active partner at all the stages of decision making and planning. The community is also responsible for implementing the programme where the Government plays the role of a facilitator with all necessary support It should be realized that there are no short cuts and magical solutions in agricultural development and only a well planned long term strategy would take us on the road of achieving self sufficiency in food production.

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1. Introduction

At present Ethiopia is experiencing a very serious problem of food insecurity when an estimated 14 million people are in need of external food assistance to survive. Although the present problem is perhaps the worse so far, nevertheless, Ethiopia indeed has been facing food shortages for the last three decades. It has been estimated that in recent years, around 4-5 million people regularly needed food assistance as the demand for food outstrips the domestic production [6].

However, Ethiopia is not the only country experiencing food insecurity. World over almost one fifth of the population suffer from hunger because, either the food availability is insufficient or people do not have access to food (Anon, 2001). Over the years several efforts have been made at the International level to discuss the problem, formulate strategies and to initiate action to reduce the food insecurity problems. Since the first World Food Conference in Rome in 1974, followed by many other World Forums in between, and the latest being the Vision 2020, titled sustainable food security for all by 2020, where agreed actions to abolish hunger and malnutrition by the year 2020 were accepted. Unfortunately in spite of all such pledges by the World leaders, little precious has been done and achieved but most certainly, the number of people going hungry has been continuously increasing [1].

The reasons for food insecurity in Ethiopia are many and complex. These range from increasing population at the rate of about 3% per year to decreasing land productivity at about the same rate due to land degradation. Add to these the changes in climate, gradual degradation of natural resources, reduced soil fertility and availability of water, combined with decline in land holdings, policy induced stagnation of agriculture and insufficient institutional and technical support [6].

The trends in food production [6] over the years indicate that the rate of improvement in food production has been low and slow in spite of adapting various strategies, plans and substantial investments. This trend also indicates that the food production has not been affected only due to inadequate rains but it has also been significantly influenced by our inefficiency in managing of the basic resources essential for food production. The most basic and the most important components in agricultural production are the soil, the water and the farmer. Our small farms are an integrated agricultural system and therefore, our approach should also be an integrated approach but we have ignored the holistic integrated approach, which is based on the socio economic problems of the community and their active participation. Perhaps this has been the major factor causing setbacks in achieving improved food production.

This paper briefly reviews the problems and issues related with the management of the soil, the water and the farmer and suggests possible improvements by following an integrated multidisciplinary approach based on the concept of an integrated watershed development, which has become successful elsewhere under similar conditions.

2. How Far are we from Self Sufficiency in Food?

Agricultural production in Ethiopia depends on the contribution of millions of small farms scattered around the country; however, it is the Highlands, which still remain the centre of agricultural and economic activities. Thus it is the Improvement in the condition of these farms that will lead us towards achieving self-sufficiency in food production.

Food grain production figures over the last forty years [6] show a very interesting trend. In fact from 1961 to 1973, there was a linear increase reaching up to almost 8 million tons resulting in a considerable surplus grain production. Since then, however, production actually showed reduced trends with considerable fluctuations over time and equalled the figure of 1973 only in 1994. Later on in spite of fluctuations from year to year, production continued to improve slowly reaching close to 12 million tons in the year 2000. Unfortunately this increase was not sufficient to meet the increasing demand of food.

Barring the current situation which is exceptionally serious than in previous years, it has been estimated that presently we need between 0.7 to 1.0 million metric tons of additional food grains (not including needs for increasing population) annually to bridge the gap between production and requirements [6]. This is just about 10% of what we presently produce annually. Based on the average production over the last few years, we are producing between 10-12 million metric tons of grain from as many hectares of land annually cultivated.

This also indicates that if we could produce additional around one million tons of food from the land annually cultivated, we would have reached the level of self-sufficiency at least for the present. However, this has not been possible in spite of enforcing various plans, strategies and improved packages. The trends in food production over the years also indicate that there is much more to the limited food production than only the unfavourable weather conditions and simply blaming inadequate rains will not solve our food insecurity problems. Actually the more serious and significant limiting factors are related to our approach to utilization and management of the basic resources essential for food production.

The most important factors limiting food production include:

- Inefficient Soil Management Practices

  Most of the Highlands have been affected due to soil erosion, which has reduced its power to support plant life due to loss of depth, loss of soil fertility and water. This menace is spreading like the disease cancer and we have not done enough to reverse this trend [5].

- Inefficient Management of Water

  If it does not rain it is too bad but if it rains and we can not efficiently conserve and use the falling water is even worse. This is happening as a result of insufficient efforts in water conservation and water harvesting.

- Inadequate Support to the Farmer

  He is the breadwinner and the key to our survival and prosperity yet we hardly seem to care about him, his family or about his profession. He remains one of the least educated and poorest members of our society with little support provided.

- Inadequate Attention to Post Harvest Losses

  It has been reported that every year we lose between 25-30% of harvested food as a result of inefficient handling of food during harvesting, threshing and storage. Not only this even there is a potential of harvesting up to 10% more grain if the crops are harvested at the proper physiological maturity stage [13]. Even if we can reduce these losses by only 10-15%, we can easily bridge the gap between the demand and supply.

Here we will consider the three basic components of agricultural production and these are the soil, the water and the farmer. All other resources, inputs and activities play supporting role making these three components more efficient and effective.

3. The Basic Components of Food Production

The soil, the water and the farmer are the three most important components of agricultural development and play direct role in food production. These components also play complementary roles. We cannot produce enough food even if one of these components is missing from our agricultural system. Let us see what is happening to these components.

3.1 The Soil

The soil is the base for supporting plant growth on the land. It is this soil, which has been supporting our lives for centuries yet we do not seem to bother much about its welfare. As far as agricultural production is concerned, the soil provides:

- Support to the plant and its growth, which depends on its depth and physical characteristics such as texture, structure, which are influenced by the presence of organic matter.
- Provides various plant nutrients required for plant growth. All the major and minor nutrients are provided by the soil
- Provides water for plant growth and this depends on the capacity of the soil to absorb the water and hold it in the rooting zone during plant growth. This again very much depends on the organic matter content in the soil.
- Soil is a living laboratory for biological activities in it. Millions of microorganisms thrive in the soil benefiting crop growth in variety of ways.

Until early seventies our soils were producing more food than required for the population but in later years while the demand for food kept on increasing, the capacity of these soils indicated a downward trend in production. However, this downward trend was not altogether only due to failure of rains and the loss of inherent capacity of these soils has contributed substantially to this. The real culprit behind this has been land degradation due to soil erosion by water. Soil erosion takes place when protective plant cover on the land is absent or inadequate and this happens as result of inefficient use and management of land resources. Interestingly soil erosion is caused when we are unable to either manage the falling rain efficiently or use it effectively for productive purposes or both.

The Ethiopian Highlands still the centre of major agricultural and economic activities have been the victim of soil erosion for many years. Soil loss estimates in mid eighties indicated that Ethiopia is loosing soil at the annual rate of between 1-3 billion tons. The Ethiopian Highlands occupy about 45% of the total land area of which 50% is significantly eroded, 25% seriously eroded and about 5% has lost the ability to produce. Only 20% of the Highlands were estimated to have minor problem of soil erosion [3,9]. However, in absence of adequate measures to reduce soil erosion, this menace continued to grow from bad to worse and still accelerating. Not only the loss of soil, the losses of plant nutrients due to erosion are even much higher. Let us see what has been happening under the three major land use systems that is on the cultivated, forest and grazing lands.

The reduced capacity of cultivated lands has directly hit our lives to the extent that today we are not able to feed ourselves. This capacity has been diminished in time due to inefficient farming practices, which reduces the cover on the land and also reduces its capacity to produce. In spite of sufficient technical know-how, we are still following some very inefficient cultivation and cropping practices. For example, ploughing the land with the only plough Meresha for all crops, and often cultivating land up and down the slopes and most significantly sowing of crops by broadcasting the seed on the surface ignoring the importance of optimum plant population and plant density, with minimum of weeding and inter cultivation. Add to this the absence of row cropping along contours, strip cropping with proper crop combinations etc. Such inefficient agronomic practices have have provided inadequate plant cover exposing the land to soil erosion. Uncontrolled erosion losses left the land unproductive and this could not be reversed in spite of applying improved inputs such as improved varieties and fertilizers.

And most importantly perhaps not returning to the land the sources of nutrients and organic matter such as the dung and crop residues affected both soil fertility and its capacity to hold water. The diversion of these traditional forms of replacing nutrients in the soil is estimated to reduce agricultural productivity by 10-20 percent below its potential [11].

The condition of forestlands is equally serious. Permanent and long term forests cover especially on the hilltops and hillsides provide effective cover to the land. The forests reduce runoff, flooding and silting in lower areas and ensure clean perennial water supply. However, the condition of our forest is very poor and sad. Recent reports indicate that until a century ago about 35% of Ethiopia was covered by natural high forests and today just about 2.3% cover is left [10]. The saddest thing is that while the forest cover is being steadily removed at the rate of about 200,000 hectares every year as around 77% of energy requirements are met from woody biomass. As compared to the losses, the present efforts in afforestation have been insignificant. Forest plays a very important role not only in meeting human needs but also protecting the environment, which is being polluted everyday.

The state of grazing lands is not any better either. Although we have the largest population of livestock (35 million tropical livestock units) in Africa grazing on more than 50% of the land under grazing, highly degraded and unproductive, but the returns from this sector are very poor mainly due to poor management of over populated livestock. Interestingly, in spite of this, many farmers either own one ox or no oxen at all for cultivating the land. There is no doubt that the livestock plays very important role in the lives of the farmer but we conveniently forget that livestock also significantly contributes towards soil erosion as a result of overgrazing the grasslands, removing of vegetation from cultivated lands and the physical damage caused by their movement on the dry land.

We should be equally concerned with the damage to land caused by some non-agricultural activities. For example, we are simply not concerned with the extent of damage to the productive lands caused by the activities of the Roads department. They simply divert water from the road on the cultivated lands causing serious gully formations. Similarly, various rural, urban and industrial development activities have also been responsible for serious soil erosion.

There is no alternative but to fight land degradation problems as a priority and to save the lands because, today this has become the most significant factor in limiting land productivity. However, any efforts in this direction must include both preventive and control measures of soil water conservation and at the same time these measures must add to improved food production if these are to be acceptable to the farming community. Some suggestions to improve the situation include:

- Soil erosion must be considered as a national problem and the Govt. must provide necessary support and assistance. A national soil and water conservation programme based on well planned strategy is necessary as the present piecemeal and ad hoc approach has not been effective. An alternative is a well-planned coordinated multidisciplinary approach.
- Soil erosion under major land use systems (cultivated, forest and grazing lands) has already become a serious problem and it is accelerating fast. Present efforts and resources in soil and water conservation are just a drop in the ocean with minimum concern and resource allocation.
- We must give priority to prevent and control soil erosion on the potentially productive lands by treating the causes of erosion and not waiting for the symptoms to appear.
- Improved soil, crop and livestock management practices along with physical measures provide the most effective soil and water conservation resulting in improved land productivity at the same time.
- In order to motivate the farmer to accept and practise conservation on his land and to maintain and repair them, conservation must be made productive and this cannot be done without improved land husbandry practices.
- The research and extension support necessary to save the land and make it productive must be cost effective and acceptable to the farmer. Those who are directly concerned with land use systems must also bear responsibility for soil conservation.
- Because soil erosion is caused due to inefficient and ineffective management of rainwater falling on the ground, the solution also should be found through its efficient management.

3.2 The Water

Similar to the land, we had taken for granted that water is also freely available commodity in unlimited supply. May be it was true in the past but not anymore. World over some two billion people experience water problems and this problem is multiplying every day as a result of dwindling water resources, increasing demand for water and irresponsible management practices. Water is likely to be the most limiting commodity in the 21st century as result of increasing demand and dwindling supplies. A recent article in the Ethiopian Herald on the occasion of the Third Water Forum taking in Tokyo, Japan states that by the year 2025, two third of the people will be affected due to water shortages if current trends continue unchecked.

Water is the most important indispensable commodity in our life, because without water there would be no life on this planet. There will be no biological activity on the earth and the soil without water will be more like a desert. Also there is no alternative to water like there is for fuel etc. Just imagine life without water in our every day life and its adverse effects on health and hygiene. But irresponsible use of available water and not managing water resources effectively could lead to most unpredictable future consequence.

Ethiopian agriculture is mostly rain fed and depends on the rain and its distribution. Therefore, in Ethiopia we have every reason to be concerned with water scarcity both for crop production and domestic uses. Various reports indicate that Ethiopia is endowed with enormous sources of water for agricultural development. Most parts of the Highlands generally receive adequate amount of rainfall in normal years, which eventually drains in to lakes and rivers. Unfortunately much rainwater is lost in absence of adequate conservation and harvesting activities. It has been estimated that from about 110 billion cubic meters annual surface water supply, only one percent is used for irrigation and hydropower. It also has ground water resources estimated at 2.6 billion cubic meters and many springs and small streams that can be used for water harvesting. The country has a potential of irrigating about 3-4 million hectares but presently just about 160000 hectares are under irrigation [7].

Considerable efforts are in progress in developing large irrigation schemes, which would definitely help in improved food production in the lower areas. But such schemes can not provide water to those farmers situated on the slopes in the Highlands and here small schemes to conserve and harvest water perhaps would prove more effective and useful.

The poor rainfall conditions have been blamed for our poor harvest but at the same time we lose significant amount of rainwater as runoff because of the poor infiltration and water holding capacity of our soils caused due to soil erosion as a result of poor land management practices.

Therefore, the solution to our water problem for crop production lies mainly in conserving maximum amount of rainfall in the soil, where it falls and then harvest excess runoff for additional benefits. While we do not have control on the amount, frequency and intensity of rains that are received but what is under control is to make the best use of the rainwater falling on the land. Even if the rainfall is normal, it is seasonal and unless we are able to conserve the water in the soil and store it in the root zone, crop growth could still be affected.

Thus in order to trap most water and encourage absorption in the soil and improve its capacity to store for crop growth, we must create favourable conditions both on the soil surface and in the soil. This can be efficiently achieved by following suitable land husbandry practices. These are the same agronomical practices, which are essential for both soil conservation and improved crop production. Improved land use systems can significantly affect the availability and quality of water both locally and downstream. Therefore, improved soil, crop management practices must reduce the impact of falling raindrops, slowdown the speed of runoff, encourage maximum infiltration of water and improve soil capacity to hold maximum amount of water in the soil during crop growth. Moisture conservation can also be improved by using practices such as tie ridging, ridge and furrow system along the contours, contour trenching and suitable physical conservation structures.

It is this conserved water, which at later stages becomes a source of perennial water supply and it is available to us through the wells, springs, streams and rivers which can be developed for both crop production and domestic uses.

However, when it rains, there will always be excess runoff, and if this runoff is not controlled and used efficiently, it would accelerate soil erosion, flooding and create environmental problems. This runoff must be harvested and used both for crop growth and domestic purposes. This would be especially beneficial in the Highlands where large-scale irrigation facilities cannot be made available to the farms situated on the slopes. Water harvesting has been successfully achieved and efficiently utilized on small farms in countries such as India and China, and there is no reason why it cannot be achieved in Ethiopia.

In recent days there has been a sudden spurt in water harvesting activities in some regions of Ethiopia and this indeed is a very welcome sig. However, the amount of water available in the storage structures will be small especially for crop production. Efficiency of this activity, therefore, will very much depend on the proper and efficient management of catchments, management of runoff, quality of storage structures and most importantly the efficiency of water use. Unfortunately at present little information is available the farmer on such aspects.

As already stated earlier, it is the inefficient management of falling rain on the land that has caused soil erosion problems and as a result the food insecurity and therefore, efficient water management both by way of conservation and harvesting must be given priority in the development of agriculture. And this must be achieved by developing both small and large-scale irrigation facilities. If water is made available to in the dry zones, their productive potential can also be exploited.

3.3. The Farmer

The farmer is the backbone of agriculture and food production in Ethiopia. It is a fact that we could not produce enough food without the active support and participation of the individual farmer in the country and yet to day he is the most neglected and least respected member of the society. We consider him illiterate and ignorant and make decisions for him or on his behalf even without understanding his problems

We must not forget that the farmer has been a great survivor for centuries against all the adversities around him. The ten to twelve million tons of food we annually produce comes from the contribution of millions of small farmers and with very little support to him. The farmer has been a victim of circumstances both natural and man made and in spite of his hard work, he remains poor. It is he who goes hungry first during bad times and receives any assistance at the last. We have found an easy escape goat in the farmer who is blamed for all the problems on the land, even at the cost of our inefficiency in assisting him correctly.

Without properly understanding the farmer, his views, his problems and their causes, we the educated, "we know everything people", do not fail in imposing our views on him.

The farmer learns his trade from the only teacher, his parents and we have done little to educate him on improved farming techniques. To day the farmer faces a variety of problems on his land and they are related to policies, technical, financial and social aspects, however, these are all interrelated and need to be considered all together in a common approach.

Let us see how the life of the farmer and therefore, food production is influenced by the environment around him.

Policies

- Policies and decision making: Rather than making the farmer a partner in formulating policies and decision making, these are made for him and on his behalf without consulting him or understanding his problems.
- Policies and regulations related to land use: No clear directions and laws are enforced

relating to land use; especially on using land according to its capacity on the slopes, development and utilizing of community lands, responsibility of correctly managing land related assets and the land used for non agricultural activities.

- Limited information and assistance is reaching the farmer
- The inefficiency in assisting farmer is further aggravated by shortage of experienced manpower, frequent reorganizing and restructuring of bureaus and departments and displacement of experts which disrupt the continuity and effectiveness of the services.

Technical

- Educated people responsible for assisting the farmer spend much of their time in meetings, workshops, seminars and their own trainings and the farmers are left on the mercy of the DA who is least educated and experienced.
- In spite of substantial research being conducted, this has not helped the farmer even in improving some very basic inefficient farming practices.
- Departments and disciplines follow an independent approach where as the activities on the farm are integrated, interdependent and complementary thus creating more inconvenience to the farmer.
- There is shortage of experienced manpower actually assisting the farmer.
- Improved farming techniques have not been convincingly demonstrated to the farmer and often improved inputs are not readily available to all the interested farmers
- Little efforts have been made in reducing post harvest losses.

Financial

- Resources invested in agriculture development and natural resource conservation are not enough. Very little of the resources marked for help him actually reach him
- The farmer has no easy access to credit and insurance facilities against failures
- The farmer suffers when he produces less and he also suffers when he produces more due to unfavourable marketing structure.
- Infrastructure facilities such as warehousing facilities, easy access to inputs, approach road and transport make farming activity inefficient and uneconomical.

Social

- Society does not respect him and ignore him considering a second class citizen
- Consumer demand often compels him to follow damaging farming practices.
- The farmer cannot afford too many holidays for not working on the land.
- He has no easy approach to clean water, health, education, recreation, and other facilities available in towns and cities.

One thing however, is certain that we cannot think of building food security without active participation of the farmer and the farming community and here we are talking about millions of farmers. It is a simple fact that unless the farmer agrees to produce more all other inputs would be left useless. Also we cannot force him to do anything unless he is willing to do so. Therefore, we must make necessary amendments in our approach which will actually help and assist him in achieving our objectives and at the same time it will improve his lot, otherwise, he will stay poor and also keep us poor which we can not afford.

4. An Integrated Approach to Agricultural Development

Being an agricultural country and with little alternatives, we can build our food security only by developing our agriculture sector. Agricultural productivity directly depends on the state of natural resources and active participation of millions of farmers. Unlike the large mechanized farming systems, it is the small contribution from these millions of farmers around the country, which will fill our food bowl and lead us towards achieving self-sufficiency.

The small farm is an integrated complex mix of soil; crop and livestock management systems and these are interdependent and play complementary roles. The independent approach followed by various disciplines and institutions responsible for developing the agricultural system has often created problems for the farmer. Agriculture development is not just a mechanical exercise of growing food on the farm. The whole rural community depends on this activity for their survival, well-being and prosperity and this can not be ignored or overlooked.

The most important task in front of us is to conserve our natural resources and improve their productivity at the sustainable level by providing all necessary assistance to the agriculture sector. We already have well-established infrastructure, technical knowledge, resources and manpower with us. What is required is to integrate the activities of various institutions and departments so that they can work together as a team for the common objectives. This approach must put the rural community and the farmer in the forefront of this activity. We must respect their rights, views and understand them and their problems before we initiate planning of any activity on their land. Unless we make them an active and willing partner in the development programme, we cannot expect to achieve any positive results, because anything we do for them affects them directly and has influence on their life.

Therefore, it would be necessary to develop an agricultural development proagramme, which is based on the principle of a participatory integrated multidisciplinary and holistic approach which will enable us to conserve and develop the natural resources for and by the community and where the Government will play the role of a facilitator by providing support in the form of suitable policies, resources to meet technical and financial, infrastructure and socioeconomic requirements. A recent experience with the homestead development activities under the World Food Programme assisted Meret project has convincingly showed that it is indeed possible to follow an integrated holistic and multidisciplinary participatory approach and it actually works [4,2].

Thus when an integrated holistic multidisciplinary coordinated development approach is followed to agricultural development with an active participation of the rural community in decision making, planning and implementing such programmes which are based on their socio economic problems, this approach is called an integrated participatory development approach. When this approach is planned and implemented in a defined geographical area called the watershed, it becomes an integrated watershed development approach. Thus if we accept the principle of an integrated approach to agriculture development then following an integrated watershed development approach is the best option we could have to solve the problems of soil erosion and food insecurity at the same time. Actually the relationship between land, water and people is the basis for many watershed development programmes in the world.

The integrated watershed development approach is a multi dimensional approach because this also helps in ecological stability and economic and social sustainability. The salient features of an integrated watershed development approach are as follows

- It is a participatory approach in every respect because, the community owns the programme, is responsible for decision making, planning and managing the programme with necessary assistance.
- The Govt. plays a constructive role of the catalyst, conveyor and a facilitator providing necessary financial, technical and infrastructure support.
- The programme is based on agro ecological and socio ecological problems in the area and includes components such as diversification, employment etc.
- This is a holistic integrated multidisciplinary coordinated approach where various disciplines work together as a team providing necessary technical assistance.
- This is a production and income oriented approach, which ensures availability of inputs to improve farm production and to exploit improved conditions as a result of soil, and water conservation.
- Applying both preventive and control measures of soil and water conservation by combining physical measures with suitable farming practices, maximum conservation is achieved. This approach also ensures quality and effectiveness of the measures.
- One of the conditions in this approach is that there is complete control on the free movement of livestock by providing alternatives to free grazing and improved animal production.
- Water conservation, harvesting, storage and efficient utilization is given increased priority to improve crop production.
- Resources are created in the watershed, which discourage people from leaving the watershed for cities and towns, especially the landless members of the community
- The role of women in the society and their participation in decision making and sharing the responsibility must be improved.

Several countries in the Asia and the Pacific region, notably China, India, Indonesia, Australia, Nepal, and Sri Lanka have accepted the concept of watershed management as the fundamental means of tackling soil and water conservation problems [8]. This approach therefore, calls for a general change in our approach and attitude towards conservation and management of our natural resources in general and agricultural development in particular.

This is what the Indian Experience has to say on the integrated watershed development.

"Integrating conservation and development activities through stakeholders participation and collaboration among different institutional and social actors is increasingly being recognized as the most promising approach to sustainable natural resource management". The recent spurt in participatory watershed development programmes is a policy response to such an approach. Starting from the scattered measures in soil and water conservation undertaken mainly as a relief works on ad hoc basis, watershed development programmes have traversed through a fairly long way to its present status of a well conceived integrated approach for watershed based development within micro region [12].

5. Conclusion

From the above discussion it is abundantly clear that we are facing a serious problems of food insecurity in the country and we have failed to produce more in spite of various efforts being made. There is little chance of success unless we improve our approach to agricultural development.

Being an agricultural country our natural resource base, its conservation and sustainable development are vital to our survival and prosperity. Unfortunately in the pursuit of wanting more from these resources against their capacity, we have not used them responsibly and ignored the long-term consequences.

It is also true that all hope is not lost. These natural resources still have the required capacity to feed us provided we start using and managing them efficiently and effectively. Attaining food security will not be a reality unless we improve the capacity of the basic components of agriculture. These are the soil, the water and the farmer. Presently all the three components are in poor health and are waiting for urgently needed improvements. Soil erosion indeed has beco me a very serious problem and must not be neglected.

Both soil and water conservation and improved food productivity must be achieved by following improved farming techniques combined with physical soil conservation measures at the same time. This can be easily achieved by following an integrated agricultural development approach. An integrated multidisciplinary approach with an active participation of the farmer can be efficiently practised in the form of an integrated watershed development approach. This approach ensures conservation and efficient utilization of soil and water by the farmer with improved food and income generating activities and efficient and effective utilization of various resources and inputs.

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Organic Farming in the Context of Food Security in Ethiopia: Novelty or Necessity?

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Abstract

Population growth coupled with lack of clear and practical natural resources management strategies, extensive use of agricultural inputs including pesticides, artificial fertilizers, farm machinery etc. have all led to the immeasurable destruction of natural ecosystems/balance of nature globally in general, and in Africa and Ethiopia in particular. According to WHO. About 20,000 pesticide poisonings due to extensive use of pesticides result in deaths annually worldwide. Furthermore, studies show that 50% of all poisonings worldwide and 75% of all fatal poisonings occur in developing countries although only around 15% of pesticides consumed world wide are used in developing countries [17]. The impact of fertilizers leached into water bodies combined with the impact of heavy agricultural machinery in destroying soil structures and textures thereby affecting the decomposition roles of soil born micro-organisms are again immeasurable concerns. As a viable practical option, organic farming has a role to play in averting the current alarming global catastrophe owing to man's misuse of natural resources under the guise of modernization in which agricultural intensification is a component responsible to losses this planet has suffered from over time. Organic farming is believed to contribute to the creation and maintenance of sustainable agriculture thereby alleviating food insecurity in particular, and restoring benign-agro-ecosystems in general as a result of creating agricultural/farming system that is harmonious to the daily complex interwoven processes in the natural ecosystems. The present review addresses the roles that organic farming could play in creating and maintaining balanced natural ecosystems thereby assuring sustainable agriculture and steady production leading to reduced national food insecurity.

1. Introduction

Organic farming is farming in harmony with nature, with the aim of providing produce of a high nutritional quality without the aid of synthetic inputs. Organic farming largely excludes synthetic inputs - pesticides, herbicides and fertilizers and genetic manipulation of living organisms. It focuses instead on biological processes such as composting and other measures to maintain soil fertility, natural pest control and diversifying crops and livestock. Organic agriculture gives priority to long-term ecological health, such as biodiversity and soil quality, contrasting with conventional farming, which concentrates on short-term productivity gains. The aim of organic farming is to achieve optimum harvest levels without exploiting the natural base (the soil) or degrading the local environment [1].

Many agricultural systems are now in a continuous state of change. As the agricultural systems change, new problems emerge which have to be addressed. The solution to the problem, if adopted, then contributes to a further modification of the system which itself may produce problems of a different kind. Not all modifications will however create new problems,

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and as a system develops and evolves it should gradually move towards a more balanced state which meets the economic needs of the human population it sustains. However, if the economic needs of the population are not met, then the agriculture will continue to be modified [2].

Consumer's fear, triggered by food scarce and technological developments such as genetic modification and food irradiation, have been translated into serious concern about food safety, in addition public awareness of the irreversible damage done to the environment by practices that lead to soil and water pollution, the depletion of natural resources and the destruction of delicate ecosystems have all led to calls for more responsible attitudes towards our natural heritage, which is organic farming that cannot only produce safe food but also environmentally sound too [3].

2. Why Organic Farming?

2.1 Similar or Higher Yield

The charge that organic farming is lower-yielding is misleading. Studies simply evaluating the reduction or elimination of inputs in conventional systems may not accurately represent conditions in alternative systems. Furthermore, abstract comparisons made when farms have just turned organic do not tell the whole story, as it takes a few years for yield to increase. Thus, it is necessary to make long-term comparisons [1].

A study on conventional and alternative farming systems for tomatoes over four years indicated that organic and low-input agriculture produce yields comparable to conventional systems. Nitrogen (N) availability was the most important factor-limiting yield in organic systems, and can be satisfied by biological inputs.

Another experiment examined organic and conventional potatoes and sweet corn over three years. Results showed that yield and vitamin C content of potatoes were not affected by the two different regimes. Results indicated that long-term application of composts is producing higher soil fertility and comparable plant growth.

When yield of tomato obtained using convectional and organic farms was compared, only little yield difference was observed in the first year. In the second year, tomato yields were higher on farms with a history of organic production, regardless of soil amendment type, probably due to the benefits of long-term organic amendments. Mineral concentrations were higher in organic soils whilst soil quality on conventional farms was significantly improved by the addition of organic fertilizer [1].

A review of replicated research results in seven different US Universities and from Rodale Research Center, Pennsylvania and the Michael Fields Center, Wisconsin over the past 10 years showed that organic farming systems resulted in yields comparable to industrial, high input agriculture. For, example:

- Corn: With 69 total cropping seasons, organic yields were 94% of conventionally produced corn.
- Soybeans: Data from five states over 55 growing seasons showed organic yields were 94% of conventional yields.

- Wheat: Two institutions with 16 cropping year experiments showed that organic wheat produced 97% of the conventional yields.
- Tomatoes: 14 years of comparative research on tomatoes showed no yield differences.

2.2 Efficient Production

The world's longest running experiment comparing organic and conventional farming pronounced the success of organic farming. The 21-year study found that soils nourished with manure were more fertile and produced more crops for a given input of nitrogen or other fertilizer. Nutrient input in the organic systems was 34 to 51% lower than in the conventional systems, whereas mean crop yield was only 20% lower over 21 years, indicating efficient production and use of resources. The ecological and efficiency gains were more than made up for lower yields. In the long term, the organic approach was commercially viable, producing more food with less energy and fewer resources [4].

The biggest bonus was improved quality of the soil under organic cultivation. Organic soils had up to 3.2 times as much biomass. The enhanced soil fertility and higher biodiversity is believed to render the organic plots less dependent on external inputs and provide long-term environmental benefits.

2.3 Better Soils

Indeed, organic agriculture is helping to conserve and improve farmers' most precious resource, the topsoil. To counter the problems of hardening, nutrient loss and erosion, organic farmers are using trees, shrubs and leguminous plants to stabilize and feed soil; dung and compost to provide nutrients; and terracing or check dams to prevent erosion and conserve groundwater. Organic matter virtually puts life into the soil by promoting activities of varied types of innumerable organisms. It has been rightly said that " no soil without life and no life without soil". The organic matter serves as a food for microbial population. These micro organisms in turn release large amount of plant nutrients in available form. Organic matter improves physical condition of the soil. Heavy soils containing adequate amount of organic matter are less prone to drainage problems. The periodic supply of good quantity of organic matter to very light soils renders them more retention of moisture and nutrients. The major sources to supply organic matter are farmyard manure, compost and green manure [5].

Compost is created by the decomposition of organic matter such as yard waste. The chief advantage of compost is its ability to improve soil structure. Good garden soil is loose and has a high water-holding capacity with adequate drainage. Adding compost to heavy clay soil improves drainage by improving soil structure. Compost also absorbs water and improves the water-holding capacity of sandy soils. To conserve moisture or develop a landscape requiring little water, it is essential to have soils with good water-retention [6].

In addition to improving soil structure, decomposing compost will slowly release plant nutrients. Unless applied in very large amounts, compost will not provide all the nitrogen that highly productive crops require. Organic gardeners can supplement generous compost applications with manure to produce good yields without the addition of other fertilizers [6].

3. Innovative uses of Compost:

3.1 Bioremediation and Pollution Prevention

Each year agricultural effluents, industrial residues, and industrial accidents contaminate surface waters, soils, air, streams, and reservoirs. A new compost technology, known as compost bioremediation, is currently being used to restore contaminated soils, manage storm water, control odors, and degrade volatile organic compounds [7].

3.2 Control for Plants and Animals Diseases

Compost technology is a valuable tool already being used to increase yields by farmers interested in sustainable agriculture. Now, professional growers are discovering that compost-enriched soil can also help suppress diseases and ward off pests. These beneficial uses of compost can help growers save money, reduce their use of pesticides, and conserve natural resources. In the poultry industry, composting has also become a cost-effective method of mortality management. It destroys disease organisms and creates a nutrient-rich product that can be used or sold [7].

3.3 Erosion Control

Compost has been viewed as a valuable soil amendment for centuries. Most people are aware that the use of compost is an effective way to improve plant growth. Compost-enriched soil can also reduce erosion and nutrient run-off, alleviate soil compaction, and help control of disease and pest infestation in plants. These beneficial uses of compost can increase healthy plant production, help save money, reduce the use of chemical fertilizers, and conserve natural resources [7].

3.4 Reforestation, Wetlands Restoration, and Habitat Revitalization

Plants within a habitat contribute much more to their surroundings than mere beauty. They provide food for nearly every other member of the habitat. They enrich the air through the gases they produce and minerals they exchange. Even when plants die, they continue to support grasses, flowers, and trees by becoming the humus, or organic material in soil, that is so vital to living plants. Original wetland plants can be restored with the use of compost during planting. Compost provides tree seedlings added rigor for survival and growth [7].

4. No Pest Increase

Because organic farms don't use synthetic pesticides, critics claim that losses due to pests would rise. However, research on Californian tomato production found that the withdrawal of synthetic insecticides does not lead to increased crop losses as a result of pest damage.

There was no significant difference in pest damage levels on 18 commercial farms, half of which were certified organic systems and half, conventional operations [2].

Arthropod biodiversity was on average one-third greater on organic farms than on conventional farms. There was no significant difference between the two for abundance of pests, but densities of natural enemies were more abundant on organic farms, with greater species richness of all functional groups (herbivores, predators, parasitoids). Thus, any particular pest species in organic farms would be associated with a greater variety of herbivores (i.e. diluted) and subject to a wider variety and greater abundance of potential parasitoids and predators [2].

5. Higher Biodiversity

Maintaining agricultural biodiversity is vital to ensuring long-term food security. Organic farms often exhibit greater biodiversity than conventional farms, with more trees, a wider diversity of crops and many different natural predators, which control pests and help prevent diseases.

Organic farming has proved to be viable through confirming that planting a diversity of crops is beneficial (compared with monocultures), in controlling pests and diseases which are the main cause of yield reduction world wide. For example, thousands of Chinese rice farmers doubled yields and nearly eliminated one most devastating disease, without using chemicals or spending more. Instead of planting large stands of a single type of rice, as their typical practice, they planted a mixture of two different kinds of rice: standard rice which does not usually succumb to rice blast disease and much more valuable sticky rice known to be very susceptible [1].

Furthermore, empirical evidence from a study conducted since 1994 shows that biodiversity ecosystems are 2-3 times more productive than monocultures. In experimental plots, both aboveground and total biomass increased significantly with species number. The high diversity plots were fairly immune to the invasion and growth of weeds, but this was not so for monocultures and low diversity plots. Thus, biodivers systems are also less prone to weeds [7].

6. Organic Farming as a Component of Traditional Farming

In traditional farming, farmers rely on locally available natural resources to maintain soil fertility and to combat pests and diseases that complies more or less with the principles of organic agriculture. They show the way towards sustainable agriculture through systems of crop rotation, soil management, and pest and disease control, based on traditional knowledge. It can be said traditional farming is organic. Originally in Africa agriculture depended on local resources, knowledge, skills and even institutions. As farming conditions changed (over time) largely due to increased population, modern forms of government, modern farming techniques, foreign influence etc. farming system also changed. Unfortunately, the new changes swung towards heavy use of external inputs such as fertilizer, improved seeds, exotic livestock breeds and heavy machinery which in many cases were not suitable and were unaffordable to many small scale rural farmers. The poor African farmers cannot afford the technologies and synthetic inputs. This system relied heavily upon external experts for development and dissemination of agricultural technologies and totally ignored indigenous knowledge, local talents and skills. It is for this reason that the promotion of organic agriculture in Africa becomes very vital. Since African farmers have small land holdings in general, considering farming organically is a sound approach.

7. Practical Components of Organic Farming

Organic farming involves the following activities [8]:

- Compost making to provide fertility
- Using the A- frame to determine contour lines along which all cultivation and terracing are made
- Crop rotation to relieve the mineral drain on different areas of the farm.
- Mixed cropping to discourage pest build up and to improve soil cover
- Mulching and green manuring to ensure permanent ground cover
- The making of liquid manure and plant trees for top dressing.
- Crop protection by means of plant lures and deterrents.
- The making of natural pesticide sprays using plants, weeds and herbs with known insecticide properties.
- The use of raised beds to allow closer spacing of vegetables.
- Water harvesting to retain water during the dry season.
- Agro forestry- the planting of leguminous shrubs and trees to add nitrogen to the soil and provide fodder, fuel wood and fence posts.
- Animal husbandry which tries to cater for the animal's natural instincts, but may also include zero grazing as a way of collecting animals manure.

8. Overview on the Current Status of Organic Farming Globally

Organic farming is practiced in approximately 100 countries of the world and the area under organic management is continually growing [9]. Increased consumer awareness of food safety issues and environmental concerns have contributed to the growth in organic farming over the last few years, the public now understands that you cannot have healthy people without healthy food and healthy environment. In addition, the area of certified "wild harvested plants" is at least a further 10.7 million hectares according to various certification bodies [9].

Almost 23 million hectares are farmed organically throughout the world [10]. Currently, the major part of this area is in Australia (10.5 million ha), followed by Argentina (3.2 million ha) and Italy with more than 1.2 million hectares (Fig. 1 and 2). In North America, more than 1.5 million hectares are managed organically. In most Asian countries the area under organic management is still very low. The total organic area in Asia is now almost 600,000 hectares. Organic farming is increasing in Africa, especially in the southern countries. An important growth factor in Africa is the demand for organic products in the industrialized countries. More than 200,000 hectares are now managed organically in Africa [13].

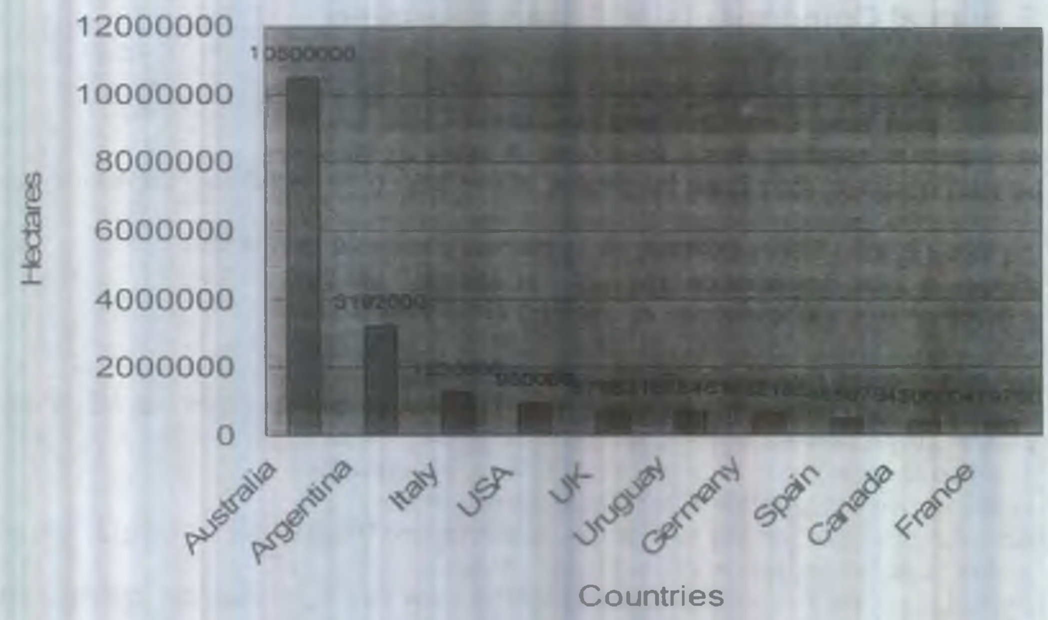

Figure 1: Ten Countries with the Largest Land Area under Organic Management

Source: [10]

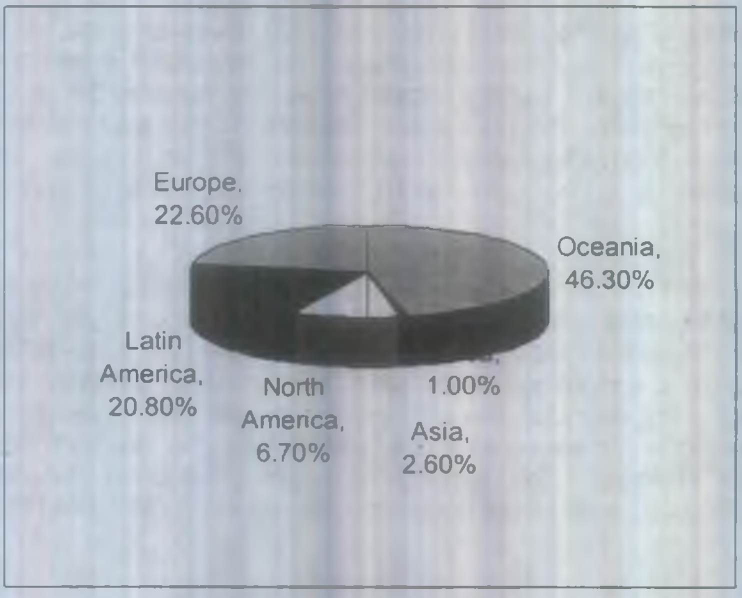

Figure 2: Total Area under Organic Management - Share for Each Continent

Source: [10]

The organic share of the total food market is expected to rise from the present 1-3 % to 5 -10 % in the larger markets of Europe and the USA in the coming few years. The forecast annual growth rates have, however, been reduced a little compared with last year and are currently estimated at 5 -15 % in most countries [11].

Organic farming has in fact developed into one of the most dynamic agricultural sectors in the European Union. The organic farming sector grows by about 25 -30% every year. Ten thousands of farms have been converted to organic as a result of increased consumer awareness of, and demand for, organically grown products [12].

9. The Challenges of Organic Farming

- Organic farming is not cost free, rather organic foods cost more initially. They are very expensive. Jennifer Jones of Leicester in Central England, says: "Many people say they are buying organic food not for themselves, but for their children. Until the price comes down we just give it to our young children.
- Organic products are usually lower in quality and consumers may be distasteful when they see some insect pests and their excreta on food items, as biological control agents are not 100% effective in eliminating the pests.
- Organic farmers get lower yields per acre, than convectional farmers.
- The biggest yield problem for organic farmers is that they refuse to replenish the nitrogen in their soils with chemical nitrogen. Instead, they produce their nitrogen by using extra land for green manure crops or fallow. This means on the average 1/3 of organic farm is wasted. That land is producing organic nitrogen instead of food. For example the turn to organic farming in Europe removes surplus, which is 20%, but a move to all organic cropland would do more than erase the surplus. It would create a food deficit that could only be rectified by putting an additional 22 million hectares. Where would that land come from?
- By 2050, when world population is expected to reach nine billion, the world will need three times its current food harvest. Under an all-organic regime, farmers would have to plow virtually every bit of available land to get it. So what is the solution?
- Labor intensive. One of the most attractive areas of organic farming for the government, which is wrestling with rural decline, is that it employs between 30 and 70 per cent more people than conventional farming.

10. The Challenges of Organic Farming in Africa

- The hot African environment is full of different pests and diseases. It is almost impossible to grow some crops without any use of chemicals.
- The local market also does not differentiate organic and convectional farm produce, and farmers have no incentives to go organic. There is no certification of organic produce for the local market [16].
- The lack of fund, especially in developing countries to carry out reputable scientific research on different aspects of organic farming.

11. Organic Farming and Food Security

Under organic farming, a steady permanent output is assured. Through improved soil, by improving soil nutrients through decomposition of organic matters, reduced erosion, hence more yield. Reduced pests and diseases, because of the high number of natural enemies that keep the pest number lower so reduced crop losses. High biodiversity, maintaining agricultural biodiversity is vital to ensuring long-term food security. Reduced synthetic inputs, vast savings to the national economy, by producing more healthy crops, and healthy environment and hence improvement in national health system which leads to less cost towards health related national expenditure [16].

Thus, organic farming contributes towards reduction of food insecurity directly or indirectly as it leads to steady production through regeneration of natural resources which in turn pave the way to sustainable agriculture that results in less food insecurity situations. Organic farming leads to conditions in which expenditure towards chemical pesticides will be reduced or avoided. Ethiopia for example is spending ca. 10 ml USD to clear obsolete pesticides alone (Alemayehu.pers.com), fertilizers and heavy machinery which could contribute to improved national savings.

Soil amelioration through improved soil structure and textures, better soil-microorganism interactions, reduced soil erosion and water percolations (porosity which directly contributes to the betterment of soil nutrients is another aspect for which organic farming brings about. This obviously plays a major in reducing allocation meager resources towards the importation/production of artificial fertilizers. Because organic farming is labor intensive by its nature, it creates better employment opportunities, which at the moment are one of the challenge resources poor nations have faced.

The other aspect for which organic agriculture is appreciated is its contribution towards the creation and maintenance of healthy food and healthy environment (through avoidance of pollutants) which in turn lead to the creation of healthy society and sustainable agriculture resulting in sustainable and healthy production/products attracting higher prices per produce thereby ensuring food security.

By its very nature, organic farming involves many hands hence participatory for it is not sophisticated. Less sophistication give rooms for wider participation and wider participation in turn many more productive hands the ultimate outcome of which is increased food for the whole society.

Furthermore, the indirect contribution of organic agriculture also goes along with its vital roles in generating higher and sustainable foreign (hard) currency through attractions that could be created as a result of unaffected wild lives, plants, acquatic resources etc.

In addition, organic farming has direct contributions to the development and maintenance of sciences such as agriculture (bee husbandry), sericulture (silk production), fishery, etc the existence of which are at risk due to extensive and misuse of chemical pesticides and fertilizers under the guise of modern agriculture.

Conclusion

- Organic farming utilizes environment own systems for controlling pests and diseases in crops and animals and avoids the use of synthetic agricultural inputs. Instead organic farmers use a range of techniques that help sustain ecosystems and reduce pollution.
- Organic farming has positive environmental effects
- The organic market offers better income possibilities for farmers
- The development of rural areas can be positively influenced by organic farming (e.g. tourism, processing activities)
- Organic farming has proved to be one of the most recommended options for higher foreign exchange earning with lesser but healthier products.
- Steady produce is assured by organic farming
- It reduces expense on agricultural inputs (pesticides, fertilizers etc.)
- It is highly participatory: involves every one with minimum skills and technology.
- The world continues to grow organic with the impressive dynamic intensity. Moreover, the market for organic products is growing continuously.

Recommendations

- It will be difficult to apply organic farming in large-scale farming. However, it is more successful if it is applied in small scale farming such as vegetables.
- Nitrogen availability is the most important factor that limits yield in organic farming, therefore it is needs to be supplemented with biological inputs continuously
- To avoid the possible human health effect, organic farming should not use untreated manure, but instead it has to use compost
- Since organic farming enhances soil fertility and higher biodiversity that make it less dependent on external inputs, it is better if it is integrated with some environmentally sound synthetic agricultural inputs to boost its productivity.
- A favorable political environment should be created that includes a clear definition of organic agriculture with legal enforcement.
- It is high time to all concerned citizens of this country to seriously assess and see how far we are left behind our fellow Africans, near and far, in terms of institutionalizing and in making use of benefits organic farming may render.

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Policies and Institutions to Enhance the Impact of Irrigation Development in Crop-Livestock Mixed Systems in the Highlands of Ethiopia

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Abstract

Improvement in access to water serves as a powerful tool to increase income, diversify livelihoods and reduce vulnerability, since irrigation water creates options for extended production across the year, increases yields and outputs, and creates employment opportunities. In crop-livestock mixed systems, irrigation can increase livestock feed supply through increased crop residues of food-feed crops, thus relieving the pressure on grazing lands and improving livestock productivity. In sub-Saharan Africa, inadequate growth in food production and increasing water scarcity pose serious challenges to future agricultural and economic development. Water for food has been identified as a critical challenge for society in the 21st century. The challenges arising due to increasing water scarcity can be addressed through two strategies: supply management (policies and actions to locate, develop, and exploit new sources of water for irrigation, household and industrial uses) and demand management (incentives and mechanisms that promote efficient use and conservation of water). Irrigation water development in Ethiopia during the Imperial and Military regimes focused on the development of large-scale irrigation schemes. This trend was reversed by the current government which emphasised the development of small-scale schemes. However, the history of irrigation development has been characterized by emphasis on technical and engineering aspects, with inadequate attention accorded to policy, institutional and socio-economic factors. The lessons from the experience of irrigation development in sub-Saharan Africa in general, and Ethiopia in particular, show that a pluralistic approach to water development (which includes carefully selected and managed large-scale schemes, and farmer managed small-scale projects); provision of supportive legal framework and secure water rights; development of local management and leadership capacity; active involvement of beneficiaries in design, implementation and management of schemes could enhance the impact of irrigation on farm household income, natural resources management, and the local and national economies. Project engineers should continuously interact with agronomists, economists and other social scientists from the beginning in order to prepare a comprehensive ex-ante assessment of irrigation projects. Moreover, policy and institutional interventions to enhance the impact of irrigation also need to be based on the objective of enhancing the contribution of irrigation to sustainable livelihoods of rural people. This could be done by enhancing the contribution of irrigation to household asset building by strengthening market access, promoting high-value crops, and improving systems for providing extension and technical support to smallholder irrigation. The best place to start perhaps is to ensure access to farm inputs and produce markets.

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1. Introduction

Water plays a critical role in the sustainable livelihoods of rural people. Improvement in access to water serves as a powerful tool to diversify livelihoods and reduce vulnerability for small producers, since irrigation water creates options for extended production across the year, increases yields and outputs, and creates employment opportunities. Increased household income may be spent locally thus helping to stimulate the rural economy. Participation in water users associations (WUA) widens social networks and empowers people, thus facilitating the creation of social capital.

In crop-livestock mixed systems, irrigation can increase livestock feed supply through increased crop residues of food-feed crops, thus relieving the pressure on grazing lands. Irrigation can also increase the productivity of the grazing lands themselves if water is used for producing feed directly, thus perhaps allowing crop residues to return to the soil to maintain soil fertility. Livestock are important assets and sources of cash income of the rural people, especially the rural poor. Improved feed availability increases the productivity of livestock, thus improving household income.

During the twentieth century, human population tripled and water use increased six-fold, mostly for agricultural use. Agricultural productivity has also risen sharply in recent decades due to higher yielding varieties, increased fertilizer use, and major investments in water resources infrastructure. Investment in many billions of dollars in irrigation infrastructure has been the key component of the Green Revolution.

Agriculture today accounts for the majority of water withdrawals, and accounts for about 80% or more of water withdrawals in developing countries (Cia et al, 2001). As populations continue to grow further, the demand for agricultural water will increase and irrigation will be required to provide increasing share of total food production to meet the growing food demand [24].

In sub-Saharan Africa, inadequate growth in food production and increasing water scarcity pose serious challenges to future agricultural and economic development. Moreover, semi-arid and arid areas are home to about one-six of the world's population. Inadequate water is the principal cause of poverty in these areas. Water demand for domestic and industrial uses is also projected to grow even faster than agricultural water demand, especially in developing countries [25].

Accordingly, water for food has been identified as a critical challenge for society in the 21st century. The 2nd World Water Forum in March in the Hague expressed the increasing importance of water powerfully. The forum, attended by over 120 ministers and 5000 stakeholders representatives, and more than 600 journalists, emphasised water as a major political and economic issues in the 21st century. The Global Water Partnership concluded "*On the one hand fundamental food shortage encourages ever greater use of water resources for agriculture. On the other, there is a need to divert water from irrigated food production to other users and to protect the resource and the ecosystem. Many believe this conflict is one of the most critical problems to be tackled in the 21st century*" (Global Water Partnership, Framework for Action, 2000, p.58). The conclusion clearly shows that society is facing a fordibale challenge of growing more food with less water, a challenge which requires a substantial increases in productivity of water in agriculture. The UN Secretary General, Mr. Kofi Annan, on his report to the Millenium Conference in October, 2000 also concluded, *"We need a Blue Revolution in Agriculture that focuses on increasing productivity per unit of water- "more crop per drop"*.

However, water scarcity is not necessarily caused by inadequate rainfall, but by lack of conservation, and sustainable management and use of the available water. Even in the so-called dry regions, rainwater is available in abundance. For example, IWMI estimates that the total renewable water resources in sub-Saharan Africa (SSA) are about 4,000 km^3 per year. However, most of it evaporates or flows into saline sinks before it is put into beneficial use, mainly due to the difficulty posed by the nature of rainfall. The rain is very poorly distributed in both spatial and temporal terms. The most critical challenge is, therefore, how to deal with the poor distribution of rainwater leading to short periods of too much water and flooding, and long periods of too little water. There is a need for the development, adaptation and application of innovative technologies and management strategies for more efficient conservation and use of rainwater, surface and groundwater.

The challenges arising due to increasing water scarcity can be addressed through two strategies: supply management (policies and actions to locate, develop, and exploit new sources of water for irrigation, household and industrial uses) and demand management (incentives and mechanisms that promote efficient use and conservation of water).

In Ethiopia, despite an estimated potential of 1.0- 3.5 million hectares of irrigable land, only about 5-10% is currently estimated to be under irrigation. Modern water development in Ethiopia started during the Imperial regime in the 1950s, with large-scale irrigation schemes and hydroelectric power projects. The large-scale irrigation projects were intended to supply agricultural raw materials for the agro-processing sector, and for export. These large-scale projects were nationalized in 1975 by the Military regime, and handed over to the Ministry of State Farms. The focus of both the Imperial and Military regimes was on large-scale irrigation projects.

Unlike its predecessors, the government of the Ethiopian Peoples Revolutionary Democratic Front (EPRDF), since it assumed power in 1991, has given strong emphasis for small-scale irrigation development in the country. However, the history of irrigation development in Ethiopia has been characterized as one that considered irrigation development mainly as a technical or engineering issue. Policy, institutional and social factors were not accorded due consideration in the design, implementation and operation of irrigation projects. This paper intends to present and discuss important policy and institutional issues that need to be considered in research and capacity building for water resource development in Ethiopia.

2. Irrigation and Rural Livelihoods

A livelihood can be defined as a set of capabilities, assets and activities required for a means of living. In other words, livelihoods are the means people use to earn a living. Peoples livelihoods' are determined by their capital (human, financial, physical, natural, and social) endowments, available technology, and political, social, and economic institutions. A livelihood is said to be sustainable when it can withstand and recover from adverse and fluctuating natural and economic conditions, without undermining the natural resource base.

Opportunities and constraints faced by rural people interact to create the set of livelihood options. The role of policies and institutional interventions is, therefore, to expand the set of viable livelihood options by enhancing the opportunity set of choices and mitigating the impact of constraints.

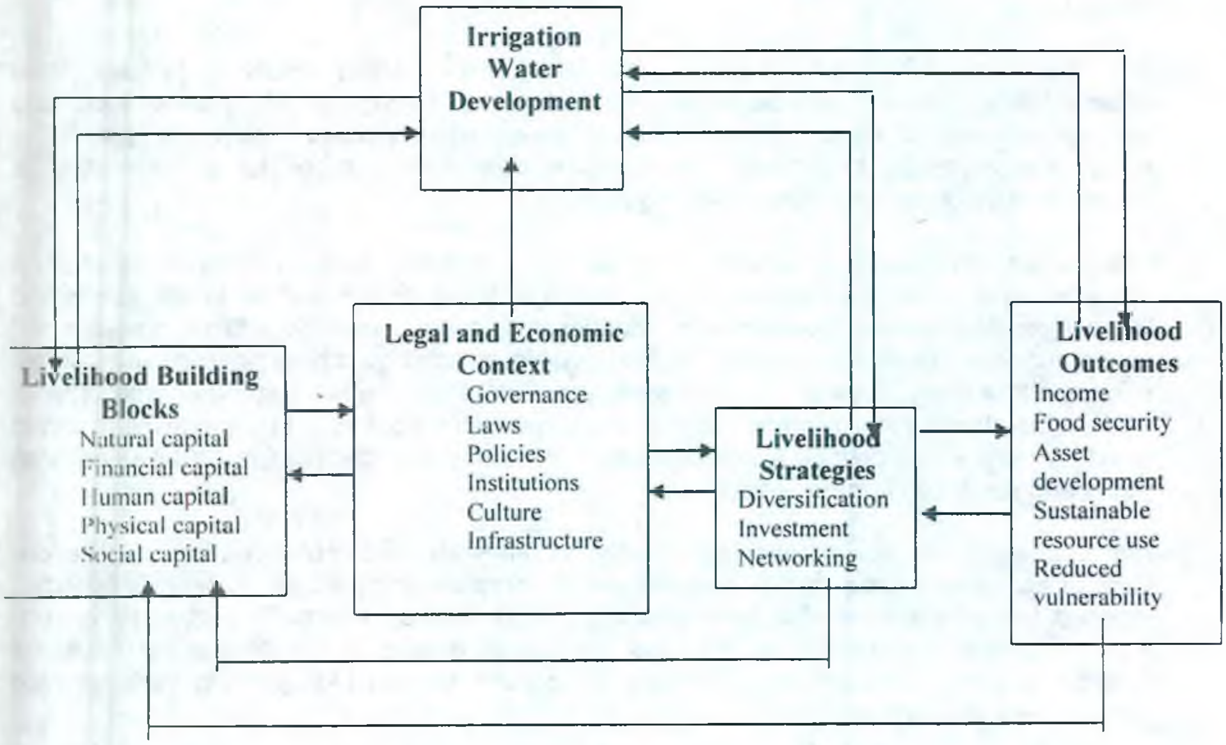
Water is an essential element of rural livelihoods because of the food security and income options it generates in rain fed and irrigated crop production, livestock production, fisheries and non-farm enterprises [11]. Policy makers, planners, designers, agriculturalists and managers involved in irrigation water development can support rural livelihoods when dealing with water by appreciating the many roles of water (crop and livestock production, fishery production, human health, environmental values) in rural livelihoods and creating enabling environment for rural people to defend and negotiate their livelihoods. When irrigation development is viewed from the perspective of sustainable livelihoods, institutional viability of water users' organizations, systems operations, and water use practices; equity of access and social justice for water users; political democracy of representations; and economic viability of livelihoods all become clearly important considerations.

The sustainable livelihoods framework also involves understanding the interaction between water, the environments and technologies; understanding and working with the political processes and small farmers through which local people can question water assessment and allocation mechanisms. Livelihood thinking seeks to understand the opportunities and needs created by different water technologies and institutions and the interactions between them, and empowers local groups.

Irrigation water development affects rural livelihoods, through its effect on household livelihood building blocks (capital endowments), livelihood strategies and livelihood outcomes (Figure 1). For example, irrigation increases the livelihood options for rural people leading to diversification to mitigate risk and stabilize income. Higher income may lead to savings and investment resulting in improved capital endowment of households. In general, the more the role of irrigation water in the livelihoods of rural people, the higher the probability that water users could coordinate efforts and contribute to collective irrigation management. Rural livelihoods in turn affect irrigation water development. Livelihood building blocks (natural, financial, human, physical, and social capital) determine water users capabilities to manage and contribute for irrigation development. Livelihood strategies such as social networking can be important determinants of rural household's propensity to organize themselves for collective irrigation management.

At the watershed or river basin level, water productivity also needs to be evaluated in terms of its effect on the wider eco-system services and social impacts such as health, together with the systems of resource governance that ensure equitable distribution of these benefits. Hence, the livelihoods framework also helps to understand the interactions between different watersheds with respect to water use. Substantial modification in water use at one-location influences the resource at another, so a systemic approach is required which links changes in catchments and basin hydrology with people who use it. Such an approach also anticipates the impacts of complex interactions, which occur between socially, economically, and politically diverse groups. Resolution of the 'hydrologic dyslexia', that is, the institutional disconnectivity that occurs between hydro logically connected people, will increase the potential gains offered by advances in biophysical performance.

Figure 1: Irrigation Water Development and Rural Livelihoods



3. Irrigation Development in Africa

Water demand in Africa has grown rapidly, at 3.5% per year since 1970, much higher than the world average of 2.4% [23] and agriculture in the continent accounts for about 85% of water withdrawals although the physical irrigation potential is far from being tapped (ibid). It is estimated that only about one-third of the potentially irrigable land is under irrigation in the continent. In the Eastern African countries of Burundi, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda, less than 10% of potential area is irrigated (ibid). A few countries have also developed substantial irrigation infrastructure. According to FAO (1987) [8] the Sudan has 2.2 million hectares of land under irrigation; Madagascar, 1.00 million; and Nigeria 0.9 million.

Nearly all of North Africa can be considered as arid, with irrigation essential for agriculture. Eight sub-Saharan African countries (Botswana, Burkina-Faso, Kenya, Mali, Mauritania, Niger, Senegal, and Somalia), which contain about 14% of the population of the sub-continent, have little or no land with rain fed growing period above 200 days. For these countries irrigation is likely to be an essential part of any overall strategy of increased agricultural production [23]. Moreover, twelve countries (Botswana, Burkina Faso, Chad, Ethiopia, Kenya, Mali, Mauritania, Niger, Somalia, Sudan, Tanzania, and Zimbabwe) have rain fed growing period of less than 120 days on over a quarter of their territory. High growth rates for non-agricultural water use are also expected in the sub continent.

Growth in irrigated areas in Sub-Saharan Africa has slowed since the early 1980's, due to the lagged effects of declining irrigation investment as of the late 1970s (ibid). Between 1970-82, irrigated area in Sub-Saharan Africa grew by 2.13% per year, and by 1.62% between 1982-93, while the corresponding figures for East Africa are 7.67% and 2.61%, respectively.

In Sub-Saharan Africa shallow groundwater has been exploited widely by farmers, lifted either manually using traditional means or mechanically through use of shallow wells and gasoline powered centrifugal pumps. Continued expansion of pump irrigation is likely to be locally and regionally important. There remains considerable scope for dissemination of improved technology for groundwater irrigation.

Large-scale irrigation investment costs in Sub-Saharan Africa are higher than in other parts of the world and there are higher risks of failure in these large systems. In addition to the higher cost of irrigation, benefits from irrigation are lower. Inherently difficult agro-climatic and agronomic conditions including highly variable climatic conditions, particularly rainfall, surface water flows, temperature and wind; variation in soils within command area; severe weed infestation; shifts in insect, pest and disease resistance due to uniform plant stand resulting from water control; and increasing soil salinity and compaction [20] reduce crop yields and returns to irrigated agriculture.

High returns to irrigation require high-yielding varieties and substantial fertiliser application. Lack of appropriate crop verities and low use of complementary inputs, especially fertilizer, reduced the potential benefits from irrigation in sub-Saharan Africa. Fertilizer use in sub-Saharan Africa remains low at 10kg per hectare compared to the developing countries average of 60kg per hectare. Proportion of farmers planting high yielding varieties also remains very low as well.

Insecure land tenure and water rights reduces incentives to invest in and maintain irrigation facilities and land quality. Problems in co-ordination of technical and socio-economic, and institutional aspects of irrigation and irrigated farming, combined with management problems, including scheduling and timing of water releases, arrangements for common services such as field preparation or transport, provision of inputs, and crop marketing [20] have reduced the profitability of irrigated agriculture in the sub-continent.

Moreover, poor operation and maintenance of irrigation systems has been a major problem of irrigation development in sub-Saharan Africa. Maintenance of irrigation systems may have suffered due to initial design and construction faults, inadequate recurrent expenditures, unrealistic expectation of farmer contributions, and failure to understand the importance of routine maintenance.

Irrigated crop yields are generally lower in Sub-Saharan Africa than in other regions, although the relative difference in yields between rain fed and irrigated crops in Sub-Saharan Africa is comparable to other regions [23]. Overall irrigation efficiencies (the product of irrigation system efficiency and field application efficiency) are also generally low, ranging from 20-30% (FAO, 1986). These water use efficiencies are however computed from individual system evaluations rather than from basin wide assessments, which may have higher overall efficiency.

4. Irrigation Development in Ethiopia

There are various estimates of the irrigation potential in Ethiopia. These estimates range from 1.0 to 3.5 million hectares of irrigable land, of which between 160,000 -190,000 hectares (5-10%) is estimated to be currently irrigated. About 65,000 hectares is estimated to be under traditional irrigation. Per capita irrigated area is also estimated at about 35 m^2, compared to the world average of 450 m^2. About 352,000 hectares of land is said to be irrigable using small scale irrigation schemes.

Modern water development schemes are recent phenomena in Ethiopia. The Imperial government in the 1950s took the first initiative in water resource development. Large scale water development projects both for agricultural purposes and power generation were constructed at the end of the 1950s. These developments were concentrated in the Awash valley as part of the agro-industrial enterprises development initiative. Water resource development at that time gradually expanded to the rift valley and the Wabe Shebele basin. The government's focus of water resource development was on large-scale and high technology water projects. At the beginning of the 1970s, about 100,000 hectares of land was estimated to be under modern irrigation in Ethiopia, about 50% of which was located in the Awash Valley [31]. During the imperial regime, the main objective of irrigation was to provide industrial crops to the growing agro-industries in the country, many of which were controlled by foreign interests, and to increase export earnings. Main crops grown were sugarcane, cotton, sesame, fruits and vegetables. Management and operational problems that resulted in salinity and water logging problems are said to have put thousands of irrigated land out of production in the Awash valley in the 1980s after less than five years of cultivation [16].

All large-scale irrigation schemes that were constructed during the Imperial regime were nationalized by the military government in 1975, and handed over to the Ministry of State Farms (MSF). Most landlords based small-scale irrigation schemes were also handed over to producer cooperatives. The military government, like the Imperial regime, was keen to develop large-scale water projects and focus was on commercial farming. High technology water development schemes were managed by the nationalized agro-industrial and agricultural enterprises. However, little attention was given to small-scale and traditional irrigation schemes constructed and managed by smallholder farmers.

It was only during the second half of the 1980s, after the devastating famine of 1984/85 that the Derg regime started to show interest in small-scale water development schemes [29]. This interest was signalled by the establishment of the Irrigation Development Department (IDD) within the Ministry of Agriculture (MoA) in 1984, a department that was entrusted with the task of developing small-scale irrigation projects that would benefit small farmers. However, IDD's performance was slow, only 35 small-scale projects were constructed between 1984 and 1991, of which about a third were improved traditional irrigation schemes [18]. Moreover, small-scale irrigation development was considered as "infrastructure development" and grouped with rural roads and similar construction teams, and largely staffed with engineering personnel.

Like the Imperial regime, the military government's focus was on commercial farming and smallholder beneficiaries were excluded. Despite the long success of farmer-managed traditional irrigation systems, the military regime destroyed this tradition by confiscating them and handing them over to producers co-operatives. The lessons from the experiences and

Failures of irrigation development during the Imperial and military regimes indicates that a pluralistic approach to water development and active involvement of beneficiaries in the design, and implementation of water development projects, and management of operational schemes could have benefited small-holders better and contributed to the national food production.

The focus on large-scale irrigation development and the neglect of small-scale schemes was reversed when the Ethiopian Revolutionary Democratic Front (EPRDF) took power in 1991. The EPRDF government put the development of small-scale irrigation schemes and improvement of farmer-managed traditional schemes at the forefront of its water development policy. Moreover, with the creation of the Ministry of Water Resources (MWR), there is now a unified public agency for water resources development.

In 1994, IDD was dissolved while the government's interest in small-scale irrigation remained very high, as manifested by the creation of the Regional Commissions for Sustainable Agriculture and Environmental Rehabilitation (Co-SAERs) in a number of regions. The primary mandate of the Co-SAERs has been to promote small-scale irrigation for the benefit of small holders. However, like IDD the focus of the Co-SAERs also remained rather technical-oriented, with inadequate attention accorded to policy, socio-economic and institutional issues. However, there has been a significant improvement in beneficiary participation compared to during the military regime.

In sum, irrigation development planning in Ethiopia has been beset by the emphasis on the agronomic, engineering and technical aspects of water projects, with little consideration to issues of management, beneficiary participation, availability of institutional support services such as credit, extension and input supply, and marketing. The experience of irrigation water development in the last five decades in Ethiopia suggest that several measures need to be taken to support farmer-managed small-scale irrigation projects in Ethiopia. These include enhancing and improving the efficiency of the traditional irrigation systems such as by improving the durability of head works; making simple, cheap, and environment friendly irrigation technologies such as hand pumps and shallow tube wells available; improving market access by building roads, price support and improving product quality; developing appropriate extension and credit services, and input supply system; and enhancing beneficiary participation in governance (establishment of working rules and responsibilities) and management (running the day-to-day operation of projects).

The impact of irrigation development during the last decade appears to be mixed. Based on a survey of 50 communities, 500 plots and more than 2000 plots in the highlands of Tigray in 1998/99, irrigation was found to increase the intensity of input use, especially labour, oxen labour, improved seeds and fertilizer [21]. Use of manure or compost was about 50% more likely on irrigated plots than on rainfed plots, controlling for other factors. By promoting increase in use of such inputs, irrigation contributes to increased crop production. The predicted average impact of irrigation, based on the predicted impacts of irrigation on use of inputs, was an 18% increase in crop production relative to rainfed field plots. However, the impact of irrigation on the productivity of land management practices (i.e the effect of irrigation controlling for use of inputs and practices) was statistically significant. Thus the main impact of irrigation on crop production is through promoting increased intensity of farming, rather than through increased productivity of farming practices.

Similarly, in the Amhara highlands, irrigation was associated with increased intensification through greater use of fertility-improving technologies (fertilizer and manure), and other purchased inputs (improved seed and pesticides), labour and drought power [3]. However, the impact of irrigation on the productivity of farming practices, controlling for other factors was insignificant. The reason why irrigation failed to improve the productivity of farming practices in both the highlands of Amhara and Tigray deserves further and careful research on the technical, institutional, governance and managerial aspects of irrigation.

5. Policy and Institutional Research Issues

A comprehensive irrigation development strategy should take into account the technical requirements (eg. equipment, spare parts, operation and maintenance), policy issues (eg. incentives, pricing, cost recovery), and institutional issues (eg. farmer participation and organizations, extension and credit services, marketing, governance and management of water resource). Sectoral policies affecting water development should be harmonized. There is a need to determine the appropriate mix and role of government and non-government agencies, the private sector, communities and individuals in the effort to develop, control and manage water resources. Institutional mechanisms need to be put in place in order to minimize transaction costs and resolve conflicts.

In many developing countries the success of irrigation systems is highly affected by policy, institutional and social factors much more than technical issues [2]. Hence, in this section we present and discuss important policy and institutional issues of irrigation development that need to be considered in irrigation development strategies in Ethiopia.

Demand and Supply Management for Irrigation Water

In order to meet the challenges of increasing water scarcity both more vigorous demand management accompanied by comprehensive water policy reform to make better use of existing supplies, and supply management involving the development and exploitation of new water supplies will be required [23]. The level of economic development and the degree of water scarcity will determine the appropriate mix of supply and demand management. At the current level of development of and degree of water scarcity, most sub-Saharan Africa countries will likely be primarily concerned with water supply augmentation. However, demand management should not be ignored. With economic growth and development, the competition for water increases raising the value of water, and the benefit from and the role of demand management increases significantly.

Effective water demand management saves water in existing uses, increases the economic efficiency of water use, improves water quality, and promotes environmentally sustainable water use. With economic growth, a large share of water to meet new demand must come from water saved from existing uses through comprehensive reform of water policy. However, water reforms are challenged by the long-standing practices, and cultural and religious beliefs that have treated water as a free good, and by entrenched interests that benefit from the existing system of subsidies and administered allocation of water [23].

As water scarcity increases, the supply of impounded or diverted water becomes inelastic. As economies grow the demand for water delivery increases rapidly and the competition for water among the different uses increases. Externality problems that were not important with adequate water supply become increasingly important. All these factors raise the value of water and so the benefits from efficient allocation of water, thus possibly shifting the likely balance of effort from supply management to demand management [22].

Policy instruments potentially applicable for water demand management include [1]:

1. Enabling conditions i.e. measures that modify the institutional and legal environment of water delivery and use, including reform of water distribution systems and water laws, assignment of water rights, and organization and operation of water user associations.
2. Market-based incentives intended to directly influence the behaviour of water users through incentive systems to conserve on water use. These may include pricing reform, subsidy reduction, and development of water markets.
3. Non-market instruments, such as restriction quotas, license requirements, and pollution controls
4. Direct intervention including public conservation programs, maintenance and repair programs, and infrastructure development

Empirical evidence shows that farmers are price responsive in their use of irrigation water, by use of less water on a given crop, adoption of water-conserving irrigation technology, shifting of water application to more water efficient crops, and change in crop mix to higher-valued crops [26]. The choice between market, and non-market and administrative methods should be largely a function of which approach is more cost-effective. Research is needed to determine which approach has a relative advantage in specific country situations.

Large Versus Small-Scale Irrigation

Failures of large-scale irrigation projects in Africa abound. Construction costs as high as US$40,000 per hectare and estimated negative rates of return have been documented [23]. The high costs and negative rates of returns have been primarily due to design and technical flaws, management failures, and political difficulties (ibid). Inability of ministry and agency headquarters to respond timely to field level problems, excessive centralization of management taken away from farmers, poor training and skill levels, uncontrolled over-head costs and rent-seeking are some of the other reasons for the failure of large-scale irrigation schemes.

However, irrigation development in Africa has also documented successful large-scale schemes. For example, efficient management, relatively low-cost infrastructure, low operating costs, good technical design, availability of ergonomically suitable crops and cropping systems were cited as factors for success of large-scale irrigation systems in Cameroon [3].

Since the 1980s, the widespread failures in large-scale irrigation systems have been used to advocate future investment strategies based on small-scale irrigation systems. However, failures and successes in both large-scale and small-scale systems have been observed in Africa. Scale as such seems to be less important than the extent to which control is operated by the farmers, and where systems are managed bureaucratically, the extent to which quality of management is maintained and equitable distribution of income among farmers is achieved [23]. Hence, it is not so much the size of the irrigation system that determines its success, but a host of institutional, physical and technical factors. Large-scale irrigation should be carefully assessed as a possibility for specific locations.

In general, small-scale systems may have advantages over large-scale systems. These advantages include: small-scale technology can be based on farmers existing knowledge; local technical, managerial and entrepreneurial skills can be used; migration or resettlement of labour is not usually required; planning can be more flexible; social infrastructure requirements are reduced; and external input requirements are lower. However, these advantages may not be realised if the mode of implementation is not right.

Hence, a pluralistic strategy of irrigation water development needs to be pursued in Africa. Large-scale projects need not be abandoned provided that they are carefully designed and implemented; they have no significant environmental problems; participation of beneficiaries in planning, operation and management is ensured; and they ensure benefits to the surrounding population. However, there appears to be a general consensus that small-scale and user-based schemes have higher advantages, are less costly and more sustainable.

Direct Vs Indirect Investment Strategies

Public investment strategies for the development of farmer-controlled small-scale irrigation schemes, including the improvement of traditional schemes, can be categorized as direct and indirect investment strategies [6]. In direct investment strategy, government agencies are directly involved, using their own budget and staff, in the design, construction, and operation of new or improved irrigation facilities on the traditional irrigation systems. These new or improved irrigation schemes will then be solely government-controlled or co-managed with the communities. In the indirect investment strategy, government agencies get involved through the provision to farmers of grants, loans and technical expertise, to implement irrigation development on works owned and controlled by individual users or group of users.

Experiences in Southeast Asia indicate that the indirect approach may be superior, since it leaves ownership and management of the system with traditional groups or individuals, and often leads to complementary investment of local resources. Available evidence in Africa also indicates that the indirect approach may be a preferable option to assist farmer-controlled irrigation. In Nigeria, the successful *fadama* development program had several characteristics of the indirect investment approach. The availability of small inexpensive petroleum pumps in the markets in Nigeria in the early 1980s enabled farmers to replace their traditional water lifting devices. Following the success of the small pumps, the government launched a National Fadama Development Project (NFDP).

Hence, high priority may need to be given to indirect investments for expansion of farmer-controlled small-scale projects, especially in areas where potential for rain fed agriculture is poor and risky. Initial grants or loans to establish economically sustainable technologies, for example, for purchasing a small tube well, may be reasonable given the absence or weakness of credit markets in much of Africa. Expansion of small-scale farmer-controlled irrigation would have the additional benefit of developing farmer experience not only with respect to the technological skills of operation, but also with respect to the economic, social, and institutional aspects of implementation. However, research is needed to determine the strengths and weaknesses of the indirect investment approaches in the specific country situation in Africa, and to identify the cost-effective way of implementing it.

Farmer-Controlled Versus Government-Controlled Irrigation Schemes

Irrigation systems can be public, private or group owned. There is much evidence that farmer-controlled small-scale irrigation has better performance than government-controlled small-scale systems. The substantial farmer-controlled small-scale irrigation sector that exists in many countries in Africa, often without government support, indicates that these systems are economically viable. Areas under farmer-controlled small-scale irrigation systems have grown rapidly over the past decades, and account for large and growing share of irrigated area in Sub-Saharan Africa [23].

Water users associations or cooperatives, or private individuals manage the small-scale farmer-controlled systems. Some of the factors that contributed to the relative success of farmer-controlled small-scale irrigation systems include: use of simple and low-cost technology such as small pumps; active involvement of farmers in project design and implementation; availability of supporting infrastructure adequate to permit access to inputs and markets to sell surplus production; generation of high and timely cash returns to farmers [4].

Moreover, devolution of water rights from centralized bureaucratic agencies to farmers has a lot of other advantages: empowerment of water users, by requiring user consent to any reallocations of water and compensating the user for any water transferred; security of water rights tenure, which may induce investment in irrigation technology; when marketable rights exist, they induce water users to consider the full opportunity cost of water.

Farmer-controlled schemes can be group or individual-owned. Individual schemes are owned and managed by individual owners. Private schemes are mainly small schemes that make use usually of pumps and tube-wells and are operated by the owners. Technology is simple and management is less complicated. Some argue that private irrigation has good potential in Africa and governments need to provide the necessary policy environment for the expansion of private irrigation schemes.

In Asia it is widely documented that private pump irrigation from ground and surface water bodies is far more productive and profitable relative to public irrigation systems [7,14,27]. Several researchers have also shown that private small-scale pump irrigation (from ground and surface water sources) is much more productive than canal irrigation and is more financially viable and self-governing.

However, pump irrigation, the most adapted irrigation for private irrigation, is suitable only in areas with sufficient ground water or along the banks of rivers or lakes. Unrestricted expansion of private irrigation will also lead to the depletion of aquifers. Therefore, the scope of private irrigation may be limited. Moreover, there are schemes that are better managed and operated communally. In this case, group ownership and management becomes essential.

When irrigation schemes are collectively owned, schemes that balance all costs and benefits for all people in a watershed are most likely to gain long-term support. When irrigation schemes are group or publicly owned, securing water rights to beneficiaries becomes important. However, since water is vital for livelihoods, water rights are the results of the interaction of state law, project regulations, religious laws and values, and local institutions and norms [17]. Formal laws may not always coincide with peoples' own perceptions of water rights and the ways in which water has been managed at the local level, since property rights are only as strong as the institutions that back them up [17]. Local institutions are important in translating water rights in actual access and use, since local institutions affect the implementation and enforcement of rules. In some cases local institutions can modify formal laws. Hence, attention needs to be given to the mediating institutions that translate water rights (from whatever source) into actual access to water. Research is needed to understand the extent to which formal statutory laws regarding water rights are translated into practice and the role of mediating local institutions.

Moreover, despite the existence of a number of technologies that have potential to increase water productivity, the rates of farmers' adoption of the technologies have been slow. Research is needed to identify policies and institutional arrangements, environmental and socio-economic factors that promote farmers' adoption of water productivity-enhancing technologies, and to understand how experience in participatory research and extension in other areas can be applied in irrigation technology development and adoption.

Poverty and Irrigation

Poverty can be defined as "*pronounced deprivation in human well-being encompassing not only material deprivation but also poor health, literacy and nutrition, vulnerability to shocks and changes, and having little or no control over key decisions*" (ILRI, 2002, page 2.). When resources becomes more scarce, the poor and vulnerable in society are hard hit and suffer most. Increased competition for water in agriculture and non-agricultural uses in developing countries reduces the access to water for the rural poor, especially rural women. Increased water scarcity also may lead to frequent conflict, loss of life and generally to the marginalization of the poor and powerlessness in terms of access to water.

Irrigation development may benefit the poor by raising labour productivity, promoting the production of high-value crops, and the generation of farm and non-farm employment opportunities, especially when increased production stimulates the local economy through backward and forward linkages (i.e. water systems can be used as "growth centers" where services, markets and employment are also stimulated). However, there does not seem to exist a consensus on the impact of irrigation on poverty alleviation, in the absence of targeted interventions aimed at benefiting the poor. IRRI led research in six villages in Madha Pradesh, India, found that incidence, depth and severity of poverty were substantially lower in villages where there were irrigation facilities compared to rain fed villages [13], while similar studies in Myanmar concluded that recent expansion of irrigation infrastructure in the 1990s has not increased household income due to farmers' inability to cope up with the economic and technical demands of the new rice-based technologies (Gracia et al, 2000)

Hence, targeted measures to ensure that poor people are reached and gain from irrigation investments need to be on the agenda at the earliest stages of scheme development. For example, water allocation based on land size may reinforce the existing inequities in land distribution in the distribution of water and water-created wealth. Irrigation may induce land transactions as resource poor farmers may lease their land out. This may exacerbate income distribution further.

Some research results also indicate that plot location in relation to the irrigation scheme (head, middle and tail) may have implication for poverty alleviation. Moreover, irrigation usually induces changes in crop choice and poor farmers usually grow low value crops. Hence, targeted interventions to make inputs available to the poor is one option to enhance the impact of irrigation in poverty alleviation. Representation in the Water Users Association (WUA) of the poor and women is one way to ensure that the interests of these people is considered in irrigation water decision making.

A pro-poor approach to irrigation development requires a good understanding of the relationship between water and poverty and the causes of poverty, so that strategic poverty reducing interventions can be identified. The assessment of impact on poor people will verify appropriateness of the research priorities. Other income sources of farmers who use irrigation water should also be considered in order to get a complete picture of the poverty dimension of the farmers. Research will be needed to determine indicators of poverty and to identify strategies for intervention to reduce poverty through irrigation development. Other key research issues related to poverty in irrigation development programs may include the extent to which capital and/or operation and maintenance costs be recovered from water users and how this would affect income distribution and poverty; how water prices should be determined; and what should the relative role of private and public investments be for expansion and maintenance of irrigation systems.

Gender and Irrigation

While playing a crucial role in many water and food related issues, women still tend to be underrepresented in the decision-making fora. Gender issues in irrigation water development need to be looked at three levels: farm/field level, association level, and leadership level [15].

At the farm level, gender performance of irrigation projects need to address whether or not there are systematic gender-based differences categorically engrained to water rights, irrigated land and associated obligations. At the water users association level, irrigation projects need to ensure that systematic gender–based differences in the participation in these associations do not exit. Water users associations create formal and informal forums through which collective management of irrigation schemes are implemented.

At the leadership level, irrigation schemes need to make sure that there are no systematic gender-based exclusions from leadership positions of irrigation management. It is important to note that the systematic gender bias at the field, water users association and leadership levels may not necessarily be the result of formal laws or institutions. Informal institutions based on local culture and religion could be important sources of systematic gender bias. Social science research is required to identify systematic gender-based exclusions or biases in irrigation schemes, and devise appropriate strategies to ensure equitable representation and distribution of benefits.

Land Use and Management for Better Rainwater Conservation

Rainfed agriculture produces the highest proportion (over 60%) of food crops in the world. Including livestock production, the contribution of rainfed agriculture to food and commodity production is very high. Moreover, rainwater is the only source of agricultural water for many rural poor.

Research results estimate that in many farming systems, more than 70% of the direct rain falling on crop fields is lost as non-productive evaporation or flows into sinks before it is used by plants. Hence, in rainfed agriculture wastage of rainwater is probably an important cause of low yields or complete crop failure more than absolute shortage of cumulative seasonal rainfall. For example, adoption of improved water conservation technologies in the Great Plains of the USA have contributed to about 45% increase in average wheat yields, compared to the contributions of improved varieties (30%) and fertilizer practices (5%).

The necessary technologies for overcoming loss of water in rain fed agriculture are the popular soil and water conservation (SWC) practices. The principle requirement is the improvement of infiltration, water holding capacity, and water uptake by plants. Conserving water on fields for better use by crops results in win-win benefits converting erosion-causing runoff into plant available soil water, and non-productive evaporation into productive transpiration.

Impact of land use (vegetation management) for improved water conservation may have beneficial effects for both upstream and down stream users. Upstream users may benefit due to higher availability of water which would otherwise be wasted as run-off. Downstream users would be benefiting through the reduction of floods, sedimentation and a more smooth flow of water throughout the year. Streams and springs may be better recharged if water is conserved upstream, but this needs research to be confirmed.

Appropriate strategies need to be identified for dealing with climatic variability and droughts, and identify the land use and management practices to reduce land-use related degradation of surface water. Additional research is also needed to identify policy, institutional and socio-economic factors that promote improved household and community land use practices for better conservation of rainwater on fields.

Collective Action and Water Users Associations/Organizations

Identification of factors that facilitate the establishment and effectiveness of collective action for irrigation development would help identify where collective action can easily be established and be effective, and where concerted effort is needed for the establishment and effectiveness of collective action. Key research issues regarding collective action for irrigation management include how people organize themselves with respect to water, what consistent and detectable influences of policies and other instruments can be deployed to modify stakeholder behaviour, and how experience in participatory research and extension and common property management be used to facilitate local organizations for water management.

The best starting point perhaps is to learn from the success of traditional irrigation systems, especially from the institutional and legal aspect of water administration and management. Understanding the evolution, development and functioning of traditional water users associations should provide important insights as to how to organize and develop modern irrigation associations.

International experience with farmer irrigation management suggests that, for a successful community management of irrigation schemes, the economic and financial costs of sustainable self management must be a small proportion of improved income, the transaction cost of the organization must be low, and irrigation must be central to the improvement of livelihoods for a significant number of members. Developing local leadership skills for irrigation management also appears to be a key factor for successful collective irrigation management.

Land Rights

Land rights and land allocation can be a major source of conflict among farmers. Secure land tenure rights are also essential to induce farmer investment in irrigation technology and maintenance. Irrigation development may displace farm households, which would raise the issue of appropriate compensation and resettlement. Land allocation within the irrigation schemes is another issue that deserves careful analysis. Landholders around the irrigation schemes may be required to share land with others who either lost their land to the scheme or otherwise are negatively affected. However, minimum land size determination should be based on careful research and analysis, considering such factors as the available technology, household size and labour supply.

Environmental Impacts of Irrigation

Dams and reservoirs may inundate arable and pasture land. Sometimes land lost due to inundation can be either equivalent to or larger than the land under irrigation. Dams interfere with water flows downstream. Water impoundment has also been associated with serious health hazards, such as malaria and schistosomiasis. Salinization could be a more serious environmental consequence of irrigation projects. Poor water management and inadequate drainage usually result in salinity and water logging. Salinity reduces the productive capacity of the soil, and in some cases could put the land out of cultivation.

Strategies to combat the negative environmental consequences of irrigation water development need to be included in the design of irrigation projects. Research may be needed to determine farmer willingness to pay for health services. Increased health risks around irrigation schemes may also reduce labour productivity. A comprehensive assessment of the impact of irrigation should, therefore, consider the productivity, health and environmental impacts.

6. Conclusions and Implications

Improved access to agricultural water supply plays critical role in the sustainable livelihoods of rural people, since it increases yields and outputs, facilitates diversification, reduces vulnerability and creates employment opportunities. In crop-livestock mixed systems, irrigation increases feed supply through increased crop residues of food-feed crops, which my reduce the pressure on grazing lands. Improved livestock productivity through better availability of feeds has the potential to increase household income.

With population growth, the demand for agricultural water increases and competitions with non-agricultural use intensifies. In sub-Saharan Africa countries, inadequate growth in food production and increasing water scarcity poses serious challenges to agricultural and economic development in the 21st century, thus increasing the need for more efficient utilization of water and the development of new supply sources. Both water demand and supply management will be increasingly required to mitigate the effects of water scarcity, although currently sub-Sahara Africa countries may need to focus more on supply management.

In Ethiopia, despite an estimated potential of irrigable land ranging from 1.0-3.5 million hectares, only about 5-10% is estimated to be currently irrigated. Irrigation water development in Ethiopia during the Imperial and Military regimes focused on the development of large-scale irrigation schemes. This trend was reversed by the current government which emphasised the development of small-scale schemes. However, the history of irrigation development has been characterized by emphasis on technical and engineering aspects, with inadequate attention accorded to policy, institutional and socio-economic factors.

The lessons from the experience of irrigation development in sub-Saharan Africa in general, and Ethiopia in particular, show that a pluralistic approach to water development (which includes carefully selected and managed large-scale schemes, and farmer managed small-scale projects); provision of supportive legal framework and secure water rights; development of local management and leadership capacity; active involvement of beneficiaries in design, implementation and management of schemes could enhance the impact of irrigation on farm household income, natural resources management, and the local and national economies. Project engineers should continuously interact with agronomists, economists and other social scientists right from the beginning in order to prepare a comprehensive ex-ante evaluation of irrigation projects.

Moreover, policy and institutional interventions to enhance the impact of irrigation also need to be based on the objective of enhancing the wealth-creating potential of small holder irrigated farming by strengthening market access, promoting high-value crops, and improving systems for providing extension and technical support to small holder irrigation.

The best place to start perhaps is to ensure access to farm inputs and produce markets. A wider menu of irrigation technologies need to be available for farmers to choose from, so that farmers would respond more flexibly to irrigation development opportunities.

Although public agencies may need to be directly involved in investing in selected-large-scale projects, high priority needs to be given to indirect investment strategy through the provision to farmers of grants, loans and technical assistance for the development of small-scale farmer managed irrigation schemes. Such an indirect investment strategy empowers farmers by providing ownership and management of the system, and leads to complementary investment of local resources.

There does not seem to be a consensus on the impact of irrigation on poverty alleviation in the absence of targeted interventions aimed at ensuring that the poor are reached and gain from irrigation development. For example, allocation of water rights based on land size may exacerbate existing inequities in income distribution. Hence, when the objective is poverty alleviation, targeted measures to ensure the poor and vulnerable benefit need to be incorporated at the earlier stages of scheme development.

Gender issues are also important in irrigation water development, since often women get underrepresented in the decision making fora. Gender issues in irrigation development need to be considered at three levels: field level, to ensure the allocation of water and land rights, and associated responsibilities do not involve systematic gener-based differences; at the water users association level, to ensure that there are no gender-based exclusions from participation; and at the leadership level, to ensure equal opportunities exist for leadership positions.

In rain fed agriculture, lack of conservation and efficient use of rain water is probably more important than absolute shortage of water in determining crop yields or total crop failure. Conserving water on fields through changes in land use and management results in a win-win benefit by converting runoff into plant available soil moisture, which would otherwise result in soil erosion or possible flooding, and non-productive evaporation into productive plant transpiration.

Understanding the factors that facilitate farmer organizations to manage irrigation water, and its effectiveness would help devise strategies to facilitate the development and effectiveness of local organization for water management. The best starting point perhaps is to learn from the evolution, development, operation and success of traditional water users associations, in order to gain insights for the development of modern water management organizations.

Secure land rights are critical for farmers to invest in irrigation technologies and maintenance. Moreover, land allocation around irrigation schemes is an issue that deserves careful analysis, since it will have direct effect on income distribution. Perhaps, such land allocation programs may need to be based on the determination of minimum land size for profitable farming. In cases where irrigation development displaces local people, compensation and resettlement provisions need to be part of the scheme of the development planning right from the early stages.

Environmental and social aspects of irrigation development include flooding, obstruction of water flows downstream, health hazards, water logging and salinity. Hence a comprehensive assessment of irrigation development projects need to take into account environmental and social consequences.

Footnotes

1 A distinction can be drawn between water withdrawal and water consumption. Water withdrawal refers to water removed from a source, some of which may be returned to it and reused. Water consumption refers to the water withdrawn from the source and actually consumed or lost to seepage, contamination, or a "sink" where it cannot be economically reused.

2 Policies and actions that affect the quantity and quality of water at the entry point to the distribution system are classified as supply management, while actions that influence the use or management of water after this point are considered as demand management (UNDTC, 1991; World Bank, 1994).

3 The wider range of estimated irrigation potential indicates the lack of precise estimate of irrigable areas in the country.

4 'Hydrologic dyslexia' may occur at community, catchment and basin scale. It results from the deficiency of institutions that could enable more effective use of shared resources. This complex challenge can be divided into three facets: water and livelihood, catchment hydrology, and social organizations.

5 For example, traditional Asian technologies such as "sludging", and more modern hand techniques such as hand augering, washboring, and vibro-bailing could profitably be disseminated for more efficient shallow lifts (Rosegrant and Perez, 1999). However, careful testing and evaluation of these technologies need to precede any effort to disseminate them.

6 In North Africa, overall irrigation efficiency ranges from 40 - 45% (Rosegrant and Shetty, 1994). In Israel, Taiwan and Japan, overall efficiencies ranges from50-60 %.

7 In Ethiopia, there are four different types of small-scale irrigations systems used by farmers: diversion systems (diverting natural river flow), spate systems (systems that make use of occasional flood flows), spring systems (that use flows from springs) and storage systems (that store water behind dams), and lift systems (which extract water from rivers, irrigation canals reservoirs and wells). Diversion systems are probably the most common forms of small-scale irrigation systems in Ethiopia, although there may be regional variations.

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Comprehensive Community and Household Asset Building Approach (CCHABA) for Improved Food Security in Tigray

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Abstract

Recent studies in Tigray revealed that more than 40% of the total households living in the region have to rely on food aid every year for their own survival. Thus, food insecurity has continued to be a prime challenge and a top agenda in the region. This food insecurity problem in the region has two dimensions. On the one hand, it exists in the inability of households to produce all their food requirements because of lack of access and diminishing quality and quantity of productive resources combined with unfavourable or highly variable environment. The other dimension goes to the inability to acquire food from markets because of inadequate household incomes or unreliable markets, which deliver food at very high prices. The major cause for this problem to occur is that the households and communities' productive assets are depleted considerably. The theme of this paper lies on the paradigm advocated that interventions should target to build both the household and community productive assets. The new approach in this paper seeks an optimal balance between households based interventions and community ones, the aim being pointing towards bringing tangible and immediate benefits to households and at a same time recovering community assets. This approach is called: Comprehensive Community and Household Asset Building Approach (CCHABA). The key characteristics of CCHABA enable the poor rural households to freely choose any options that suit their situation based on their potentials and problems. It farther attempts to provide households with a wide range of package options that meet the food security benchmark and enables households to cross up the food poverty line within specific time. In this paper the general situation analysis of the region, the rational for CCHABA and its dimension, key characteristics of the approach and possible challenges are assessed in depth. Importantly, we have to mention that this product is not a research work rather it is a consolidated experience from the last few years in the region. The practical experience shows that this approach is the one that can improve food security situation using the existing and potential resources in the country.

1. Introduction

The Tigray Region's State is the northern most region in the Federal Democratic Republic of Ethiopia bordering the Sate of Eritrea in the North, the Sudan Republic in the West, Amhara Region in the South and Afar Region in the East. The region covers an area of 80,000 Sq. kilometres of landmass, most of which is highland and plateau interspersed within low laying hills and flat lands with an altitudinal variation ranging between 1500-3000 masl.

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Livelihoods in the region are predominantly dependent on agricultural income support options. Agricultural production and diversification and other income support options are however; very low. Average size of land available to a household with four-person average family size is about 0.5 hectare, which is too small to support the family. The average production of cereals, the major agricultural output is 4-7 quintals per household. On the average, this staple grain food can feed the family only for 5 months a year. Households are thus vulnerable to chronic food-insecurity.

The region's government in cooperation with the communities and donor agencies is exerting a concerted effort to break this cycle of low production and low effective demand and to build purchasing power and a more sustainable rural household production profile.

As part of this effort, the region has designed an integrated food security program in 16-highly drought prone woredas. This regional food security program is in line with the overall national food security program, which was elaborated in 1998. It addresses the root causes of food insecurity such as, environmental degradation, lack of water supply for household and crop production, low access and command over external inputs, low off-farm income diversification opportunities and low capacity of the extension system.

The regional food security program main focus is on undertaking household focused but integrated activities. The activities are being implemented using the new approach that aims at improving production and income at household level through the provision of household asset building packages and implementation of household support and community wide interventions. The main activities in this approach include; environmental rehabilitation, irrigation development, livestock development, water supply development, promotion of basic health and education services and construction of labour based rural access roads. This approach is named as Comprehensive Community and Household Asset Building Approach (CCHABA), presented around the following main elements: household asset building packages, household support interventions, and community wide activities.

The recent evolution of this concept is characterized by focusing more on water harvesting (e.g. ponds, spring development, and river diversion) and very specifically targeting the households that are producing food. Here, CCHABA only covers their food needs for less than five months. Another element is providing income directly to vulnerable households and families through products that can be sold locally (e.g. honey, meat etc.).

Another element in CCHABA is the determination of food security benchmark, which was calculated to be birr 3500. This is the minimum income that a household of an average family size of five needs to fulfil its food needs for a period of one year. Once the household will achieve this income level, it will not need to receive food aid any more and thus be deducted from the vulnerability caseload.

CCHABA addresses entitlement, interpreted as access to food through reducing vulnerability and increasing self-provisioning capacity by building the resource base (assets) of the poorest rural households in the most drought prone woredas. The approach also seeks to improve and develop community assets particularly the natural resources and gear that development to production. In short, it is a holistic approach to improve and develop the economic and natural resource base of the economically disadvantaged and ecologically fragile areas and people in the region. It specifically enables to improve the food security situation of the target households by increasing their productivity through improved technologies in their livestock and crop production, small-scale irrigation, and better natural resource management. Furthermore, it is enabling them to move livestock and crop production to market in order that they can procure more and cheaper food, increasing employment and incomes in off-farm activities. Similarly, it is an appropriate way to improve life for people through rural roads, water supply, nutrition education, health, non-formal basic education, off-farm enterprise development, and capacity building at all levels from farms to public institutions.

2. Situation Analysis

2.1 Socio-economic Conditions that Prevail in the Region

Livelihoods in Tigray strictly depend on agricultural production having to face structural inadequacies. The following are the most important indicators for the problem.

- Landholdings are too small (0.5 hectare per household) to allow most farming households to achieve food-production self-sufficiency.
- Soil fertility, already low, is further declining due to severe environmental degradation, intense cultivation and scarce application of yield-enhancing inputs.
- Recurrent droughts, vulnerability to pest, livestock and plant diseases add threatening elements to food production shocks and to low yields.
- Land shortage reduces pasture and fodder resources that are vital to maintain plough oxen, severely hindering households to draught power.
- Population growth of around 2.6% per annum decreases per capita land holding further contributing to the fragmentation of land.
- The poor development of the main factor markets resulted in the high marketing cost, as a result of which farmers get low price for their produce.
- And last but not least, scarce off-farm employment opportunities restrict income diversification and migration options, keeping rural people in Tigray trapped in dependency on enviable and highly risky rainfed agriculture.

The tangible results of these gloomy conditions can be summarised as follows.

- Average production per year per household is between 3-4 quintals. This output can feed the households (with an average of 5 people each) for no more than 3 to 4 months per year. Consequently 40% of households have to rely every year on food aid for their own survival.
- Child nutrition is also severely affected revealing amongst the bleakest figures in Africa, notably underweight 48%, 11.1% wasting and 55.3 stunted. In addition, recent survey on the population shows that 34.9% of the women have an average body mass index (BMI) of 18.5.

- Very poor social services, where access to potable water supply are on average 37.11% and 49.9% in regional and drought prone woredas, average respectively, that include functional and non-functional water points.
- Infant Mortality Rate and Under Five Mortality Rate are 103.6 and 169, respectively.

2.2 Food Security Challenges

Based on the above facts, the problem of food insecurity in the region has two dimensions. One dimension is the inability of households to produce all its food requirements because of lack of access and diminishing quality and quantity of productive resources combined with unfavourable or highly variable production environment. The other dimension is the inability to acquire food from the markets because of inadequate household incomes or unreliable markets, which deliver food at very high prices.

In reality, it is noticeable that the picture we are portraying of these households is not a momentary one but a chronic one that has to be tackled with long-term strategies. Even in the season that has sufficient rainfall, the majority of the vulnerable families did not attain a sufficient level of food sufficiency, which is clear evidence of the complexity of the problem. In fact the root causes of the food insecurity in Tigray must be found nowadays more in lack of food access than in food availability. Therefore, it would result in a serious policy failure to concentrate efforts only to the agricultural aspect while overlooking other important features such for instance as the development of a rural non-farm economy. The enhancing of the latter ought to generate income for households enabling them to be entitled for purchasing food from the market.

Lastly, it would be essential to pursue a strategy that while generating adequate food and income it shows resilience against shocks such as droughts in order to basically achieve what is fashionably called these days sustainable livelihood. Households assisted to pursue this strategy will never need assistance (except in extreme circumstances) because they will have a rational balance between farming and non-farming earning activities. Conversely it would be a serious misconception to adopt strategies that are satisfactory in good times but not resilient against adverse shocks and trends. The latter could be named unsustainable livelihood and by that the households will receive some immediate benefits but will not be strengthened in the long run persisting to be very vulnerable in case of unfavourable situations.

3. Initiatives for the New Approach

The regional government of Tigray has invested considerable amount of resources in the area of development and rehabilitation during the last several years. However, the region at large made little progress in fighting poverty and reducing food insecurity. Thus, the majority of the households in the region still remain poor and food insecure having to depend on continuous external assistance for their survival for more than half of the year. There are various reasons for this phenomenon.

3.1 High Costs/Slow Return Vs Low Cost/Quick Return Kind of Intervention

In economic development and growth there are certain trade-offs to be maintained; that is, between high cost and low cost investments. It often occurs that the high cost investments (infrastructures) are mostly chosen as the determinants of the low cost ones, i.e. the transfer of asset to households with the dominating view that there would be valuable trickle down effects of these complex and costly activities to households. Indeed in Tigray it was decided to go for complex and expensive development activities like for example huge areas for soil rehabilitation and construction of huge dams.

3.2 Poor Coordination and Integration of Development Activities

Another major shortcomings in the execution of the development policy were that the measures that were taken so far did not largely respond to the key principles of integration of activities and coordination between the levels, i.e., community level and household level interventions. Hence the multiplier effects as well as the synergy were rarely achieved.

3.3 Absence of the Food Security Benchmark

In the past whenever it was attempted to target needy households and provide packages in order to improve their income position, the required scale was not properly valued. This means that no benchmark or threshold was set. Consequently, there was a generic unfocused effort that in most cases was not sufficient to meet the needs. It occurred very often that, wary of implementing mere activities, the lack of a benchmark to evaluate the intervention at household level undermined a genuine understanding of the situation and the adoption of the proper measures.

3.4 Absence of Menu of Packages

Households in the past used to receive some generic packages like for instance beekeeping or poultry. However, this was done in very rigid and unsystematic way vis-à-vis neglecting the essential requirements of training, financial viability, and interest and capability of the targeted beneficiaries.

3.5 Lack of Baseline Information

The introduction of packages in the earlier period was designed without taking into account detailed households' starting position that is, as a matter of fact, highly differentiated according to the area. This problem coupled with the absence of a benchmark to measure eventual changes at household level made the past approach vague and ineffective.

3.6 Inappropriate Terms of Loans

The packages being given on a credit basis and not as a grant it is obvious that the terms of loan are a key factor for the households to be involved in a motivated manner from the very onset. In fact the rigidity of the past loans in terms of packages' contents together with its inflexible repayment period of one year had discouraged many farmers. It is apparent now that some households' activities upon which packages are based such as beekeeping and also dairy requires a longer time than one year to see the achievement of tangible benefits.

4. Dimensions of CCHABA (The New Approach)

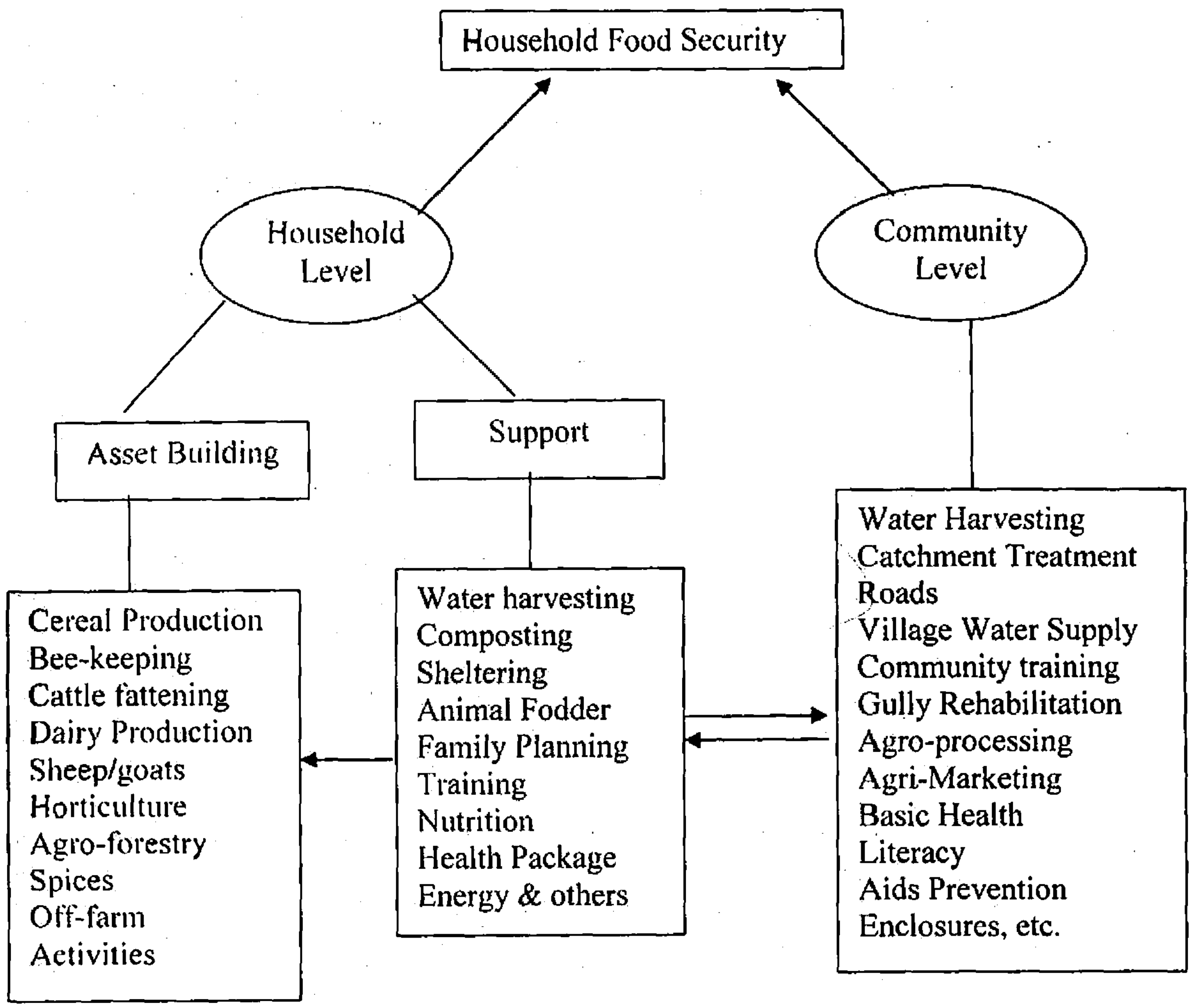
It is well recognized that the *households and communities productive assets depletion* are the major causes for the food insecurity to occur. In order *to break this circle* an approach that seeks an *optimal balance* between households based interventions and community ones, and which aims at *bringing tangible and immediate benefits to households and at the same time recovering community assets is needed*. This approach is called Comprehensive Community and Household Asset Building Approach (CCHABA).

Indeed the nature of the *CCHABA is cash oriented* owing to the fact that the CCHABA packages are composed, in addition to cereal production of, livestock, irrigation, agricultural output (horticultural products), as well as honey and off-farm economic activities like petty trade and rural building that are immediately cashable interventions. The packages are composed of diversified, sub-diversified and specialized forms.

Households are free to choose any options that suit their situation (based on their potentials and problems). An attempt has been made to provide households with a wide range of options but if households do not think that their interest is not reflected on the list of options provided to them, they are free to have one that suits their situation and be supported accordingly. As a principle, the intervention that households are engaged with should enable them to move well above a household food security benchmark of Eth. Birr 3500 (equal to approximately US $ 400). This is the minimum income that a household with an average family size of 5 requires to fulfil its food needs for a period of one year. The menu of packages enhances the farmers' capacity to cope with their chronic vulnerability, enabling them to go above this income level (see annex: "Package options").

To be able to properly manage the asset building packages and thereby reach the minimum income, households are provided with full technical support and back up. In the first place, beneficiary households are made to have the necessary skill through focused, intensive practical training. Looking at training as input to the whole process, training is provided to farmers to enable them to properly manage the package inputs that they are involved with. Another organizational feature is that amongst the household beneficiaries specialized production cadres are selected and provided intensive and follow-up training to technically support their peer groups. Usually one cadre serves between 5 -10 beneficiary farmers. They are also supported to make the necessary preparations such as land preparation, shelter, fodder, etc.

Paradigm of CCHABA



N.B. The paragraph next to the chart was not clearly written!

Water is key to the success of CCHABA and the whole endeavour of improving people's livelihood. As a prerequisite to obtaining the packages households are made to have water-harvesting schemes that meet their demand, i.e., a scheme that can harvest water that enables to properly manage the package. Wherever possible, efforts are excreted to develop, enrich and utilize available ground and perennial surface water sources such as springs and river diversions. Households that would not have such options are supported to construct simple, low cost and stable ponds where they can harvest rainwater.

Other development activities at household and community levels have to be undertaken in such a way that would synergetically match the household asset building packages. The major ones are catchments treatment, basic health service, water supply, rural road, literacy

program, energy, etc. A high degree of integration is to be found between household and community levels of intervention.
The community vulnerability assessment, in which the community selects beneficiaries through open discussion and public debates, is used as a means of targeting. This targeting system has been found to increase people's participation and local control over the program. The probability of inappropriate targeting appears also quite low. While income, food stock and assets are considered as key indicators in the selection of target households, certain categories of households such as female headed, landless and displaced are selected to be beneficiaries of the program regardless of their status in terms of the stated indicators.

The present approach demands more and better integration in planning and implementation with purpose of improving household food security through enhanced income and production. This type of implementation modality can only be materialized at watershed levels thus at very small *scale*. In fact district scale is likely to be too vast to achieve a fruitful level of integration. Hence, watershed is taken as a planning and implementation unit. The approach seeks to improve and develop all types of lands falling within a micro-watershed and gear that development to production.

Finance is provided to woredas in the form of tied block grant. Woredas are encouraged to use this fund in combination with other sources including their contribution to ensure integration and bring sustainable impact at community and household level. Funds for household asset building interventions are administered in the form of revolving fund in which households are provided with soft loans to enable them to receive asset-building packages. Funds for community wide interventions are provided in the form of grant except that communities should contribute at least 10% in the form of free labour/or local material.

Monitoring focuses on livelihoods and not on activities. The region has established a monitoring system that commences with the collection of baseline data principally including information related to socio-economic characteristics of households and communities. The system centres on simple one-page format with beneficiary baseline information that is collected at "Tabia" a level against which eventual changes is measured during subsequent evaluation.

Technology generation and dissemination focuses on making inventories and on verifying and disseminating available technologies rather than developing new ideas using basic research. To strengthen this process, a special complementary project called "Food Security Operational Research and Capacity Building" has been initiated.

5. Key Aspects of CCHABA in Detail

5.1 Optimal Scale of the Intervention

The new approach intends to correct the above-mentioned imbalance of being in favour of high cost investments at the expense of the low cost ones. In fact, through the households' packages the new approach aims at directly decreasing the vulnerability of the households not only with respect to food insecurity but also to overall poverty alleviation.

The basic principle that somehow small is beautiful is reflected not only in the packages but also in the planning of other activities. For instance, micro water catchment treatments, households based small-scale irrigation, households livestock production, flexible family credit facilities are but only some of the many innovations at policy level that are evidently substantiating the change in course.

5.2 Setting the Benchmark

One of the gaps in the past approach as mentioned above was that food security benchmark was not defined in quantitative terms. The new approach therefore defined food insecurity standard in qualitative terms taking into consideration both the regional reality and the international standards.

On the basis of the latter coupled with investigations of household consumption expenditures a household food security standard of Eth. Birr 3500 (equal to approximately 400 US $) was set. This is the minimum income that a household with an average family size of 5 requires in fulfilling its food needs for a period of one year. This food security standard is being used to set the program objectives and properly target the food insecure households. Although a certain degree of arbitrariness in this benchmark has to be acknowledged; it at least allows households to be valued in terms of the packages gross margins and thus contributing to overall food security.

5.3 Determination of Priority Package Items

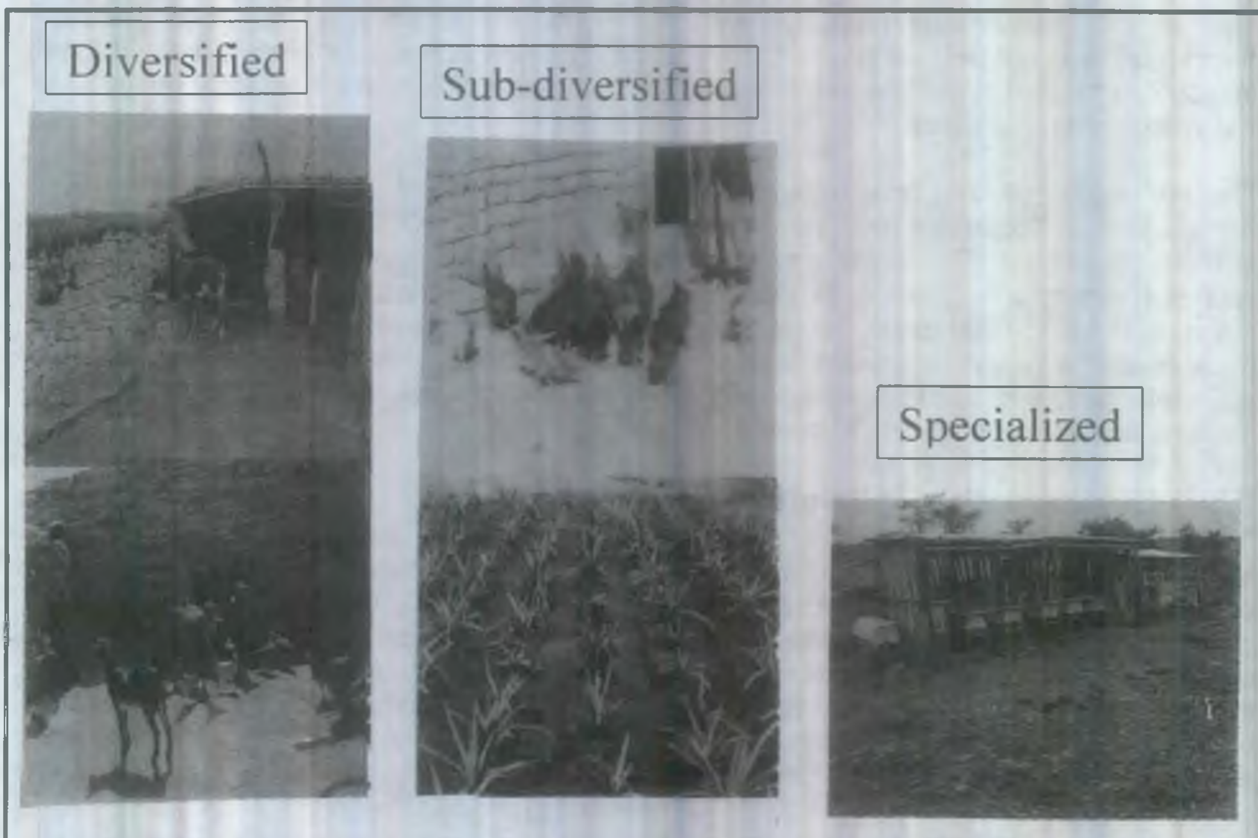
Many rural people in Tigray depend on agriculture for their survival with little scope for economic diversification. In the agriculture setting farmers experience mixed farming system including combination of crop and livestock. This objective reality in the region urged to concentrate on package items whose contents was to be directly agriculture oriented. Albeit the choice of the packages could have been rather wide some criteria for prioritising had to be found. These criteria are the following:

- Marketability
- Manageability
- Return time in benefits (maturity period)
- Labour requirements
- Potential to use conserved areas

Based upon the parameters poultry, sheep and goats, cattle fattening, beekeeping and small-scale irrigation have been listed as first class priority within the package items. Other items such as dairy, fishing and hillside utilization are categorized as second priority as they exhibit some shortcomings in their viability. For instance dairy packages might be undermined by a low local demand for milk, while agro-forestry profitability might face constraints due to the long time required in gaining benefits. These households who prefer these items ought to be aware to the drawbacks and they should be ready to cope with them.

5.4 Package Items Use and Practice

The objective of the packages use is, as mentioned, to enable participating households to obtain a minimum income of birr 3500, an income deemed sufficient to purchase food for one year for a family of 5 people (see annex No.1). Packages can be specialized namely with only one item. i.e. livestock or irrigation; diversified with three items i.e. poultry, sheep and goats, cattle fatting; sub-diversified with two items i.e. sheep and goat, cattle fattening.



In total the type of packages are 16 and out of these 5 are diversified (three items), 5 sub-diversified (two items) and 6 are specialized (only one item). Recent experiences reveals that 10% of the households prefer the single item packages, 29% are in favour of packages with 3 items or more and the vast majority, 61% wish to receive 2 items packages (sub-diversified).

Generally speaking the choice of the households originates from their own preferences and from the suitability of the area where they live for a certain kind of activities. For instance, in areas where there is a potential for groundwater households may want to concentrate on irrigation whereas with plenty animal grasses would have comparative advantage in receiving dairy and cattle fattening packages. Besides, there might be cases of farmers naturally very interested in beekeeping for various reasons.

It is to be emphasised that, though the development workers advise the farmers on the packages, the final decisions on the choice lies entirely on the households', making the whole process absolutely unique and attractive.

5.5. Technical Training and Follow-up

The training to households with regard to packages has been different from a non-specific ("it will improve the situation") type of training conducted to farmers in the past. This training has been highly focused on the technical feature of the packages themselves. For example if there were beehives in the packages, proper equipment was brought to the farmers' sites and beehives management was taught. The same applied for other items like goats and dairy cows. Then after this first phase of training that was completed, follow up sessions will be executed to verify that proper practices are still applied and eventually improved. This training is based on a standard training manual written in Tigrigna. Another interesting organizational feature is that amongst the households' beneficiaries specialized production cadres are selected to technically support their peer groups. Usually one cadre serves between 5 and 10 beneficiary farmers. The concerned institutions provide the necessary training to these cadres periodically.

5.6 Strengthening the Adoption and Multiplication of Technologies

One of the principal responsibilities of the policy-makers is to see that agricultural technology is adequately targeted. This means ensuring that technology is available for various types of farmers and that it supports equitable rural development. The region acknowledged the importance of the agricultural technologies research and dissemination as one of the major tools for increasing agricultural production. At the end of the spectrum increasing production wherever possible would definitely impact on the households' food security.

What is required at this stage is to make a sort of inventory and verify the technologies in farmers' fields together with farmers themselves so as to make the necessary adjustment to suit the local realities. This activity needs to be strengthened and to this end, a special complementary project called "Food Security Operational Research and Capacity Building" has been initiated. Needless to say that farmers should have to participate in all stages of knowledge processes. The methodology focuses on adoptive technology generation and utilization rather than transfer of technology (TOT) model. Scaling up mechanisms for disseminating the technologies to other fitting areas will also be developed.

The link with the packages is also critically evident. In fact one of the constraints in effectively utilizing the packages for improving household food security lies in the shortage of supply of technologies and inputs. Supply of improved poultry, dairy breeds and treadle pumps are very frequently below their demand. Efforts are being made to improve the supply of these inputs through the establishment of technology multiplication centres (breeding centres) and assisting the private sector to be involved in the multiplication of these technologies. Farmers who have the necessary technologies are also encouraged to act as a source of supply. In areas where it is difficult to obtain the required technologies and inputs through the aforementioned means, participating households are urged to purchase locally available inputs and breeds.

6. CCHABA Challenges Ahead

There are various challenges that will have to be faced while trying to execute the CCHABA strategy in Tigray region. The most critical ones appear to be market opportunities. Market in the region is still fragmented. As a result possible market failure may hinder the rational absorption of the increased supply owing to the scaling up of CCHABA with special reference to the packages.

The region views this problem not as an immediate one as for the time being both the volume of the CCHABA' packages and the nature of the single items themselves do not seem to be critically undermining the market fragile equilibrium in the rural areas. Nonetheless, it is well known that a very watchful eye with pressing measures is to be directed towards the correction of the market failures and the opening of viable and sustainable market outlets.

Ad hoc infrastructures such as market facilities and access roads will have to be timely constructed and a system of market information will have also to be set up in view of creating a synergy network between the producers and the buyers.

Another challenge to be confronted lies in the necessity of strengthening the social services, notably the veterinary and extension services. In addition, since CCHABA is about livelihood diversification, it will also have to confront itself with the complex issues of urban small-scale enterprise development and rural non-farm economy. The boosting of Agro industry and Trade therefore goes in line with it.

Annex I

Assumptions

The so-called package approach hinges upon the following assumptions:

1. Improved dairy cows:

   The first assumption is that it is possible to obtain 5 litres of milk per day for a total period of six months at a cost of 2 Birr per litres.

Water and fodder will be the result of the idle labour (the opportunity cost for rural poor households nearly negligible) and no cost is computed.

100 birr is taken for supplementary feed and 50 birr for drugs.
The cost of an improved dairy cow is 1200 Birr and this value is obtained on credit basis to be paid back within a four-year period.

Based on the above-mentioned assumptions the net income is calculated as follows:

Annual cost /Birr/

• Supplementary feed	100
• Health service	50
• Principal	240
• Interest	90
Total	480
Gross income.................	1800 = (6*30*5*2)
Net income	1320

2. Cattle fattening:

- A farmer can feed a cattle for fattening for three months
- A farmer can do this fattening three times a year
- Birr 50 is required for supplementary feed
- Birr 12 for drugs
- Cost of cattle to be fattened is birr 600
- Cost of fattened cattle 1000
- Principal and interest to be paid in 4 years
- Net income is calculated as follows

1. Supplementary feed (birr)	50
2. Health service	12
3. Principal	150
4. Interest	61.20
Total	273.20
Price	1000
Capital	600
Gross income (P-Cap)	400
Net income/round	188
Net income per year	564(188*3)

3. Sheep and goat:
   - Fattening for three months
   - A farmer can do this fattening three times a year
   - No supplementary feed required
   - Birr 5 for drugs
   - Cost of goats to be fattened is birr 120
   - Cost of fattened cattle 220

- Principal and interest to be paid in 2 years
- Net income is calculated as follows

1. Health service		5
2. Principal		60
3. Interest		11.25
Total		76.25
Selling Price	220	
Capital	120	
Gross income (P-Cap)	100	
Net income/round	23.5	
Net income per year	70.5(23.5*3)	

4. Improved poultry:
   - 180 eggs per year per pullet
   - 75% to be sold, 10% to be hatched and 20% to be wasted
   - A package is composed of 5 pullet and one cockerel, 2 local cockerel.
   - From hatched, 50% to be wasted
   - Supplementary feed birr 80
   - Health service birr 30
   - Cost per package is birr 90 (6*15) to be paid in one year

   Cost:
   - Supplementary feed: Birr 80
   - Health: 30
   - Principal 90
   - Interest 11.25

   Income
   - Sale of eggs 210(180*5*70)/3
   - Sale of hens 675(5*180*10)*15

   Net income: 673.7

5. Beekeeping:
   - From modern bee hive 25 kilo
   - Cost of bee hive=675
   - Price per kilo of honey birr 25

   Expenditure/income
   - Principal Interest = 282.8
   - Annual income=500(25*20)

   Net income: 213

6. Fruit:
   - One package is composed of 10 poles
   - Production from one fruit plant is 25 kilo

- Price per kilo 2 birr
- For seed 30 cents
- Pesticides 25 cents

Expenditure/income

- Seed birr 3 (10*.3)
- Pesticides 2.50(10*.25)

Total birr 5.50

Gross income 10*25*2= 500
Net income 494.5

7. Pole:

- One package is composed of 12 poles
- Price for 6.8cm high pole is birr 6
- Total net income from one package of pole is 72 (12*6)

8. Horticulture:

Area to be cultivated 0.02ha

- Seed birr 20(.02*1000)
- Pesticide= birr 1.10

Total 21.10

Net income per round 579
Net income per year (579*2) = 1158

9. Spices:

- Area to be cultivated .01ha
- Seed= 18.8
- Pesticide= 0.55
- Gross income =212 (0.01*25*850)

Net income per round= 193.3
Net income per year = 386.3

10. Cereals:

- Area to be cultivated=0.5ha
- Herbicide/pesticide= 100
- Production per hectare=8.75qt
- Price per quintal birr 175

Net income= birr 665.6 (.5*8.75*175)-100)

11. Bench mark (birr 3500 per household).

1 Landless

1 Marned with Children! ¿ Poultry, Shoats, cattle fattening, pole, fruits, spices, dairy, off-farm horticulture dairy

2 Marned with out children Poultry, cattle fattening, pole, Fruit, spices, horticulture, dairy, off-farm, settlement

3 Single (Man) Beekeeping, cattle fattening, pole, fruits, off-farm

4 Single women(women) Poultry, horticulture, backyard spices, off-farm (local beer making, weaving)

Diversified	D_1 (1.2)	D_2 (1)	D_3 (1)	D_4 (1.2 3)	D_5 (1.2)	D_6 (1)	D_7 (1)	D_8 (1.8)	
Package type	Beekeeping/3/ 639 Poultry ¼3¼ 2021 1 Spices ¼0 02¼ 386.3 3046 4	Beekeeping/3/ 639 Shoats /5/ 352 5 Cattle fattening (3) 1692 Spices /0.02/ 386 3 3069 8	Shoats /5¼ 352 5 Cattle fatt /3/ 1692 Pole/8P/ 576 Spices /0.02/ 386 3 3006 5	Beekeeping ¼3¼ 639 Cattle fatt ¼3¼ 1692 Fruits /2/ 989 3320	Cattle fattening /3/ 1692 Poultry /2/ 1347 4 Spices /0 02/ 386 3 3425 7	Cattle fatt /3/ 1692 Poultry /2/ 1347 4 Shoats /2/ 114 3153 4	Poultry ¼3¼ 2021 1 horticulture 02/ 1158 Shoats /2/ 114 3293 1	dairy /1/ 1320 horticulture 02 1158 Pole /8p/ 576 3054	
Support activities	Water 60 M3 /Pond + treadle/ Shelter (Poultry) Alfalfa (poultry) Shade (bee) Bee flower Compost	Water 90 M3 / Pond + treadle/ Shelter (Shoats) Shelter (cattle) Fodder (Shoats Shade (bee)' Bee flower Compost	Water 90 M3 / Pond + treadle/ Shelter (Shoats) Shelter (cattle) Fodder (Shoats) Fodder (cattle) Compost	Water 90 M3 /Pond Shelter (cattle) Fodder (Shoats Shade (bee) Bee flower	Water 60 M3 / Pond / Shelter (cattle) Shelter (poultry) Alfaalfa (poultry) Compost Fodder (cattle)	Water 90 M3 / Pond + treadle/ Shelter (Shoats) Shelter (cattle) Fodder (Shoats)	Water 60 M3 ¼ Pond / Shelter (cattle) Shelter (Shoats) Alfaalfa (poultry) Compost Shelter (poultry) Alfaalfa (Shoats)	Water 90M3 / Pond / Shelter (cattle) Fodder (cattle) Compost	
Sub Diversified	SD_1 (1.2.4)	SD_2 (1.2.4)	SD_3 (1.2.3)	SD_4 (1)	SD_5 (1,2,3)	SD_6 (1,2.3)	SD_7 (1,2,3)	SD_7 (1.2.3)	
Package type	Poultry /3/ 2021 1 Horticulture /1/ 1158 0 3179 1	Poultry /3/ 2021 1 Spices /3/ 1158 9 3179 9	Beekeeping/3/ 639 Fruits /5/ 2472 5 3111 5	Dairy /2/ 2640 Horticulture 1158 3798	Dairy /2/ 2640 Fruits /2/ 989 3629	Dairy /1/ 1320 Poultry /3/ 2021 1 3341 1	Cattle fatt /3/ 2256 Fruits /2/ 989 3245	Cattle fatt /3/ 2256 Poultry /3/ 1347 4 3603 4	
Support activities	Water 60m3(pond, Treadle) Shelter (Poultry) Alfalfa (poultry) Compost	Water 60m3(pond, Treadle) Shelter (Poultry) Alfalfa (poultry) Compost	Water 90 M3 / Pond / Shade (bee) Bee flower Compost	Water 60 M3 / Pond + treadle/ Shelter (Shoats) Fodder (Shoats) Compost	Water 90 M3 / Pond/ Shelter (cattle) Fodder (cattle) Compost	Water 60M3 / Pond Shelter (cattle) Fodder (cattle) Compost	Water 60M3 /Pond Shelter (cattle) Fodder (cattle) Compost	Water 60M3 / Pond Shelter (cattle) Fodder (cattle) Compost	
Specialized	S_1 (1,2,3)	S_2 (1,2,4)	D_3 (1,2,3)	S_4 (1,2,3)	S_5 (1,2,3)	S_6 (1,2,4)	S_7 (1,2.4)	S_8 (1,2,3 4)	S_9 (2.3)
Type of package	Beekeeping /15/ 3195	Poultry ¼5P¼ 3368 5	Cattle fattening ¼6¼E 3384	Pole /48P/ 3456	fruits ¼7 P¼ 3461 5	horticulture ¼3¼ 3474	Spices ¼9¼ 3476 7	off-farm	Settlement
Support activities	Water 30 M3 /Pond/ Shade (bee) bee flower	40m3(pond, Treadle) Shelter (Poultry) Alfalfa (poultry)	Water 60 M3 /Pond/ Shelter (cattle)E Fodder (cattle)E	Water 90 M3 / Pond/ Compost	Water 90 M3 /Pond/ Compost	Water 60 M3/ Pond +Treadle pump Compost	Water 60 M3 / Pond +Treadle pump Compost		

2. Poor who have land

1. Married with Children (able bodied),
2. Married with Children (not able bodied)
3. Married with out children:
4. Single women (woment):

Diversified	D_1 (1,2,3)	D_2 (2)	D_3 (2)	D_4 (1,2,3)	D_5 (5,2,3)	D_6 (1,2,3)	D_7 (1,2,3)	D_8 (1,8)
Package type	Beekeeping/3/ 639 Poultry ¼3¼ 2021.1 Cereal ¼1¼ 665.6 3325.7	Poultry /2p/ 1347.6 Shaots¼3¼ 211.5 Cattle fatt. /2/ 1128 Cereal /1/ 665.6 3352.7	Shaots /2¼ 141 Horticulture¼2/ 2316 Cereal¼1¼ 665.6 3122.6	Cattle fatt. ¼2¼ 1128 Poultry ¼2¼ 1347.6 Cereal/1/ 665.6 3141.2	Poultry/2/ 1347.6 Horticulture ¼2¼ 1158 Spices /2/ 773.2 3278.8	Poultry ¼2¼ 1347.6 Horticulture /1/ 1158 Fruit /1/ 494.5 3000.1	Dairy ¼2¼ 2640 Pole /2/ 144 Cereal /1/ 665.6 3449.6	dairy ¼2¼ 2640 Fruit /1/ 494.5 Spices ¼1¼ 386.6 3521.1
Support activities	Water 185 M3 /Pond + treadle/ . Shelter (Poultry) . Alfalfa (poultry). Shade (bee) . bee flower . Compost	Water 185 M3 / Pond + treadle/ . Shelter (Poultry). . Alfalfa (Poultry) . Shelter (cattle) . Compost	Water 185 M3 / Pond + treadle/ . Shelter (Shoats). . Compost	Water 185 M3 . Shelter (Poultry) . Shelter (cattle) . Cattle feed . Alfaalfa . Compost	Water 90 M3 . Shelter (poultry) . Alfaalfa (poultry) . Compost	. Water 90 Shelter (Poultry). . Alfafa (Poultry) . Compost	Water 90 M3 / Pond / . Shelter (poultry) .Alfaalfa (poultry) . Compost	Water 185M3 Pond / . Shelter (cattle)E . Cattle feed . Compost
Sub Diversified	SD_1 (1,2,3)	SD_2 (1,2,3,4)	SD_3 (1,2,3)	SD_4 (1,2,3)	SD_5 (1,2,3,5)	SD_6 (1,2,3,5)	SD_7 (1,2,3)	SD_8 (1,2,)
Package type	Poultry ¼4¼ 2694.8 Cereal /1/ 665.6 3360.4	Beekeeping ¼12¼ 2556 Cereal ¼1¼ 665.6 3221.6	Dairy/2/ 2640 Cereal /1/ 665.6 3305.6	Cattle fatt./5/ 2820 Cereal/1/ 665.6 3485.6	Poultry ¼3¼ 2021.1 Horticulture ¼1¼ 1158 3179.1	Horticulture ¼2¼ 2316 Spices /3/ 1158 3474	Dairy¼1¼ 1320 Poultry ¼3¼ 2021.1 3341.1	Poultry /3/ 2021.1 Cattle fatt. ¼2¼ 1128 3149.1
Support activities	Water 185m³(pond, Treadle) . Shelter (Poultry) . Alfalfa (poultry). Compost.	Water 185m3 (pond+ Treadle) . Shad (bee) . bee flower . Compost.	Water 185 M3 . Shelter(Cattle) . Cattle feed . Compost	Water 185 M3 / Pond + treadle/ . Shelter(cattle). . Cattle feed .. Compost .	Water 90 M3 / Pond/ . Shelter (poultry) . Alfalfa (Poultry) E . Compost	Water 90M3 . Shelter (Poultry) : Alfalfa (Poultry) . Compost	Water 60M3 / Pond . . Shelter (Poultry) . Alfalfa (Poultry) . Shelter (cattle) . Compost	Water 60M3 / Pond . Shelter (Poultry) . Shelter (Shoats) Alfalfa (Poultry
Specialized	S_1 (1,2,3,4)	S_2 (1,2,3,5)	D_3 (1,2,3,4)	S_4 (1,2,3)	S_5 (1,2)	S_6 (1,2,4)	S_7 (1,2,4)	S_8 (1,2,3,4)
Type of package	Beekeeping /15/ 3195	Poultry ¼5P¼ 3368.5	Cattle fattening ¼6¼E 3384	Dairy /3/ 3960	fruits ¼7 P¼ 3461.5	Horticulture ¼3¼ 3474	Spices ¼9¼ 3474	Off-farm
Support activities	Water 40M³ / Pond/ . Shade (bee) . Bee flower	Water 185m³(pond) . Shelter (Poultry) . Alfalfa (poultry).	Water 40 M3 /Pond/ . Shelter (cattle) .. Fodder (cattle)	Water 40 M3 / . Shelter (cattle) . Cattle feed	Water 90 M3 . Compost	Water 60 M3 ¼ . Compost	Water 90 M3/ . Compost	

3. Female headed

1. With able-bodied Children Poultry, Shoats, Cattle fattening, pole, fruits, dairy, off-farm horticulture
2. With Children (not able bodied): Poultry, Shoats, spices, horticulture, off-farm, settlement
3. With out children Poultry, horticulture, backyard, spices, off-farm (local beer making, weaving)

Diversified	**D_1 (1,2)**	**D_2 (1)**	**D_3 (1)**	**D_4 (1) 2577.2**	**D_5 (5,2,3)**	**D_6 (1)**	**D_7 (1,2,3)**	**D_8 (1,8)**
Package type	Beekeeping/3/ 639 Poultry ¼3¼ 2021 1 Cereal ¼1¼ 665.6 3325 7	Poultry /3p/ 2021 1 Shaots¼5¼ 352.5 Cereal /1/ 665.6 3039.2	Shoats /5¼ 352.5 Horticulture¼2/ 2316 Cereal¼1¼ 665.6 3334.1	Poultry ¼2¼ 1347.6 Cattle fattening /3/ 1692 Fruits /1/ 494 5 3534 1	Dairy/2/ 2640 Shoats ¼3¼ 141 Cereal /2/ 494.5 3275.5	Poultry ¼1¼ 1347.6 Horticulture /1/ 1158 Cereal /2/ 665 6 3171.2	Dairy ¼2¼ 2640 Pole /2/ 144 Cereal /1/ 665 6 3449.6	dairy ¼2¼ 2640 Fruit /1/ 494.5 pole ¼2¼ 144 3278.5
Support activities	Water 185 M3 /Pond + treadle/ Shelter (Poultry) Alfalfa (poultry) Shade(bee)! bee flower . Compost	Water 90 M3 / Pond + treadle/ Shelter(Poultry) Fodder (Shaots) Shelter (cattle) Shade (bee) Bee flower Compost	Water 185 M3 / Pond + treadle/ Shelter (Shoats) Fodder (Shaots) Compost	Water 90 M3 /pond/ Shelter (cattle) Fodder (Cattle) Shelter (Poultry) Alfalfa (Poultry)	Water 60 M3 /pond/ Shelter (cattle) Shelter (poultry) Alfaalfa (poultry) Compost Fodder (cattle)	. Water 90 m3 /pond = treadle/ Shelter (Poultry). Alfala (Poultry) Compost	Water 60 M3 / Pond / Shelter (Cattle) Fodder Compost	Water 90M3 / Pond / Shelter (cattle)E Fodder (Cattle) Compost
Sub Diversified	**SD_1 (2,3)**	**SD_2 (2,3)**	**SD_3 (1)**	**SD_4 (2)**	**SD_5 (1)**	**SD_6 (2)**	**SD_7 (1,2,3) .**	**SD_8 (1,2,3,4)**
Package type	Poultry¼3¼ 2021 1 Horticulture¼1¼ 1158 3179 1	Poultry ¼4¼ 2694.8 Spices /2/ 712.6 3407.4	Beekeeping¼10¼ 2130 Horticulture /1/ 1158 3288	Shaots/1/ 775 Horticulture2/2316 3091	Cattle fatt./5/ 2820 Cereal/1/ 665.6 3485.6	Cattle fatt /3/ 2256 Poultry /3/ 1347 4 3603.4	Horticulture ½2¼ 2316 Spices /3/ 1158 3474	Poultry /3/ 2021.1 Spices /3/ 1158.8 3179.9
Support activities	Water 60m^3(pond, Treadle) Shelter (Poultry) Compost	Water 60m3 (Pond+ Treadle) Shelter (Poultry) Compost	Water 90 M3 /Pond + treadle/ Shade (bee) . bee flower	Water 60 M3 / Pond + treadle/ Shelter (Shoats) Compost	Water 185 M3 / Pond/ Shelter (cattle) Fodder (cattle) Compost	Water 60M3 /pond/ Shelter (Cattle) Fodder (cattle)	Water 185M3 / Pond Compost	Water 40M3 / Pond Shelter (Poultry) Shelter (Shoats)
Specialized	**S_1 (1)**	**S_2 (1,2,3)**	**D_3 (1)**	**S_4 (1)**	**S_5 (1)**	**S_6 (1,2,3)**	**S_7 (1,2,4)**	**S_8 (1,2,3)**
Type of package	Beekeeping /15/ 3195	Poultry ¼5P¼ 3368.5	Cattle fattening ¼6¼E 3384	Dairy /3/ 3960	fruits ¼7 P¼ 3461.5	Horticulture ¼3¼ 3474	Spices ¼9¼ 3474	Off-farm
Support activities	Water 30M^3 / Pond/ Shade (bee) bee flower	Water 185m^3(pond) Shelter (Poultry) Alfalfa (poultry)	Water 60 M3 /Pond/ Shelter (cattle) Fodder (cattle)	Water 60 M3 /Pond/ Shelter (cattle) Fodder (cattle)	Water 90 M3 /pond/ Compost	Water 60 M3 /pond + treadle/pump Compost	Water 60 M3/Pond + treadle/ . Compost	

Land Degradation, Low Soil Fertility and Water Stress: The Major Issues for Improving Crop Production and Food Security in the Dryland Areas of Ethiopia

Kidane Georgis*

Abstract

Ethiopia has a long history in which the food demands of rapidly growing population have periodically outstripped the productive capacity of the land, and this is particularly true in the dryland areas of the country. This has led to a decrease agricultural productivity and environmental degradation of the natural resource base. As the main source of economic activity in SSA is the agricultural production, declining soil productivity means not only less food is grown but also that production of cash crops and income are endangered. Thus, rectifying land degradation and enhancing productivity through appropriate soil management and conservation can play a major role in achieving farm household food security and agricultural development. This publication reviews issues related to land degradation, with focus on problems of soil fertility management in SSA. It highlights some successful experiences in the region, constraints and possible solutions specific to the major agro-ecological zones and the importance of holistic and participatory approaches for soil productivity improvement. The need for action and collaborative efforts of all stakeholders, within the framework of ongoing initiatives are emphasized. It is hoped that this document will contribute to increasing awareness of senior specialists and policy-makers about the problems and alternative solutions towards enhanced and sustained soil productivity. This article assesses the major crop production constraints and their causes as related not only to the physical environment (climate, soils) but also in light of some of the important socioeconomic and policy problems. Details of some of the major crop production problems including drought (water stress), low soil fertility, pest infestation, lack of appropriate farm implements, and both socioeconomic and policy problems are indicated. The article also gives some examples of the available technologies and assess their practicality in relation to the low technology adoption by the smallholder farmers. Based on this research gaps are identified and future research strategies for sustainable crop production is proposed. Finally recommendation and suggestions on requirements in terms of capacity building in research and extension including trained manpower and facilities and other improvements in socioeconomic and policy issues required to improve crop production on sustainable basis for the resource poor smallholder farmers of the dryland areas of Ethiopia are forwarded.

1. Introduction

At present Ethiopia is facing an environmental crisis of greater magnitude. The degradation and loss of the soil resulting from soil erosion and depletion of organic matters and nutrients are much faster than they can be replaced. Various attempts have been made to qualify the magnitude of soil erosion and its effects in the highlands. The results are not directly comparable but generally speaking do not conflict with each other. Overall, a quarter of the highlands is seriously eroded. Of the area eroded, one seventh or 4% of the total highlands are so seriously affected that they will not again be economically productive in the foreseeable future. Of the land not yet damaged by erosion, half or a quarter of the highland area, is prone to erosion due to the inherent erodibility of the soil and the expansion of cultivation into erodible area. Estimates show that only 20% of the highlands is free from

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erosion hazard (EHRS, 1986). Therefore, for developing appropriate interventions the major causes for land degradation should be clearly assessed and documented.

Ethiopia has a long history in which the food demands of rapidly growing population have periodically outstripped the productive capacity of the land and this is particularly true in the highland areas of the country. This has led to a decrease in agricultural productivity and environmental degradation of the natural resource base.

Population density is alarmingly high in Ethiopia and the rate of growth, which is about 3% is one of the highest in the Sub-Saharan Africa. Therefore, there is more pressure to make the transition from low input traditional system to more productive system. Land degradation and highly variable climate also impose great constraints on intensification to increase crop production.

Production has to be increased, but the methods must be sustainable, economically viable and socially acceptable. Among the major problems is soil fertility management, which is linked with the availability of arable land, the use of mineral fertilizers, the restoration of soil fertility (recycling manure and crop residues, fallow practices, use of legumes, etc.), and water management and climate fluctuations (e.g. drought).

One important prerequisite is access to land, as more people need to produce their food supplies and make a living from the land. Traditional land management systems are dependent on the availability of sufficient land to allow long fallow periods to maintain soil fertility, when there is no more new land, the fallow land has to be used and soil fertility falls. More intensive use of land like that in the northern part of the country also implies that it becomes more prone to soil erosion, To maintain and raise its productivity, new sustainable management measures have to be introduced and polices changed.

This paper reviews issues related to land degradation, with focus on problems of soil fertility management in Ethiopia. It highlights some successful experiences in the region, constraints and possible solutions specific to the major agro-ecological zones and the importance of holistic and participatory approaches for soil productivity improvement. The need for action and collaborative efforts of all stakeholders, within the framework of ongoing initiatives are emphasized.

It is hoped that this document will contribute to increasing awareness of senior specialists and policy-makers about the problems and alternative solutions towards enhanced and sustained soil productivity.

2. The Problem of Land Degradation

Land degradation in most agricultural lands in Ethiopia particularly in the dry land areas is taking place at alarming rate. The major causes are the ever increasing human and livestock population and the associated demand for the basic natural resources such as land, water, forest and their products. Thus, the population growth and economic changes in the dry land areas are increasing the demand for food of plant and animal origin and existing pressure on the land and water resources.

FAO (1984) reported that on two million ha of cultivated land, the soil depth is so reduced that the land is no longer able to support any vegetative cover. The Hararghie highlands in Eastern Ethiopia, Tigrai, Wello, and Semen Shoa highlands in the North and the Gamo-Gofa highlands and the Bila-te River basin, which starts in Eastern slopes of Gurage highlands and stretches through Eastern Hadiya and Kembata highlands, are some of the seriously eroded land surfaces in Ethiopia. The highland areas in Ethiopia are defined and delineated to represent the land areas above 1500-m a.s.l. and low lowlands are defined as areas below 1500 m a.s.l in altitude.

Land degradation is seriously threatening the economic and social development of the country as a whole. Due to degradation, increasing number of Ethiopians have become vulnerable to the effects of drought. The severity of the devastating droughts and the resulting famines in 1972/73 and 1984/85 can be attributed to an accelerating process of degradation combined with widespread general poverty of the population.

As a result, current patterns of resource base and production practices are becoming unsustainable. Soil erosion, nutrient depletion of soils, deforestation, desertification of over-cultivated and overgrazed lands all contributes to environmental degradation. Thus, the dry areas of the country suffer several forms of environmental degradation. Forest resources are currently being cleared at an alarmingly high rate.

Therefore, high runoff and severe erosion has led to the loss of topsoil in many dry areas. Currently it can be observed that extensive dryland areas of the country particularly the arid regions of the Afar and Somalia are under continuous threat of desertification and substantial *croplands* are abandoned annually because cropping can no longer be supported on the highly degraded areas. For instance, FAO (1982) reported that where no measure has been taken to check soil erosion, there has been a long-term net decrease in rain fed crop production of about 16.5%, and a decrease in net productivity of 29.4%. Hunri (1993) [5] reported that soils in Tigrai region has lost about 30 to 50% of their productive capacity compared with their original state. This implying that a farmer today with the same input as a farmer 500 years ago would obtain only 50 to 70% of the yield at the same time.

It is claimed that four-fifth of the erosion in the highlands results from croplands, with the rest resulting from overgrazed lands, wastelands and newly deforested, but cultivated areas. Foe example, about 14 million ha, half of the area of the highlands, is significantly eroded and on two million ha crop production is no more sustainable. Traditionally, livestock formed an important component of the farming system, with soil fertility maintained by the return of manure to the soil. But, grazing land has become increasingly scarce. Short fallows were formerly common, but now are rare. Farmers still endeavour to maintain some livestock, fed on crop residues and weeds, but the search for firewood and building poles has led to deforestation in many areas. Inclusion of grain legumes in cropping systems can mitigate the need for nitrogen, but fixation and yield are low unless phosphors levels in the soil are improved. Fertility maintenance is now impossible unless fertiliser is used and farming systems adopted to prevent erosion. Fertiliser uses increased rapidly between 1971 and 1996, but fell following the removal of the government subsidy in 1997.

3. The Problem of Soil Water Stress

Soil water is the most limiting resource and will continue to be the most critical crop production factor affecting production and sustainability in the dryland areas. The major cause for this problem is related to rainfall and edafic factors. It is therefore, very important to highlight the major factors of water stress associated with rainfall and soil factor.

In the dry land areas low, erratic, short duration and poor distribution of rainfall leads to water stress problems. The amount of rainfall varies considerably between years and within seasons. The within season variation is particularly critical in terms of development of appropriate management practices for successful crop production. Because the within season rainfall is so erratic and that the incidence of water stress early in the season, mid season or late season is common experience [9]. Thus, field crops can be exposed to water stress at any time during their life cycle. In most dryland areas of the region as exemplified by the Semi-arid areas of Ethiopia (Kobbo, Mekelle and Melkassa areas), late season stress due to early finish of rains is particularly critical to successful crop production. The rainfall also frequently comes in heavy showers of short duration. It is not uncommon for 50 percent of the annual precipitation to occur in 10-15 percent of the rainy days. Thus runoff is usually high leading to substantial soil loss. In addition, in the Semi-arid areas the dry soils are quite different to handle prior to the beginning of the rainy season, thus, all agricultural operations (such as land preparation, planting) are conducted following the onset of rainy season. Often, therefore, the early rains arrive when the field is bare. This situation further aggravated by the non-stable soil structure (soils with low organic matter content), enhances the soils' tendency to develop surface seals, which decrease infiltration and profile recharge even under moderate or mild rains. These seals harden into crusts during intermittent dry periods. Such conditions deter the establishment of adequate productive cover early in the season. As a result, the traditional system of farming is also inducing to excessive runoff and soil loss. Later in the growing season, the poor crop establishment combined with continued poor growth results in very low rainfall utilisation. There are very few hydrological and water balance studies done on the different soil types and climatic conditions in the Semi-arid areas. However, hydrologic studies at ICRISAT (International Crop Research Centre for Semi-Arid Tropics) centre have shown that of the total rainfall potentially available, an average of about 26% is lost through runoff, 33% is lost through deep percolation and only 31% is used for crop evapotranspiration (El-Swaify, et al 1985). For the cropping areas in Semi-arid regions where the physical and fertility status is generally marginal and profile often shallow, excessive runoff and soil losses represent further degradation of the resource base and have led to decrease in soil productivity.

In the ASAL a fragile natural resource base characterise regions of Ethiopia. Soils are coarse-textured, sandy, low in inherent fertility, organic matter content (usually less than 1%) and generally of shallow depth (25-50 cm for example in the Northern highlands of Ethiopia) with limited soil water retention capacity. The soils loose their moisture content with a short dry spell of 3-4 days. Therefore, even in average or above average rainfall season field crops are exposed to water stress conditions and this limits crop production as exemplified in most parts of the country including the highlands of Wag-Hamer, north Wello. Thus, water will continue to be the most critical production factor affecting sustainability of crop production in the dryland areas. Maximisation of use or efficient use of rainwater will be the key issue.

In dry land where its excess and deficiency occur back to back and success of cropping depends upon raising of its availability, research for successful crop production should be conducted with water as a nucleus in all activities.

4. The Problem of Soil Fertility

Soil fertility depletion in smallholder farms is the fundamental biophysical root cause of declining per capita food production in Ethiopia. This is a major problem of crop production not only in Ethiopia, but also in almost all Semi-arid areas of Africa. The depletion rates for the major plant nutrients is estimated to be greater or equal of 40, 15 and 40 kg ha^{-1} per year for N, P_2O_5, K_2O, respectively. It is a fundamental root cause, because no matter how effectively other conditions are remedied, per capita food production will continue to decrease unless soil fertility depletion is effectively addressed. Nutrient depletion is intense and the highest in Ethiopia (Smaling et al 1997) as indicated in Table 1.

Table 1: Classes of Nutrient Loss Rate for SSA (Kg/ ha/year)

Class	N	P_2O_5	K_2O
Low	< 10	< 4	< 10
Moderate	10-20	4-7	10-20
High	21-40	8-15	21-40
Very High	> 40	> 15	> 40

Source: Stoorvogel and Smaling 1990

However, the estimate of nutrient depletion in SSA is widely quoted. Some scientists, however, have expressed concern about the approach used, as it is based on approximation and aggregation at country level – which could be misleading, masking the "bright" spots and the "hot" spots where urgent nutrient replenishment is required. Assessment of fertility decline at micro-watershed or community level would be more appropriate, but would be costly and time – consuming.

Soil fertility decline (also described as soil productivity decline) is a deterioration of chemical, physical and biological soil properties. The main contributing processes besides soil erosion include decline in organic matter and biological activities, degradation of soil structure and loss of other soil physical qualities, reduction in availability of major nutrients (N,P and K) and micro-nutrients etc.

4.1 Traditional Soil Fertility Maintaining Practices

Traditional soil fertility maintaining practices, which include fallowing, crop rotation, intercropping, and use of manure and crop residues are technically sound, but quantitatively deficient. The maintenance of soil fertility by these methods without the use of inorganic fertilizer is becoming almost impractical at this moment in time. Fallowing has broken down due to population pressure, crop residues are used as animal feed, fuel wood, and construction materials, farmyard manure is used as fuel wood, green manure presupposes growing the manure crop at the expense of a food or cash crop. Finally, agroforestry and alley cropping is knowledge intensive, nutrient management systems that have met with limited success, especially in countries such as Ethiopia where poverty and hunger force farmers to employ desperate short-term survival strategies that take procedure over long-term sustainability practices.

Grain legumes need phosphorus for their growth and development and enhanced N fixation, however, most soils in Ethiopia are deficient in available P, this aggravated by complete removal of the residues and substantial nutrients exported through the grain that is harvested. Because, most of the nitrogen fixed is concentrated in the pods, which are removed with the harvested product. Nitrogen is also limited by a short growing season in the dry land areas. Thus, traditional agriculture results in mining soil nutrients by removal of crop residues, leaching and soil erosion.

In addition, to the limited amount of availability of organic residues their nutrient content is generally low to replace the nutrient loss through intensive cultivation and residue removal. For example, the quality of manure is highly variable, depending on the quality of the feed and the way the manure is collected, stored, and applied. Thus, manure can at best be considered a supplement to other sources of nutrients. As a result, Quinones et al [10] also pointed out that inorganic fertilizer should be at the core of the strategies to restore soil fertility and raise crop productivity, although their use should be part of integrated systems of nutrient management in which organic sources are included. Organic sources of fertilizer, however, will be Complementary to the use of mineral fertilizers, and not the other way round. According to Hiyami and Ruttan [3] exclusive of organic fertilizers will increase food production grow by 2% per year well below population growth rate (population growth rate in Ethiopia is about 3%) and not even close to the 5% to 6% required to reduce poverty and assure food security.

Fig. 1 shows the conflict that leads to unsustainable land use for a typical subsistence farmer in the Semi-arid areas of Ethiopia. In the Semi-arid environment crop yields both grain and mainly water stress and low soil fertility limit biomass production. Farmers' income is limited. Therefore, crop production is not merely low input, but almost not input from the point of fertilizer and other inputs. The limited crop residues are fed to animals, used as fuel source and other purposes. Manure is also used as a fuel source. Almost all the organic resources are removed from the soil. As a result, the organic matter content of the soil in most Semi-arid areas are low (less than 1%). Thus, the infiltration rates (due to surface sealing, crusting and compaction) with accelerated runoff are leading to soil and nutrient loss and land degradation. The typical farmer in these areas is therefore caught up in a typical viscous circle (Fig. 1). Under these circumstances the seasonal production in Ethiopia is bound to decrease with time and indeed has. The important question is whether it is possible for a farmer to break this vicious circle. What are the practical options considering the technical and socioeconomic limitations? These issues will be addressed at a later section in this paper.

Okiboc [9[and Kidane [8] concluded that population pressure in the Semi-arid areas of both Ethiopia and Kenya has generated a rate of depletion of soil nutrients that cannot be supplied by conservation/biological strategy. They indicated that adequate sustainable production is only possible with input external to the farm or country, namely mineral fertilizer. The best strategy for food security and sustainable agriculture is a strategy of augmenting traditional soil enrichment practices (cereal-legume intercropping, crop rotation, etc) with modest amounts of fertilizer.

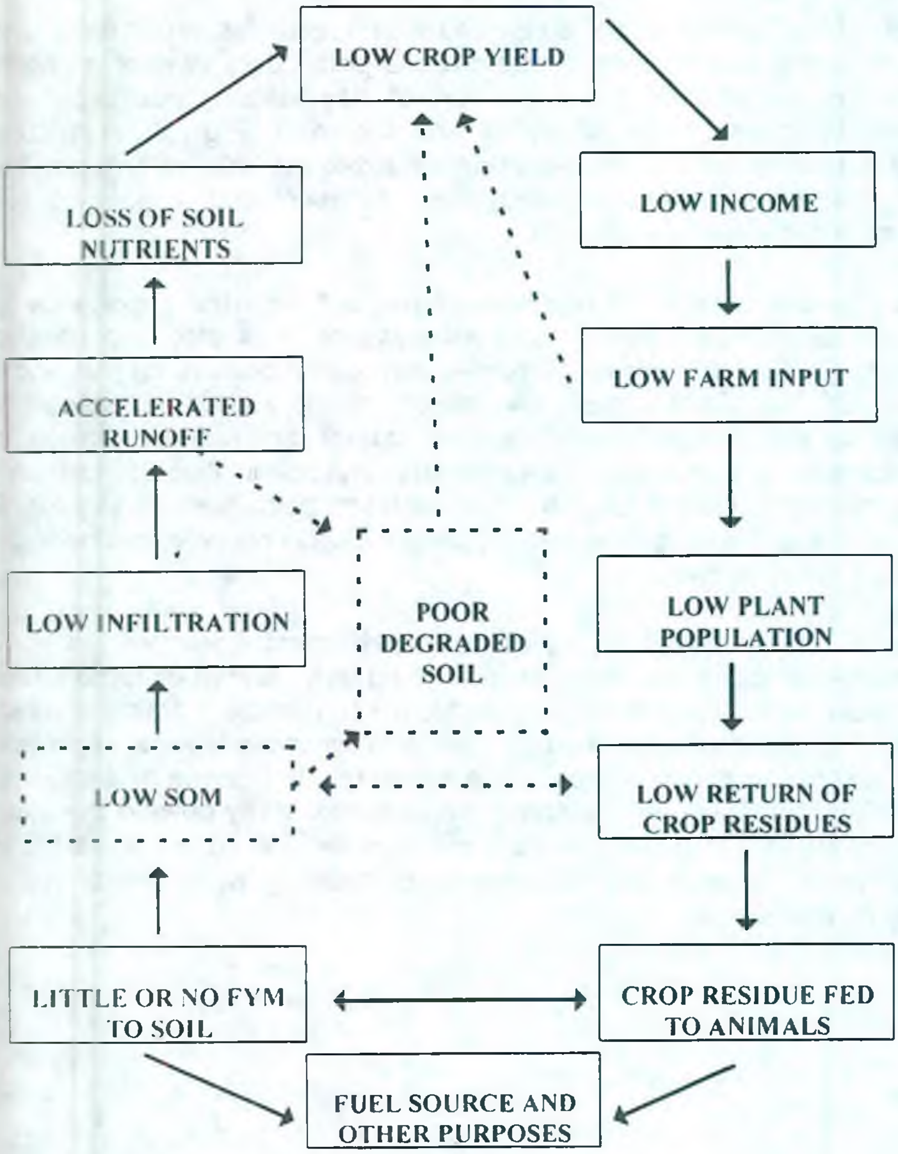

Fig. 1 The conflict that lead to unsustainable land use for a typical subsistence farmer in the SAT areas of Ethiopia

Source: (Kidane Georgis 1997)

There are experimental evidences that inorganic fertilizer application in conjunction with water conservation leads to substantial grain yield and biomass increase and is more profitable, less risky and sustainable. The key strategy, therefore, should first be first to increase biomass production and grain yield through addressing the major biophysical problems in the Semi-arid areas soil water stress and low soil fertility.

5. Relation of Soil Productivity to Soil Degradation Processes and Soil Conservation Practices

Whenever a natural ecosystem is transformed into an agro-ecosystem for the purpose of food and fibber production, there are several soil degradative processes set into motion. Hornick and Parr [4] reported that most agro-ecosystems have degradation processes and conservation practices occurring simultaneously. The relation of soil productivity to soil degradation processes and soil conservation practices is illustrated in Fig. 2. As soil degradation processes proceed and intensify, there is a concomitant decrease in soil productivity and sustainability. Conversely, soil conservation and reclamation practices tend to increase soil productivity and sustainability. Therefore, the productivity level of an agro-ecosystem at any time is a result of the interaction of degradation processes and conservation/reclamation practices, some of which are shown in Fig. 2. In natural ecosystems, sustainability is achieved through the efficient but delicate balance between all-necessary inputs and outputs. Failure of agroecosystem to maintain this balance will ultimately lead to systems that cannot be sustained.

The relation shown in Fig. 2 applies to all agroecosystems, although the importance of specific process will vary substantially between agroecosystems. It is also important to recognise that some of the processes that are generally considered positive can, in some cases, result in soil degradation. For example, the use of organic wastes increases soil organic matter, improves soil structure, enhances soil water storage, and reduces erosion. In some circumstances, however, use of organic wastes results in accumulations of toxicants or nutrient depletion caused by increased leaching. The important point illustrated by Fig. 2 is that degradative processes and soil improvement processes always occur simultaneously, and the net result can be positive or negative.

The negative impacts of soil degradation processes can become dominant. In such situations, agroecosystems cannot be sustained over the long term, and in extreme cases soil productivity can be reduced to zero. On the other hand, soil conservation practices rarely improve the productivity of croplands beyond the initial levels experienced when a virgin land is cultivated. However, soil restoration practices, to be economically feasible and forward-looking, must, of necessity, be focused on improving the soil productivity beyond the initial level experienced after cultivation. Examples of such practices include adding fertilisers in areas where essential plant nutrients are deficient, and installing water conservation practices to significantly reduce runoff.

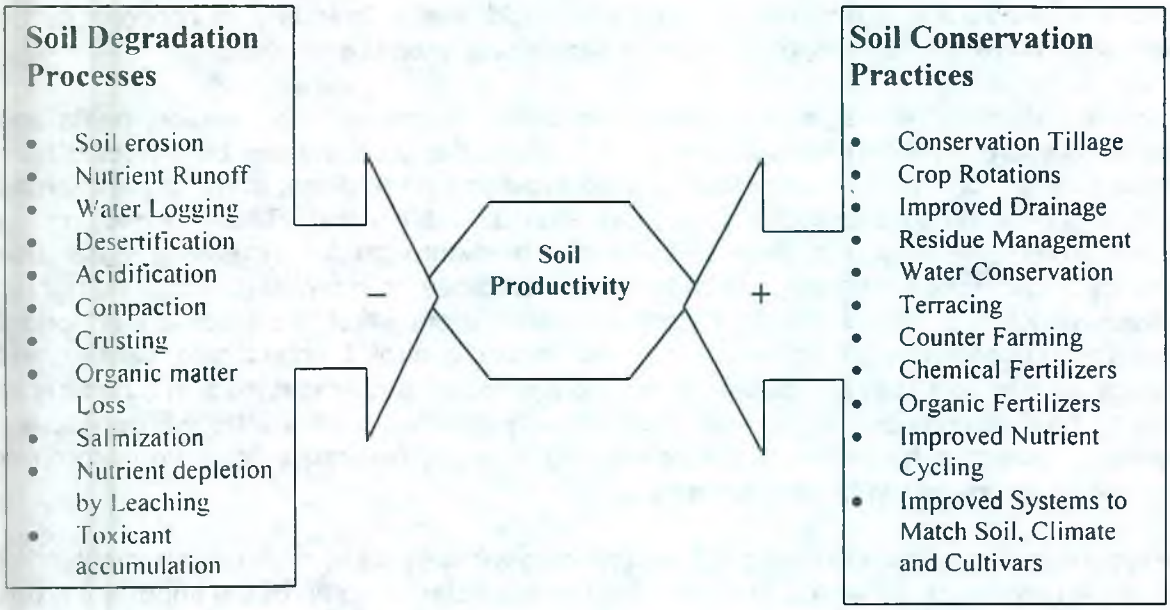

Fig. 2: Relation of Soil Productivity to Soil Degradation Processes and Soil Conservation Practices (Modified From Hornick and Parr, 1987).

6. Past Research Approach and Experience

6.1. Research Focused on Plant Breeding with Little Emphasis on the Key Issues of low Soil Fertility, Water and Other Agronomic Practices

In both national and international agricultural research centers during the last two decades, plant breeding has been the predominant discipline with other disciplines providing a supporting role. For example, in the past the crop improvement in Ethiopia focused on variety development with less emphasis on management practices. Thus, the publicity given to high yielding varieties of cereals has given rise to the popular view that the adoption of these varieties by farmers has itself dramatically raised production. Experienced breeders and agronomists know that this is not true.

Crop productivity is a function of not only the **genetic potential** of a crop, but also of the **agroclimatic**, **topographic**, and the **soil environment** in which the crop is grown. Both the genetic potential and the physical environment can be modified. With the Ethiopian context, however, it is the environment (low soil water and fertility and the associated water and nutrient stress) that limits crop yield. This is especially true in the dryland areas, where there is highly variable ecology and farming systems and **ignoring management factors avoids** the heart of the problem.

The central problem of agricultural technology development in the rainfed areas is that too much has been expected of the breeders. In contrast with those regions of the world where breeding activities have been successful, Semi-arid areas agricultural practice takes place in an extremely harsh environment. Rainfall is low and irregular; there are multiple soil fertility problems, including very low levels of the two basic nutrients, nitrogen and phosphorus; and there is minimal purchased input utilization. Asking breeders to resolve all these problems of inadequate water and nutrient availability prior to basic improvements in agronomic conditions is unrealistic. Moderate improvements in soil fertility, availability of the basic resource of water and agronomic environment would enable breeders to concentrate on developing cultivars for an improved and less variable agronomic environment.

At very low levels of management, nutrient deficiency, poor cultivation, weeds, pests and diseases are overwhelming limitations to yield and little if any benefit can be expected from plant breeding alone to address these complex problems. In addition, in the dryland areas the major limitation to successful crop production is water stress. Thus, developing an efficient water use is a high priority, but major breakthrough for increasing water use efficiency through plant breeding has been elusive. Because as Haechel [2] indicated rightly, relatively very few attributes directly associated with efficient water use which are important under dryland conditions are known to be under genetic control. Stomatal size, density, and behavior, as well as depth and pattern of rooting are heritable characteristics in a number of species. Leaf dimension, angle and crop maturity can also be controlled genetically. Therefore, breeding for water use efficient and drought resistance is a very complex undertaking and gains will be slow coming.

The most significant contribution from plant breeding will likely be in increasing harvest index with some crops such as wheat. However the harvest index of some of the important crops of the dryland areas such as grain sorghum has not been altered by genetics directly. It has been indirectly increased by the development of short-season cultivars that complete their life cycle and produce grain crop before the available water is exhausted. Plant breeding for disease and pest resistance as well as tolerance to difficult soils such as saline or high aluminum soils also holds promise for drylands. The fact remains, however, that the genetic potential of crops is generally not the limiting factor in dryland production and improved cultivars will not produce at their potential level unless adequate soil water management and soil fertility practices are implemented.

If the crop management is not improved, for example by higher soil water storage through improved tillage or by the use of inorganic fertilizer, a new environment is created. Thus there will be a scope for breeders to select genotypes that are better able to exploit the new environment. Taking an example from India, the reports indicate that the proportion of cereal crop yield increases attributed to improved seeds is only 13%, compared to fertilizer 41%, to irrigation 27%, to double cropping 10%, and other improved practices 9%.

6.2 Previous Approach in Soil Fertility Improvement

Despite the importance of low soil fertility in limiting crop yield in the dryland areas of Ethiopia very limited research was undertaken by the research organizations in Ethiopia to address the soil fertility problems. Thus limited work was done on research centers with a blanket recommendation for the whole country. However, Ethiopia has wide agricultural environments and farming systems, which within very short distances showing different soil types, rainfall conditions forming various niches.

The recommendations of such research works were not based on soil types, fertility status, climatic and cropping systems. Fertilizer studies were mainly conducted on research stations with limited follow up research on farmers' field. In the research stations where fertility status and soil properties vary considerably from the farmers field due the repeated use of fertilizers especially the use of fertilizer such as P with residual effects and also the heavy implements and herbicides, has created micro-climate quite different from the farmers field. The on station research should have been followed by on farm trials to avoid this discrepancy. The research on fertility also lacks economic studies and profitability was not assessed.

6.3 Experiences on the Role of Agronomic Management Practices in Crop Production

Under dry land farming conditions, if crop management is improved using appropriate management practices, for example by higher soil water storage through improved tillage or by the use of inorganic fertilizer, a new environment is created. Thus there will be a scope for breeders to select genotypes that are better able to exploit the new environment. However, there are many research results that indicate that improvement of management practices could result in substantial yield increase even by using the traditional unimproved local crop varieties as illustrated below.

Table 2: Impact of Soil Water Conservation Method (Tied Ridges) on Grain Yield of Sorghum, and Maize in the Semi-Arid Areas of Ethiopia

Soil conservation method (tied ridges)	Average grain yield t ha^{-1}		
	Kobo	Melkassa	Mean
Sorghum			
Flat planting (farmers practice)	1.6	0.80	1.20
Tied Ridges planting on ridge	2.9	3.0	2.95 (145%)
Maize			
Flat planting (farmers practice)	1.2	-	1.2
Tied Ridges planting in furrow	2.7	-	2.7 (125)

It is also important to note that the achievements of farm yields much closer to experimental potential is unlikely to result from a single piece of technology in isolation, but it will require an additive approach that builds on the complementarities of improved variety and agronomic practices. While this does not mean that progress in raising productivity will not be feasible without applying the whole package, it does imply the need to consider each item as a component of a technology rather than a stand-alone.

Table 3: The Impact of Improved Water and Fertility Management Practices and Weeding on Maize Grain Yield in Melkassa, Semi-Arid Area of Ethiopia

Treatments	Yield (t ha-1)
Broadcasting, no fertilizer, late weeding 6 weeks after emergence, flat planting without water conservation (farmer practice)	1.3
Row planting, no fertilizer, late weeding 6 weeks after emergence, flat planting without water conservation	1.7 (37)
No fertilizer, Late weeding 6 weeks after emergence, tied ridges (for water conservation)	1.9 (46)
No fertilizer, early weeding 3 weeks after planting, tied ridges (for water conservation)	2.3 (73)
40 N 46 P_2O_5, early weeding 3 weeks after planting, tied ridges (for water conservation)	2.9 (117)

Table 4: Improved Agronomic Practices and Impact on Grain Yield in Maize, Experience from Kenya

Component	Content	Yield t ha^{-1}
Basic	Local variety	0.6
Improved variety	With a small increase in plant population	0.7 (16.7)
Improved fertility	40 kg N/ha 15 kg P/ha	1.1 (83.3)
Time of planting	Moved to near optimum to the area	1.3 (116.7)
Weeding	A second weeding	1.4 (133.3)
Plant population	Increased from 25,000 to 35,000 plants/ha	1.5 (150)
Further improvement to fertility	Fertilizer increased by an additional 50 kg N and 20 Kg P ha^{-1}	2.1 (250)
Changed to hybrid seed improved timing of operations	Use of hybrid planted within two weeks of of start of the rains and weeded within one one month of planting	2.8 (366.7)
Improved pest control	Appropriate action to control stem borer and other pests	3.0 (400)
Additional improvement to fertility	Addition of 50 kg N/ha and 30 kg P/ha	4.0 (566.7)

Taking an example from India, the reports indicate that the proportion of cereal crop yield increases attributed to improved seeds is only 13%, compared to fertilizer 41%, to irrigation 27%, to double cropping 10%, and other improved practices 9%.

In the United State, where sorghum yields tripled in 30 years from 1.2 metric tones per hectare in 1950 to more than 3.8 in 1980, the genetic contribution was estimated to be 28 to 39 percent (Miller and Kebede, 1984:6, 11). Over 60 percent of these very large yield gains were due to improved agronomy practices, especially fertilization, herbicides, and water control (Miller and Kebede, 1984:7). The new cultivars are generally more responsive to higher inputs use. Thus, the technological development strategy needs to include both breeding and the improved agronomy (F. Miller, personal correspondence).

Critical appraisal of the breeding efforts for drought tolerance indicates that genetic improvement has necessarily to be integrated with agronomic management to improve the productivity. Therefore, more multidisciplinary approaches involving breeders, physiologists and agronomists might provide useful results during the coming decades.

7. The Way Forward, Future Research Strategies

7.1 Utilizing Indigenous Soil and Water and Fertility Management Practices: The Starting Point for Research and Development

Involving local populations at an early stage can be of great help in understanding the systems. These people do, after all, have a tremendous store of knowledge on the systems- as proved by their ability to survive in these harsh environments. They are the ultimate beneficiaries of project interventions, and thus they know best what actual needs the project objectives should indicate. However, most researchers did not appreciate the role of farmer's indigenous knowledge in planning, designing appropriate technologies to increase agricultural production on sustainable bases. Until recently there has been a general failure to realize the socioeconomic context in which a farmer operates and appreciate the traditional practices, as well. Therefore, utilizing the best practices of traditional knowledge and practice could be a starting point for research and development.

For example, the Konso people of southern Ethiopia have developed elaborate step terracing system to control erosion in the production of crops on steep mountain slopes. The farmers in Alemaya area have been practicing tied-ridges to conserve moisture, and the farmers at Inewari of Northern Shewa are constructing narrow broad-beds-and-furrows to facilitate surface drainage and enhance aeration in the root zone. In addition indigenous knowledge in agricultural management practices appears to have accumulated particularly in the dryland areas of Ethiopia where the natural resource base is under severe pressure from local communities, the ecosystems are fragile, and there is history of adaptation to severe conditions. For example, traditional soil and water conservation practices have been used widely for more than a century in regions like Tigray, North Shewa and Wello, and Haraghie.

However, these are isolated examples of knowledge and need refining and large-scale adoption by farmers in regions where these problems exist. This is a major challenge to agronomists and extension workers on how to improve and refine such traditional technologies and make them appealing as well as available to resource-poor and labor-poor farmers.

Thus, it is important to understand when we say that research should be based on indigenous knowledge. This is meant that the farmers' practice and knowledge and traditional cropping systems should be assessed and critically analyzed to identify gaps and design appropriate research programs to augment the traditional practices though science and research and not live with the farmers practice.

7.2 Integrated Soil Fertility Management

Over the last few years, the concept of Integrated Soil Fertility Management (ISFM) has been gaining acceptance. It advocates the careful management of nutrient stocks and flows in a way that leads to profitable and sustained production. ISFM emphasizes the management of nutrient flows as shown in Figure 2 below, but does not ignore other important aspects of the soil complex, such as maintaining organic matter content, soil structure and soil life. It is comparable to 'integrated nutrient management' and 'eco-intensification' but provides a somewhat broader approach[16].

Inflows are generated by management practices, such as the application of mineral and organic fertilizers, biological nitrogen fixation and agro-forestry, as well as the result of atmospheric deposition and sedimentation. Outflows refer to losses of nutrients from the system in the form of harvesting, removal of crop residues and animal wastes from the farm, leaching, erosion, run-off, and gaseous losses. A nutrient balance is the sum of all inflows minus the sum of all outflows for a certain element.

7.3 Fertilizer Augmented Soil Enrichment Strategy (FASE)

In an effort to address these problems we are proposing a strategy featuring fertilizer augmentation of current practices, **Fertilizer-Augmented Soil Enrichment Strategy or "FASE"**. This strategy is based on fertilizer use to augment the traditional strategies used for maintenance of soil fertility in these areas, so that more residues are produced and even with the outside utilization of the residues more organic matter could be returned to the soil. Production may be enhanced by improved water conservation resulting from the beneficial effects of soil organic matter. The success of such approach is likely to depend on the interaction between water conservation, crop growth and fertilizer response. Accordingly, the fertilizer amendment strategy proposed is not a "green revolution" leading to improved yield, but has the primary aim of enhancing organic matter production as a starting point for improved soil fertility. In conjunction with these complementary practices of using improved seed, appropriate population, weed control and other cultural practices should be used. Hence, it can be concluded that efforts should be made to increase the efficient use of mineral fertilizers trough sound policies and education, to maintain economic growth and food security targets, which also minimize the damage to the resource base.

The research approach was not also multidisciplinary involving the key stakeholders, which include soil scientists, agronomists, crop physiologist and economist. Therefore, the fertilizer recommendations were blanket recommendations were not adopted by farmers especially in the dryland areas of Ethiopia. Therefore there is for soil test laboratories to be established across major soil types and farming systems to improve the fertilizer studies in the country.

7.4 Strengthening Research on Plant-Soil-Water Relationships

The accelerated rate of soil erosion and recurring droughts constitute the greatest limitations to crop production in Ethiopia. This indicates that in the dryland areas the research agenda should focus on strengthening research on plant-soil-water relationship studies.

Crops and cultivars differ widely in their physiological responses to changes in soil-water relationships, with respect to both physical factors and nutrient status. One of the most important tasks is to understand the adaptation of plants and animals to the environments and the production systems in which they are produced. Whatever the environment, different crops have different economic potential at different stages in their life cycle.

The crops should make the best possible use of the time available between the sowing date and the end of the growing season, dates that are usually determined by when the rains begin and end. The kind of work that is directed to understanding these relationships has an important bearing on the development of improved crop varieties and the improvement of production systems. In rain-fed environment, the aim is to make the fullest possible use of the time when the risk of drought is least. This is why it is particularly important in the rain-fed agricultural system that dominates the semi-arid areas to understand the variations in seasonal changes in the water balance. Only when this has been done, and the risk of encountering drought has been diminished as far as possible, is worth searching for mechanisms of drought resistance in crop plants. This discipline is very weak and should be strengthened.

7.5 GIS and Dynamic Models: Modern Tools for Natural Resource Management

Rain fed crop production in the Semi-arid areas is risky. This is mainly due to inadequate and highly variable rainfall and soil factors. Thus, although broad generalization could be made from field experiments on the effect of management practices on crop growth, extrapolation of such results is limited by variation in rainfall, soil conditions and agronomic practice. The use of simulation models offers the prospect of enhancing the application of experimental results to other seasons and sites and management practices.

Some of the models including the long-term soil organic models such as CENTURY, EPIC and SOCRATES, which simulate the effect of long-term management practices on organic matter content and other sustainability issues. In addition, the CERES crop models, which are linked to DSSAT (decision support system for agro-technology transfer) micro-software. This facility provides with opportunities to users to evaluate strategies with respect to uncertainties in crop production indicators (such as yield) and associated risk in response to different weather sequence.

The crop modeling system could also be linked with geographic information system (GIS), which consists a database of a particular region's soil, climate, vegetation and topography. Simulation models can then be run for any location using the appropriate database. Simulated results can be stored in the GIS database and presented in a map form. This information is important for both policy makers and farmers. For instance, comparison of mean grain yield response to fertilizer application may be used to indicate where maximum benefit could be achieved from fertilizer use. It can also show estimation of mean grain yield for a region at various fertilizer-input levels. The analysis also provides standard deviation associated with fertilizer application. Long-term analysis such as this can facilitate an assessment of weather related risk associated with fertilizer application. The probability of attaining particular profit margins can also be mapped using this type of analysis. In situations such as Ethiopia where limited supplies of fertilizer and other inputs is available, such information could help to indicate where scarce resources should be allocated.

These expert systems models have found few or no application to date here in Ethiopia by our physiologists or agronomists. This area should be strengthened particularly in Ethiopia where resources are limited and the agroecological zoness farming systems and practices vary within short distance.

7.6 Focus on On-farm Area Based Research

Unlike irrigated land, rainfed habitats are highly variable. Therefore, there is a need to design technologies that suit specific conditions. It does not mean that each distinct area or niche should have a specific research and development setup. Packages of technologies generated at center or sub-center research stations, covering wide geographical areas, would, however, need to be farm-tested and refined or adjusted according to agroecological and socioeconomic settings; for this reason, on-farm testing assumes high importance in rainfed research. Involvement of the farmer in the on-farm-testing program is necessary to convince him of the viability of the new dryland technology.

- *Location specificity:* The technology developed cannot be applied to the entire agroclimatic zone because of the variations within a defined agroclimatic zone in spatial distribution of rainfall.
- *Consistency of technology:* The technology, to be successful, has to be tested over years, as there is vast variation in rainfall in both quantity and distribution over years.
- *Flexibility of technology:* No technology, however sound, can be adapted to all conditions. Dryland technology has to have flexibility. Aberrant weather conditions have to be taken into account.
- *Profitability of the technology:* With little or no control of moisture, the degree of response to any treatment or recommendation would vary. Thus, profitability would also fluctuate. Visual changes are essential for the acceptance of dryland technology.

First, the dryland technologies should be tested in locations around research stations. Later, the technologies should be introduced in integrated agricultural development projects. A systematic evaluation of technology has to be done by the research workers themselves so that they can make a reliable assessment, identify the bottlenecks, and work as a source of feedback for research. Thus, on-farm research projects form a vital link in the transfer of technology with the following activities:

- to critically study local agricultural practices.
- to test the research findings in farmers' fields.
- to determine the acceptability and transfer of technology.
- to determine the economic feasibility of the technology under farmers' field conditions.

- to identify socioeconomic constraints.
- to serve as a source of feedback to research.

8. Conclusion

The low total agricultural production and land productivity, coupled with a high rate of population growth and an alarming state of land degradation in Ethiopia, requires a strategy that will lead at the same time to increase in agricultural production and control land degradation. Out of the many factors that influence agricultural production crop productivity is mainly governed by the soil upon which the crop is grown, the type and variety of the crop, the climatic conditions, and the management practices.

The country's scarce resources need to be allocated in the first instance to alleviate the universal stresses (nutrients, moisture, crop genetic variability and management practices). Long term investment to arrest the land degradation processes is urgently needed.

After several years of research and extension involving complex systems, many of us are convinced that improved crop management using systems approach is one of the keys to increasing food production for the farmer with limited resources.

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Features of Grain Marketing Networks in Ethiopia:

A Synopsis of the Implications for Achieving Regional Food Security Objectives

Abebe H. Gabriel *

Abstract

The food situation and crop prospects in sub-Saharan Africa has a gloomy picture in the sense that many countries in the region have been facing exceptional food emergencies caused by difficult weather conditions, persistent civil strife and insecurity. The impact on the countries of the Horn of Africa has been particularly deteriorating. Among the various types of insecurities that many peoples of these sub-region face almost on a regular basis is that of food insecurity. Tens of million people suffer from chronic food insecurity and are often menaced by famine almost on a regular basis. There exists a profound difference among these countries in terms of the status of the food balance (in terms of cereals) and production patterns. On one end of the spectrum is Djibouti that is totally dependent on food imports. On the other end, there is Uganda that is not only self-sufficient but also has been consistently exporting since 1993/94. Eritrea has been depending on cereals imports for at least 50% of its domestic consumption needs, as is the case with Somalia. Kenya also imports cereals to meet about a quarter of its domestic needs; Sudan and Ethiopia are also importers at the margin. Those who exported cereals at least once include Kenya (in 1995/96), Ethiopia (in 1996/97), Sudan (intermittently) and Uganda (since 1993/94). From these pictures, it could be gleaned that the sub-region is characterized more by deficiency in its cereals balance. As a country, Ethiopia has been dependent on food imports (including food aid) for quite some time now. Reports indicate that between 1995/96 and 1999/2000, the proportion of population under food poverty declined from 47% to 42% respectively; however it rose from 32.5% to 46.7% in urban areas during the same period [13]. This year, the number of people directly affected by drought and consequently dependent on emergency relief food has been reported to be in the order of 14 million. In any one-year, more than four million people (mostly in rural areas) face food shortages and need relief assistance. Surplus production, lack of market outlets, and wastages in one part of the country runs parallel to prevalence of deficit and hunger in another part. Several reasons could be cited for such a picture, but inefficiency in food production and in marketing lies at the core of it. There seems to exist a hidden potential for improving the adequacy, stability and access of food for the simple reason that the gap between what could be achieved under optimal conditions and what is actually attained is extremely wide. And new opportunities, both domestic as well as global, must be captured sooner rather than later for the realization of such a potential. One of these opportunities relates to the development and utilization of market outlets at a regional level for achieving food security at national level. The purpose of this paper is to outline the major features of grain marketing networks in the Ethiopian context and relate it with the objective of improving food security status of the country as well as that of the sub-region at large. First the profile of grain production is presented to show how localized surplus grain production has traditionally been in Ethiopia. This is followed by a discussion of the domestic grain marketing networks. The extent to which this domestic network is linked with networks in

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neighboring countries is briefly touched upon. Then major constraints for improved grain marketing are outlined; and finally, by way of a summary, areas for possible improvement of the efficiency of grain marketing are presented together with policy options.

1. Profile of Grain Production in Ethiopia

The following features characterize Ethiopia's production of food grains: (i) it is predominantly produced by peasants; (ii) it is traditionally organized – motive is subsistence, technology is backward, yield enhancing inputs are not widely used; (iii) it is rain-fed, hence seasonal and extremely vulnerable to natural factors such as rainfall availability, hence susceptible to risk; and (iv) yield level is extremely low – around 11 qt/ha of cereals, 6 qt/ha of pulses and less than 4 qt/ha of oilseeds.

Cereals, pulses and oilseeds constitute respectively for 83%, 13%, and 4% of total grain cultivated area and 87%, 11% and 2% of grain production [1]. The most important cereals include maize, teff, sorghum, wheat, and barley constituting respectively for 21%, 31%, 17%, 14%, and 17% of cultivated area under cereals, and 29%, 23%, 18%, 14%, and 16% of total cereals production [2].

Annual grain production fluctuates widely; it could drop to below 4 million tons when drought hits the hardest such as in 1984 for example. On the other hand, in those years with good rainfall amount and distribution, Ethiopia could produce about 9 million tons of cereals; and this may make the country to be self-sufficient in food production. However, even in those good years, several thousand people suffer from food shortages and therefore depend on food-aid. One of the problems is that due to poor marketing and distribution networks, high transport costs and other (infra) structural factors effectively isolate and localize surplus production from outside sources of effective demand for these products. The effect is that when surplus is produced, it results in drastic falls of grain prices and reduced farm incomes. The case in point is that of the 1999/2000 experience that a 19% increase in production resulted in 40% reduction in grain prices.

Even though Ethiopia is a large country, with a total area of more than a million square kms, crop production in general is concentrated in about 40% of the total area – i.e., in the highlands that are suitable to rain-fed agriculture (Fig. 1). Among these, regions that are traditionally identified as 'surplus producing' are also localized areas. Hence, one could note that surplus production has been narrow-based with just three small zones (Shoa, Arssi, and Gojam) having to contribute to 70% of total cereals output. Fig. 2 shows the regional profile of surplus production of cereals – note how it is quite limited to few regions.

Some of the hidden potentials to increase grain production in Ethiopia include (a) the huge performance gap, i.e., between what could be achievable and what has been actually attained (area, yield, irrigation, labor utilization); (b) the government's political will and commitment to improve the agricultural performance (development strategy, policies, etc.); and (c) the existence of unutilized market outlets both domestic and international. These factors should lead to expansion of production and improvement of productivity.

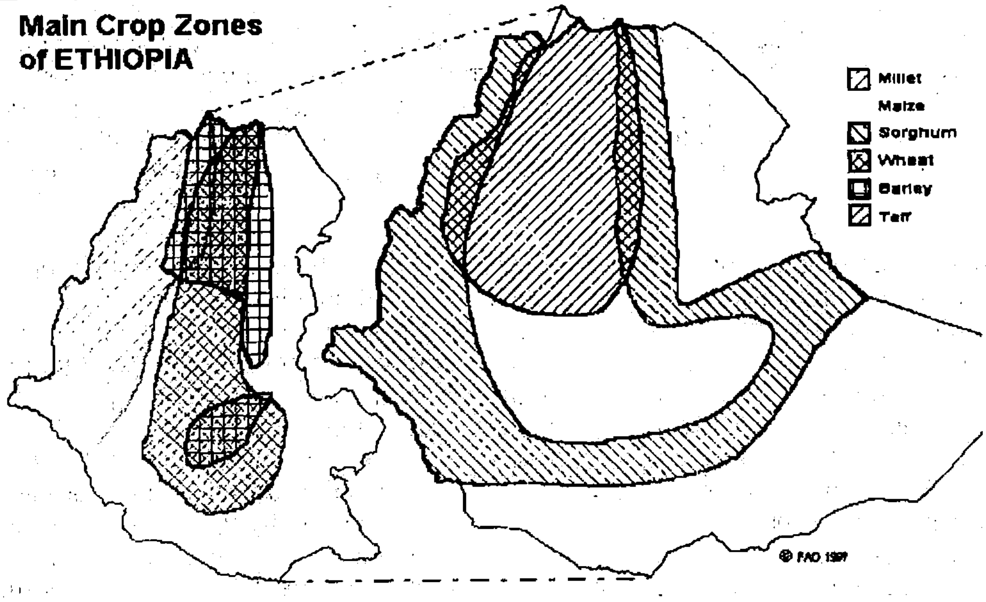


Fig. 1.

Source: http://www.fao.org/GIEWS/english/basedocs/eth/ethcul1e.stm

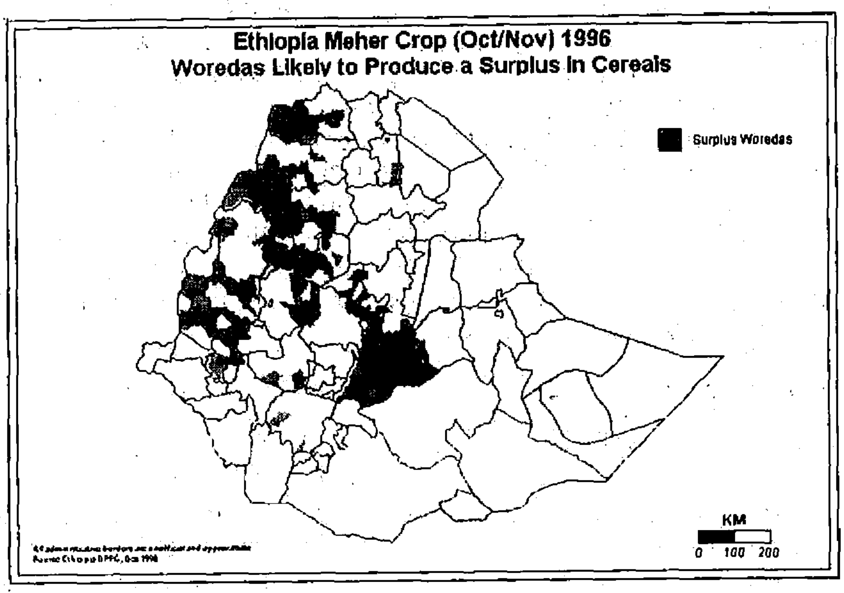


Fig. 2.

Source: DPPC, December 1996

2. Profile of Grain Marketing in Ethiopia

The performance of grain marketing network at a regional and international level could be hampered in a number of ways by the efficiency of the domestic marketing network. Cereals are the major sources of food intake in Ethiopia constituting 70% of calorie intake of which two-third being accounted for by teff, wheat and maize alone [3]; [16]. But, the major demand originates from the direct producers themselves since production is organized primarily to meet household consumption requirements rather than for the market. According to some estimates [3] the grain market-dependent population, that is the population depending on the market for all or part of its food supply, was roughly 42 percent of the total population in 1992; i.e., urban population (15%), pastoralists (12%), and grain-deficit farm households (14%).

As a result, marketed quantity of cereals is estimated to be about 26% of total production with some inter-crop differences – for example, marketed quantity for maize, teff, and wheat respectively were 25%, 21% and 14%. A reflection of the production pattern, the profile of marketed surplus by source is also very narrow. Moreover, cereals markets are characterized by large inter-seasonal fluctuations of volumes as well as prices. 79% of farmers' sales and 51% of traders' purchases occur during the first quarter immediately following harvest (between January and March). Grain prices are the most depressed during these months. As touched upon above, in 1999/2000 production year cereals output increased by 19% of the previous year causing a price decline by up to 40% [17]. Absence of processing, limited storage capacity and generally poor post-harvest grain management systems coupled with weak purchasing power in domestic markets and poor international market outlets could be cited as major (infra)structural problems surrounding grain marketing in Ethiopia.

It would be proper to quickly comment on the impacts of the pro-market reforms introduced in the country on grain markets. The reforms have rendered the smallholding farmers to be the single most important source of marketed surplus of food grains. Price levels have generally risen during the post-reform period; price variability, both temporal and spatial, tended to decline after the reform (Jayne, Negassa, and Myers, 1998). Such a result was ascribed to reduced transaction costs since smuggling and bribery have been reduced (Franzel, Colburn, and Degu 1989), the end of civil war that had disrupted the smooth flow of grains among regions (Dercon 1995) and the incentive effect that resulted from permitting traders to sell in free markets. The reform has also reportedly resulted in improved degree of market integration; in other words, price changes were transmitted more rapidly and more fully in different markets of the same crop than it used to be the case during the pre-reform period (Negassa and Jayne, 1997; Dercon, 1995).

3. Market Infrastructure

a) Transport Network

The fact that marketed surplus originates from narrow-based and localized few sources implies that it must be transported to long distances and wider areas before it reaches deficit areas. This is exacerbated by the size and topography of the country as well as by the radial configuration of transport networks with Addis Ababa at the center which has hampered inter-regional flows. Roads are the single most important transport networks as far as grain marketing in Ethiopia is concerned. However, many of the regions in Ethiopia are inaccessible using modern road transport facilities; according to some studies 70% of the country's land area is not served by modern transport system (FGE, 2002), and only half of grain markets in major production zones are served by all-weather roads (Alemayehu, 1993). Average road density in Ethiopia is estimated to be 29 kms per 1,000 km^2 of land or 0.48 kilometer per one thousand population (FGE, 2002), which is one of the lowest in Africa. This is without mentioning the appalling road conditions that significantly raises operating costs of road transport; only 30% of the road network is classified as 'in good condition'. As a result, 70% of areas are more than half-a-day walk from an all-weather road.

Hence, in view of scattered rural settlements, it is conceivable for transport costs as well as grain losses to be of higher order of magnitude.

Fig. 4 shows the major domestic road network; while Fig. 3 shows the five major road networks connecting Ethiopia with its neighboring countries. First is that connects the country with the important sea port of Djibouti which is served not only by road transport, but also by the country's ailing only railway. The second connects Ethiopia with Eritrea at two gateways: one with the seaport of Assab and another with capital Asmara. Third, there is the Addis-Moyale road that connects the country with Kenya. The fourth extends to the east connecting Ethiopia with Somalia's seaport of Berbera. And finally we have Addis-Bahrdar-Al-Qadarif road that connects Ethiopia with the Sudan. Having Addis at the center, it may seem that several hundred kilometers must be traveled before crossing the border at each direction. However, each direction may have specific purpose to serve and viewing as such the distance may not really be that long.

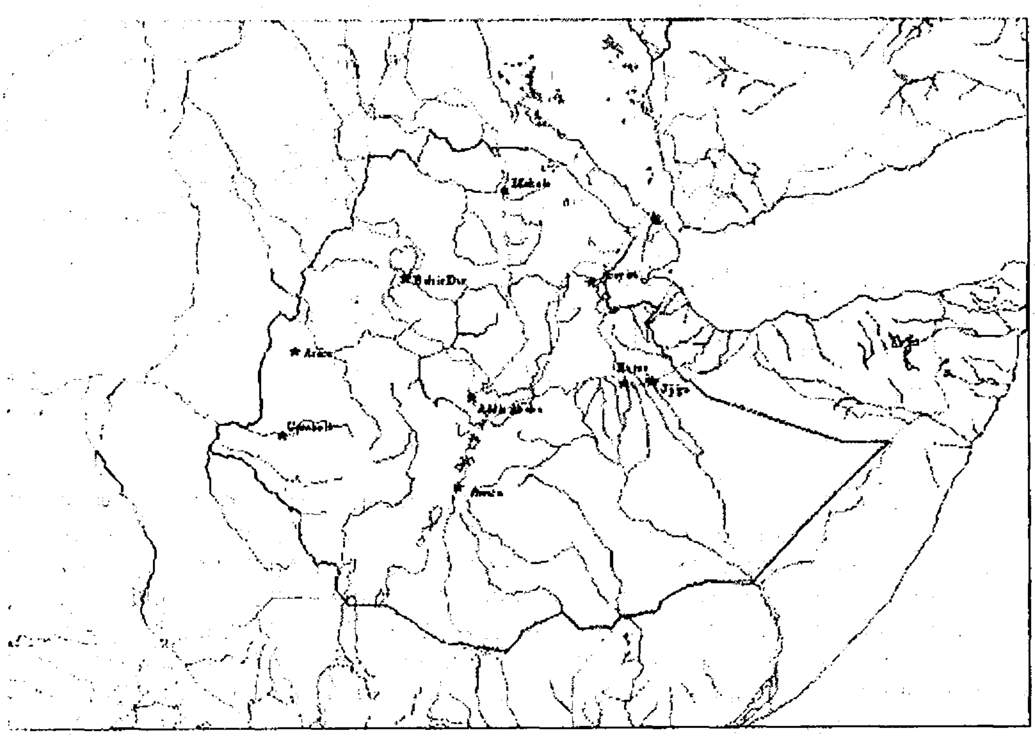


Fig. 3: Major Road Transport Networks
Source: UNDP-EUE

b) Storage

One of the features of subsistence production is that the bulk of output produced is retained for household consumption for a number of months. In Ethiopia's case these amount to 74% of the total production, which is stored on the farm using traditional structures. Storage facilities and capacities are at their rudimentary stages. They consist of farm-level small traditional grain pits, sacks and traders' warehouses with an average capacity of 100 tons that is poorly ventilated and with dirt floors (Dadi, Negassa, and Franzel 1992), which is apparently not adequate, obviously leading to high storage losses. Some estimates would suggest the magnitude of post-harvest loss in Ethiopia to be quite high; for example depending on the type of post-harvest handling method, losses could range between 5 and 19% for maize, 6-26% for millet, 6-23% for wheat, and 5-20% for teff [8]. As a result, traders would be unwilling to store stocks beyond the minimum turnover period. Even though the more than 200 warehouses that belong to the former AMC with a capacity of 1 million tons are available for renting by private traders, private traders used less than one-half of the total capacity in 1992 [3].

Table 1: Estimates of Storage Capacity

Owned by	Warehouses with capacities of:				
	3000 MT or more for government, NGO, donors and 1000 or more for private sector			Less than 3000 MT for government, NGO, donors and less than 1000 or more for private sector (Numbers not indicated)	
	No	Capacity		Total Capacity	Grand total
		Total	Average		
Government	212	1,000,000	4717	367,125	1,367,125
NGOs	1	5,000	5000	49,255	54,255
Donors	5	20,000	4000	9,695	29,695
Private sector	93	181,000	1946	200	181,200
Others				25,972	25,972
Total	311	1,206,000	3878	452,247	1,658,247

Source: EU, 1999

Storage capacity has reportedly increased after the pro-market reforms; however, these have been found to be not adequate in terms availability, storage and premise space, and location [4]. Taking into account storage facilities that are operated by government and non-government organizations as well as donors and the private sector, it could be seen that total capacity would not exceed 1.7 million metric tons (Table 1). This is around 65% of the volume of marketed output by peasants without mentioning food imports and aid. Of these, the government owns more than 80% and most of them are located in large towns such as Addis Ababa (30), Nazareth (36), Kombolcha (18), Makelle (16), Shashemene (12) (see Fig.) The private sector accounts for about 15% of total capacities, but in terms of location these are also concentrated mainly along the Addis-Mojo-Nazareth axis of less than 100 kms distance [11].

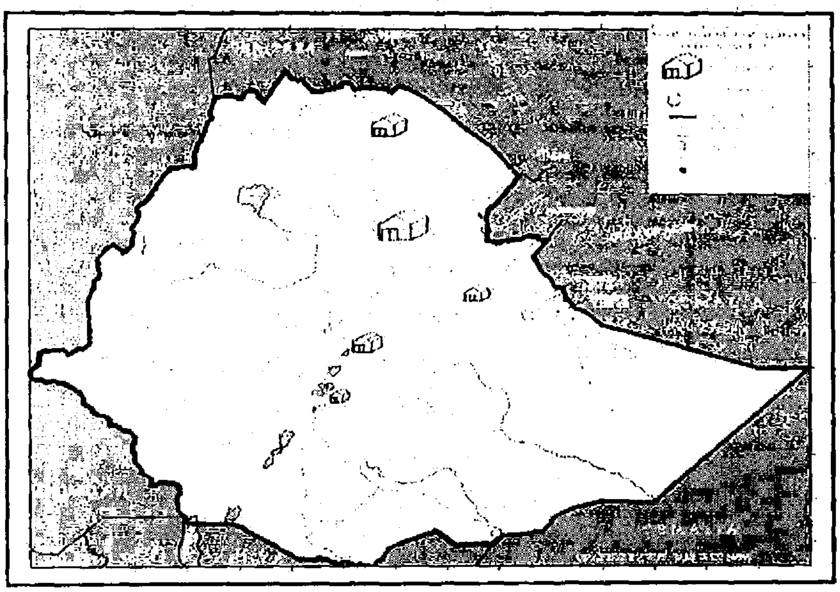


Fig.4: Major EGTE Warehouses

Source: http://www.telecom.net.et/~undp-eue/reports/Wh cap96.jpg

Market Structure

The grain market is structured in a way as to move cereals from producers to consumers through the involvement of several intermediaries including rural assemblers, wholesalers, brokers and retailers. Farmers may directly sell cereals to one or the combination of the following: rural and urban consumers (about a third of total sales), rural assemblers (about a tenth), retailers (about a fifth), regional wholesalers (about a third), and/or mills. Rural assemblers are mainly farmers-cum-traders who buy grains from farmers in rural markets for the purpose of reselling it to consumers (nearly a quarter of total sales) or regional wholesalers the rest. Although these typically operate independently, they may also act as agents for wholesalers on a fixed-fee or commission basis [14]. Regional wholesalers re-sack the grains they purchased from the farmers or the rural assemblers and store it for up to a month and a half on average. They may sell it in the Addis Ababa central market or in another terminal market (69% of total sales) through the services of brokers, to nearby mills (5%), to retailers (11%), or directly to local consumers and restaurants (15%) [10, 14, 19]. The role of central market brokers is to acknowledge receipt of the grain from the regional wholesalers, inspect its quality, determine its market-clearing price, and proceed to sell it on behalf of their clients who may be other traders, flour mills, hotels or restaurants, government agencies, or non-governmental organizations. The share of regional traders in total volume of grains marketed had been 45% in 1995/96; and that of brokers in the central markets was 31%. Entry seems to be unrestricted as both licensed and unlicensed grain traders are participating in the market. Absences of processing and specialization have rendered the market structure to be short.

Wholesale traders, EGTE, and private companies are the principal actors in domestic inter-regional grain movement. They purchase about 45% of the total domestic marketable quantity and transport and sell 69% of it in the terminal markets and deficit areas.

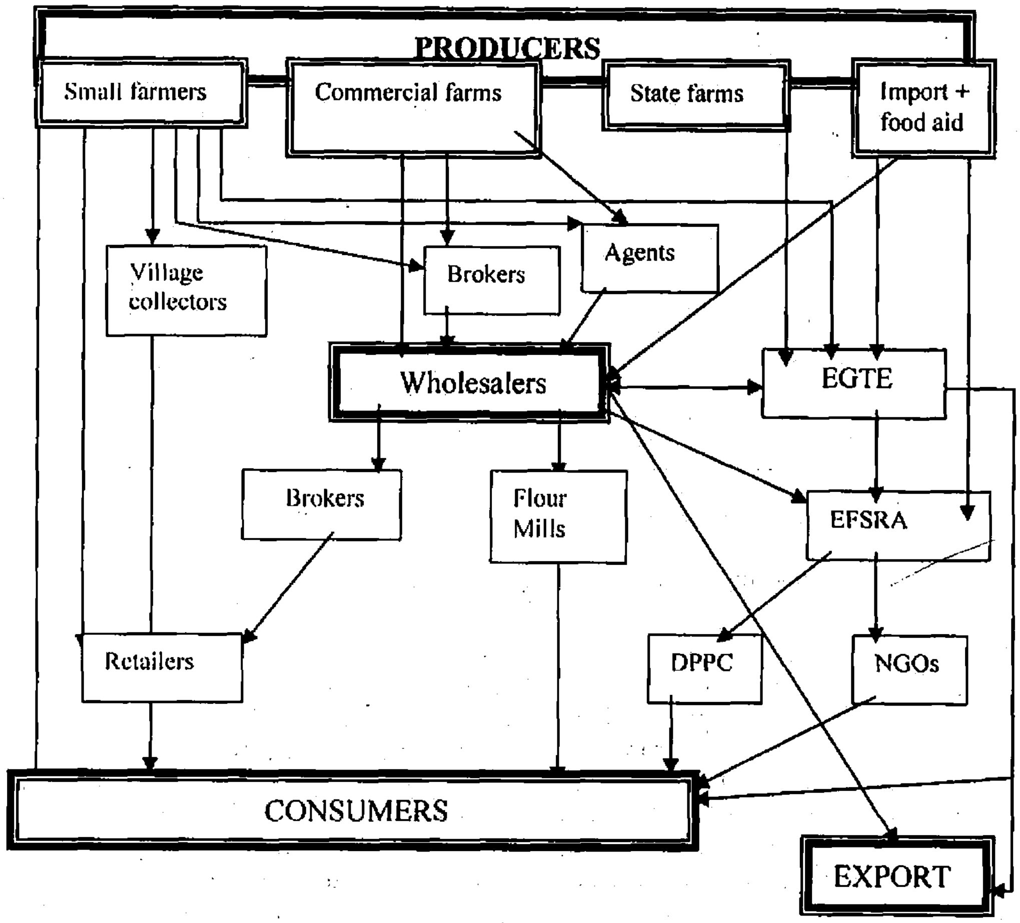


Fig. 5: Grain Marketing Channels in Ethiopia, 2001.

Note: EFSRA = Emergency Food Security Administration; EGTE= Ethiopian Grain Trade Enterprise;
DPPC = Disaster Prevention and Preparedness Commission

Source: Wolday, 2002.

Market Information

Market information is a scarce factor among farmers and traders in Ethiopia; they have very little information on prices prevailing even in nearby markets [18, 5]. Grain traders rely on contacts with brokers and transporters to obtain market information regarding prices in the Addis Ababa market (Kuawab Business Consultants 1994). Information on imports and food aid shipments is generally in short supply. Cereals grading and standardization are limited to visual inspection, at the time of transaction, of the color of the grain as well as of the amount of foreign matter, pest damage, and kernel breakage, hence it is difficult to make price comparisons (Dadi, Negassa, and Franzel 1992).

4. Import and Export of Cereals

Ethiopia has been a net importer of food grains for much of the time (Fig. 6) with food aid playing more important role than commercial imports. Wheat has been the single most important import to Ethiopia both commercially as well as in terms of food-aid. The demand for commercial wheat imports stems largely from the flour mills who require hard wheat for pasta products; the largest import figures were registered in 1995 and 1999 constituting respectively 22% and 21% of total domestic wheat supply. In contrast, little import of wheat has been reported in 1996 (3%), 1997 (nil), and 2000 (7%). Wheat food-aid seems to be more important than commercial wheat imports; it accounted for an average of 27% of total wheat supply between 1995 and 2001, ranging from 18% in 1999 to 44% in 2000. Compared to domestic wheat production, minimum and maximum shares of wheat food-aid accounts respectively for 27% (1996) and 90% (2000) with an average of 46% for the period. However, with the exception of 2000 in which it rose to 12%, wheat food-aid has always constituted less than 10% of total domestic cereal supply with an average of 6% between 1994 and 2002 [7]. Whether food-aid has any disincentive impacts on domestic production is an empirical matter. In cases where wheat import in terms of food aid becomes significant, one would only suspect that it would have a price depressing effect. However, Delioitte and Touche [7] argue that this has not been the case since import parity price of US hard winter wheat has always been higher than domestic wholesale price of white wheat in Addis Ababa (Fig. 8). This may partly reveal the relative competitiveness of Ethiopia's cereals in international market.

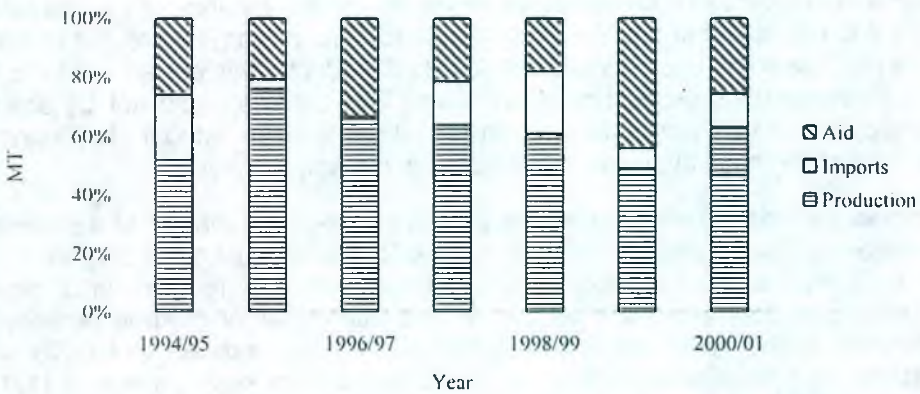


Figure 6: Trend of Ethiopia's Wheat Supply 1994/95-2000/01

Source: CSA, WFP, DPPC, Customs Authority Quoted in Deloitte & Touche 2002

Foreign market outlet was no option for Ethiopia since grain export was banned by the previous government until it was lifted in 1996. In 1996/97 however, private traders exported maize to the Middle East and other neighboring countries including 200 metric tons each to Djibouti, Saudi Arabia, Yemen, and 10,000 metric tons to Jordan. In addition 5,000 metric tons of maize was exported to Uganda for the European Union food aid program and 6,075 metric tons of maize was exported to Kenya for the German Red Cross. The WFP exported 2,796 metric tons of maize and 525 metric tons of haricot beans to Kenya and 600 metric tons of maize to Uganda in [19]. As could be seen, this took place only in one year and has not been sustained.

5. Major Opportunities and Constraints to Improved Grain Marketing

There are some opportunities which Ethiopia needs to seize for an improved inter-regional grain trade; these include (i) potential benefits that could be derived from production and supply opportunities; (ii) pro-market reforms with their favorable impacts on price levels, spread, integration, etc; (iii) low cost of production attributed largely to favorable natural factors and labor availability (iv) the potentials to reduce handling costs (through for e.g., grades and standards), processing so that it adds value and reduce losses, and provision of market information to reduce risks and transaction costs. However, the structural constraints that have contributed to marketing inefficiency must be addressed for a full realization of the potentials.

The status of the food balance (in terms of cereals) and production patterns in these countries would suggest the existence of profound differences among them; on one end of the spectrum we find Djibouti that is totally dependent on food imports; on the other end, there is Uganda that is not only self-sufficient but also has been consistently exporting since 1993/94. Eritrea depends on cereals imports for at least 50% of its domestic consumption needs as is the case with Somalia. Kenya also imports cereals to meet about a quarter of its domestic needs; Sudan and Ethiopia are also importers at the margin. Those who exported cereals at least once include Kenya (in 1995/96), Ethiopia (in 1996/97), Sudan (intermittently) and Uganda (since 1993/94). From these pictures, it could be gleaned that the sub-region is characterized more by deficiency in its cereals balance. As could be seen from Table (2), it is Ethiopia that has the capacity to produce the largest volume of cereals. Ethiopia's local grain demand can be met fairly quickly if productivity is enhanced. In fact, the potential for massive surplus production is imminent. This surplus could not be absorbed fully by domestic demand as was evidenced in recent years even without significant yield improvement; it must be made available at international markets.

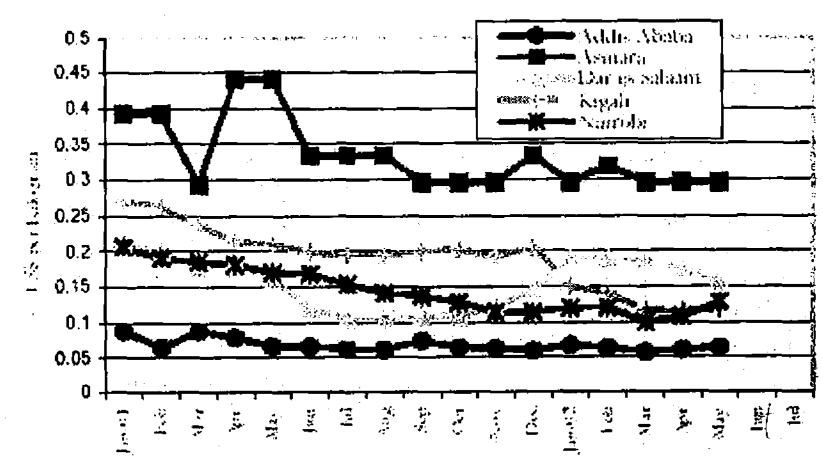
Arguably, Ethiopia can make cereals available on the sub-regional market at a competitive price since it enjoys agro-climatic conditions favorable for the production of cereals. Cost of production is fairly low; a crude production function suggests that 16 quintals of crop per annum may come from combining one hectare of land with the labor of three persons, one ox, and implements to the value of US $13. Some studies also indicate that Ethiopia has relatively a strong comparative advantage in cereal production such as wheat [15]. For example as could be seen from Fig. 9, Ethiopia's maize prices (in US$ per kilogram) for the periods between January 2001 and July 2002 have been the lowest compared to Tanzania, Kenya, Rwanda and Eritrea. Not only has it been the lowest since it never reached the US$0.10 mark per kg but also it was relatively stable over the period. The figures for other countries could be twice, or even four times as much, and with much fluctuations between months (Fig. 7).

Table 2: Estimate of the Maximum Volume of Cereals Output that has Been Achieved Since 1988– Different Years

Country	Cereals ((000 tons)							
	Sorghum	Millet	Barley	Maize	Wheat	Rice	Others*	
Djibouti	-	-	-	-	-	-	-	
Eritrea	≈120	≈60	≈30	≈20	≈15			
Ethiopia	≈2000	<100	≈1500	≈3000	≈2000		≈2000	
Kenya	<200	<200		≈3000	≈300			
Somalia	≈350			≈300		<50		
Sudan	≈4500	≈700			≈800	100		
Uganda	≈400	≈650		≈900	<50			

*A significant portion is teff which is not produced and consumed in other countries.

Source: Approximated from FAO/Global Information and Early Warning System. See Annex 1 & 2



Source of Data: FEWS NET, GHA Countries

Figure 7: Nominal Wholesale Maize Prices in Selected Markets in GHA Countries

Source: (USAID) Famine and Early Warning System Network of the Great Horn of African Countries

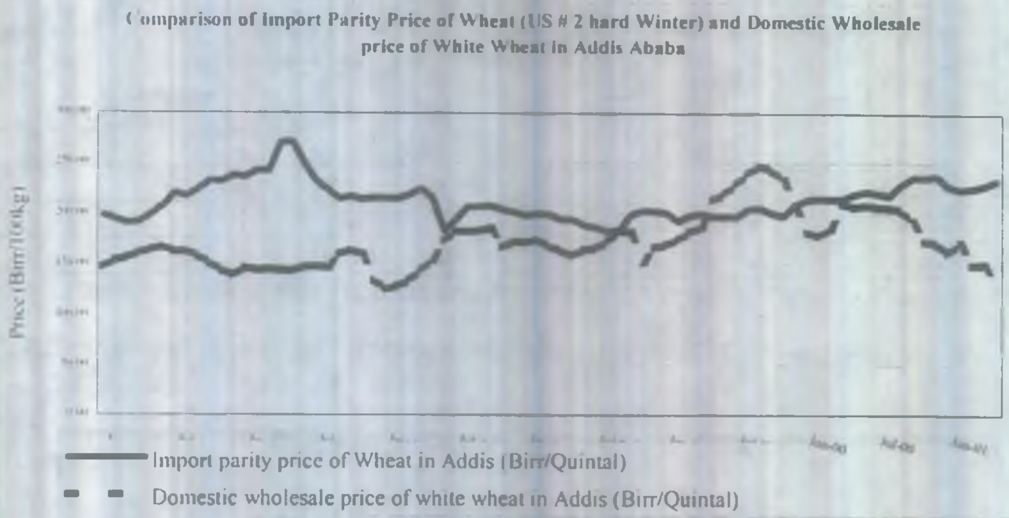


Figure 8

Source: Deloitte & Touche 2002, [7]

The major constraint is associated with the subsistent-based production system that limited marketed surplus. Unless production is market-oriented, an increase in output may not necessarily imply increase in market supply; it may as well lead to increased domestic consumption particularly in low income scenario. Second is the transportation constraint with about 70% of areas in Ethiopia being located more than a half-day walk from an all-weather road. Lack of all weather access roads to supply areas has resulted in poor market integration – among other things this reduced producer prices and significantly raised consumer prices. Transport cost alone accounted for about 66% of the marketing cost of grain, a rate identified to be quite high by grain traders. Third, weak regulatory, legal and institutional environment surrounds the grain market. The legal and regulatory framework has failed to efficiently and timely settle contractual disputes; but also in absence of strict measures to control the unlicensed grain traders, the formally licensed traders have been effectively crowded out to the extent that some have actually returned their licenses to the authorities. This obviously has negative repercussions on formal private investment. In addition grain traders complain about high income tax (40%) and multiple levies (e.g., 5% sales tax paid several times at different levels of transactions) imposed on them. Such practices have paved the way for rent-seeking behavior which undoubtedly raised transaction costs, hence reducing marketing efficiency. Fourth, even though quality of products is affected not only by post-harvest grain management practices but also with the production process, absence of standards and grades complicates the problem rendering the association of prices with quality to be questionable. Fifth, there is lack of market information at all levels. Institutions compiling market information (basically on prices only) such as the Central Statistical Authority, the Ethiopian Grain Trade Enterprise, the Ministry of Agriculture do not systematically and timely disseminate the information; and since smallholder producers are structurally isolated from the marketing system, there is very little that they can make use of such an information even if it were available. In view of the poor communication network in the country, this factor is going to be one of the serious problems in the foreseeable future. Sixth, storage problems have been identified as important constraints both in adequacy and quality. The relationship of this with losses and food security is quite obvious. Seventh, lack of credit facilities to grain traders is also cited as crucial factor (Gebremeskel, et al 1998) since tied-up capital may be quite large in cases when one prefers to hold larger stocks. Weak public-private partnership has further exacerbated the problem.

6. Some Areas for Improvements: Policy Options

Domestic competitiveness needs to be reoriented to sufficiently respond to global demands as it is going to be affected ultimately by it. The pressure of globalization has made it increasingly clear that domestic products are going to be competed out right at their point of production. This is a pressure for efficiency in production and in marketing. An economy that does not sustain an efficient production and marketing system domestically cannot do any good in international markets. If Ethiopia wants to seize the opportunities, not just for entering into international markets but also to solve its structural food insecurity (improve adequacy, stability and access), then it must do away with the sources of inefficiencies both in production and in marketing.

As regards to production organization, there needs to exist a transformation process from the current subsistence based to market- and profit-oriented production of cereals. Cereals, and any commodity for that matter, must be produced with a clear market orientation and for profit motives; and producers should not continue to produce what they directly have to consume. As long as this transition is prolonged, supply of cereals in desired quantity, quality, and prices cannot be expected. Moreover, as an offshoot of this process, the transition should embody a science-based production process whereby the direct dependence on and vulnerability to natural factors is minimized and productivity is enhanced. Taking marketing aspects, there are a number of areas that need significant improvement. This is like looking at the constraints from another angle. Three broad areas could be singled out:

(a) Improvement of market infrastructure – transportation, storage, processing, and communication – which helps to reduce costs of marketing, reduce losses, add value and improve access of food to where it is needed by linking surplus areas with deficit areas. Obviously, this has wide implications to investment – recently the Ethiopian government through its 10-year Road Sector Development Programme (RSDP) has been trying to make improvements in the area of transportation network – Phase I of RSDP (1997-2002) aimed mainly at upgrading and rehabilitating the existing road network; as a result, the proportion of road network classified in good condition has increased from 18% in 1995 to 30% in 2001; total classified-road-network has increased by about 24% during the same period, domestic regional roads accounting for 68% of the increase; proportion of areas that were more than half a day walk from an all-weather road fell from 80% in 1996 to 70% in 2002. Phase II of RSDP gives more emphasis to the expansion of road network hence its density. It aims to increase the road density respectively from the current 29 kms/1000km^2 and 0.48 kms/1000 people to 47 kms/1000km^2 and 0.70 kms/1000 people by the first three years period. However, notwithstanding such efforts, given the enormity of the problem it requires a much more concerted effort. Regular road maintenance has been a serious problem in the country undermining the initial heavy investment outlays. If investment on road construction has

(b) Been unattractive to private sector, public investment should enhance the participation of the private sector in other areas that go with it. If government puts in place the necessary conducive environment, then processing, storage, transportation, information and communication, banking, standards and grades, etc. are some of the areas that should attract private investment.

(c) Improving the capacity of institutions – regulatory, legal, information, credit supply, quality control, etc. – this helps to encourage formal private investment, reduce transaction costs, alleviate the liquidity constraints, establish grades and standards, etc. This should lead to competitiveness of private investment.

(d) Creating and strengthening of networking among institutions both locally and regionally – web of partnerships involving 'private-private', 'private-public', 'public-public' sectors – in order to enhance information exchange, harmonization of policies and practices, facilitate smooth flow of goods, capital, information and people not only domestically but also across border. This aspect could also contribute towards achieving the above two objectives. One of the reasons for poor performances both in production as well as in trade is the fact that capacities of both the public and the private sectors are too weak to live up to the challenges being faced. Worse still, often they are at loggerheads to each other and therefore do not join hands in an effort to mobilize and harness domestic capacities. In short, 'public-private' as well as 'private-private' partnerships however desirable have not been vigorously promoted and pursued. The advantage of enhancing inter-regional trade is that it brings another dimension into the picture – i.e., 'public-public' as well as transnational 'private-public' and 'private-private' partnerships. Such networks get more complex as more countries and institutions are involved but they also generate multiplier effects. For example, in a single country with two actors (public and private) one may think of two major forms of partnership ('private-private' and 'private-public'). This may be increased to eight forms of partnership by considering a two-countries-two-actors framework (i.e., 'private-private' and 'private-public' partnership in each country and between the two countries as well as 'public-public' partnership involving the two countries). Similarly, taking in just one more country into the network and ignoring inter-private sector partnerships within the same country, we could generate a total of 15 networks; each country will have a total of 9 networks, and each actor will be interconnected with a total of five networks. The implication of this for capacity creation and opening up of several windows of opportunities could be enormous. Such a proliferation of networks multiplies the flow of goods, capital, information and people not only within a single country but also in partner countries, which should be beneficial for all since it enhances efficiency in production and in marketing.

In general, it is necessary to re-orient the cereals economy in a manner that responds favorably well towards the sub-regional market signals. Such an endeavor would call for the need to convert potentials and opportunities into real benefits – with all actors including the government and the private sector necessarily taking active part in the process. Needless to mention the crucial significance of database development, management and exchange of market information not only domestically but also with trading countries including those in the Greater Horn of Africa.

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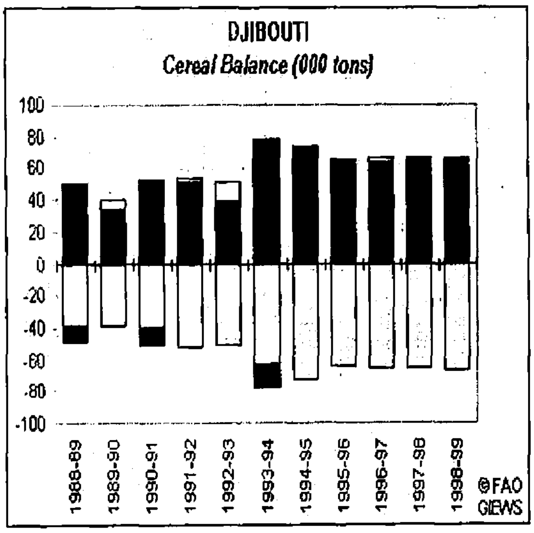
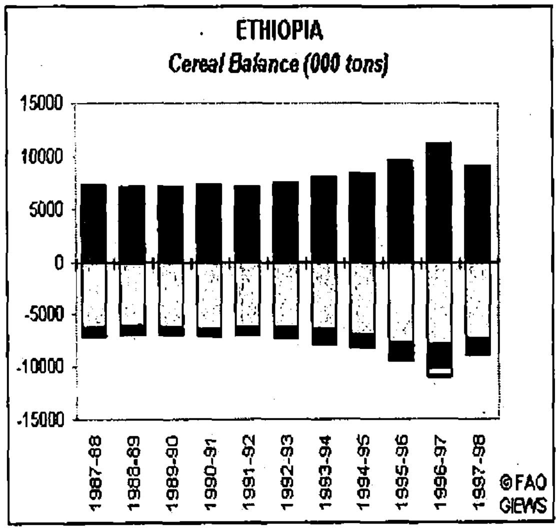
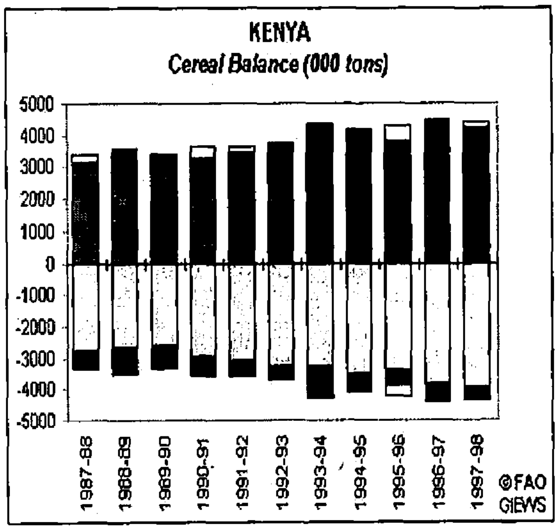
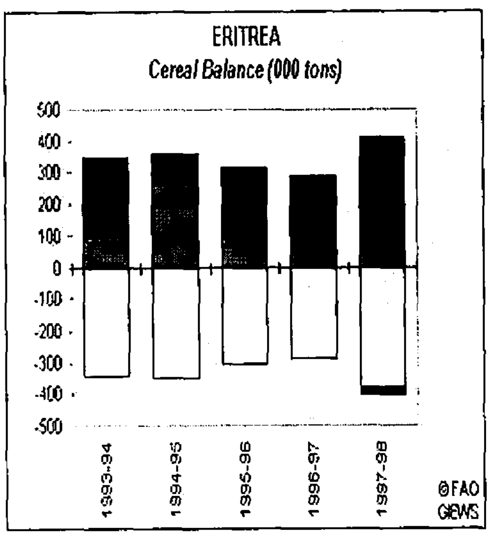
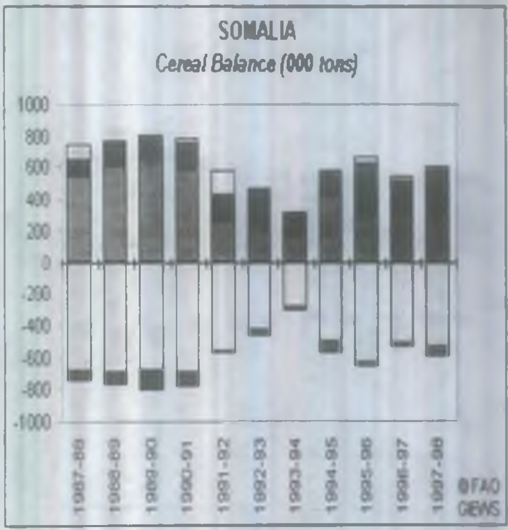
Annex 1: Food Balance Horn of African Countries

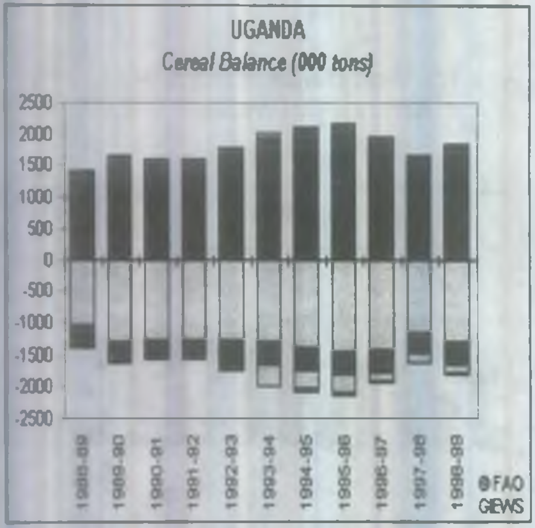


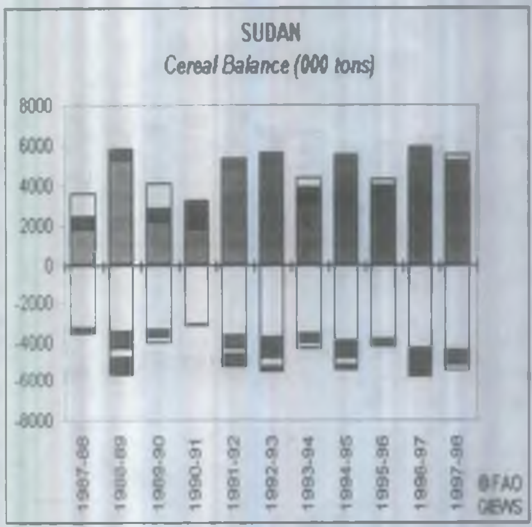












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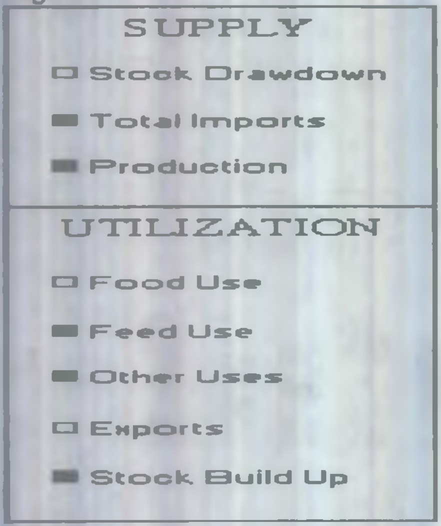

Source: FAO/GIEWS (Global Information and Early Warning System)

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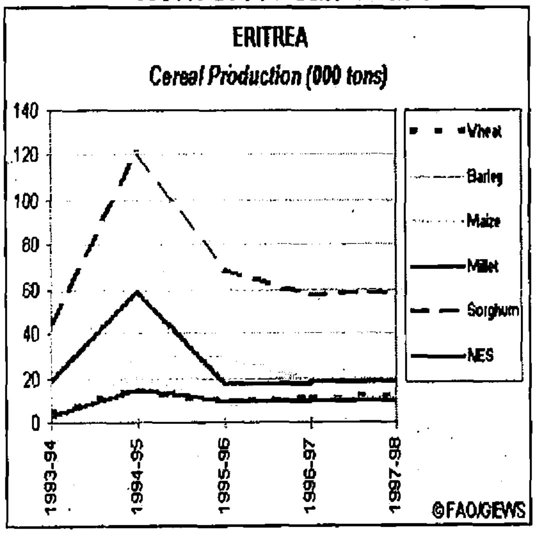
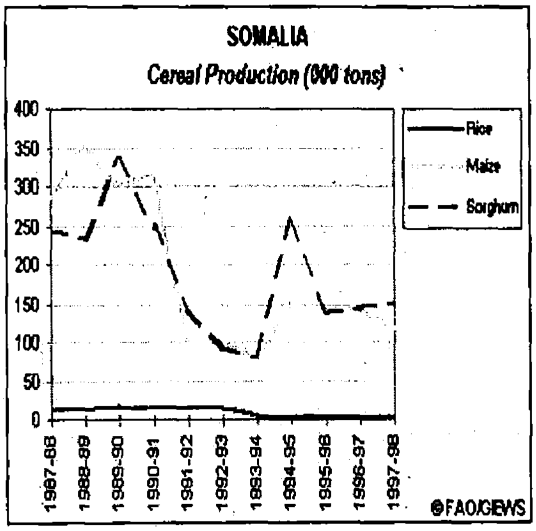
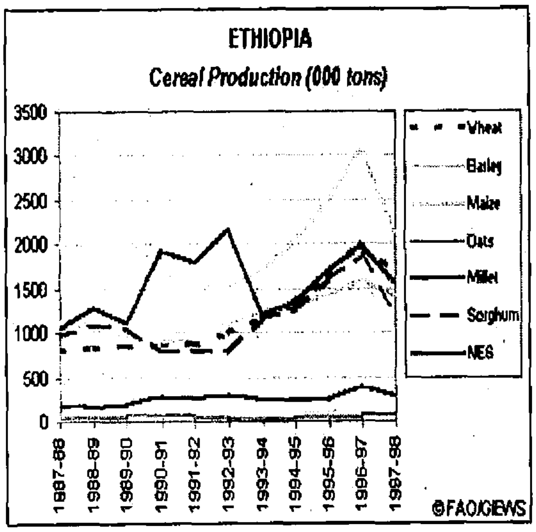
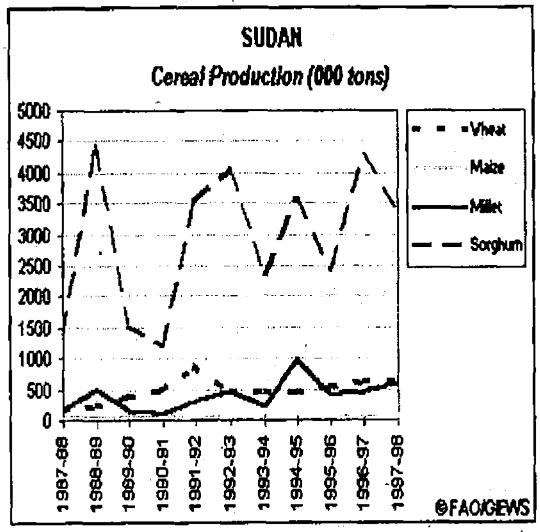
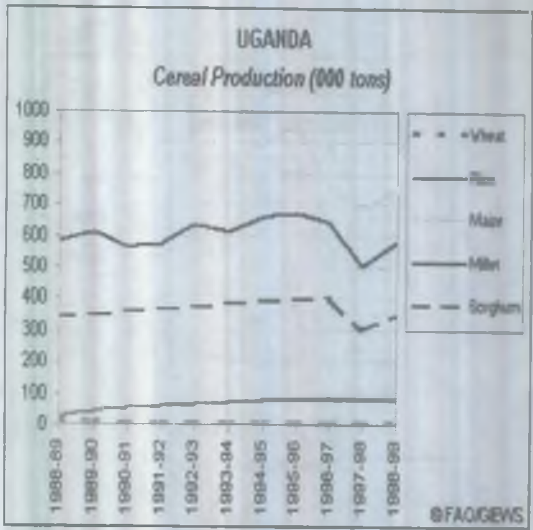
Annex 2. Production Trends for Horn of African Countries

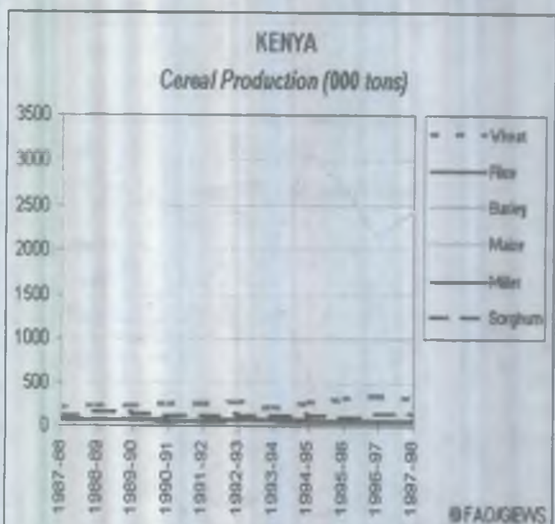












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Challenges and Prospects of Food Security in Ethiopia: Macro Issues Related to Livestock

Alemayehu Reda[*]

Abstract

Domestication of farm animal's species was initiated some 10,000 - 12,000 years ago when people began maintaining animals for work power, food, and other agricultural uses. Today about 40 mammalian and avian species have been domesticated, but the majority of the world's livestock production is derived from only 14 species. It has been reflected time and again that livestock is an important and integral component of the Ethiopian agricultural system. Of the total domesticated farm animals in Ethiopia, about four mammalian and one avian species (cattle, sheep, goats, camels and chicken) contribute to food production. According to FAO (2003) report, the average per capita milk, meat and eggs consumption for the country during the 1997 through 2001 is 19.25, 8.35 and 0.49 kg per person. Apart from the role it plays in production of foods of livestock origin, its contribution to earnings of foreign currency over the total export has ranged from 7.71 percent (in1998/99) to 17.2 percent (in 2000/2001). Draft animals provide power for over 90 per cent of the farmers in the highlands. Moreover, the survey conducted in 1999/2000 reveals that contribution of foods of livestock origin sources to daily calorie intake per person per day at a country level is 2.24 percent. Result of the same survey demonstrates that, of 52.5 percent of the total household income spent on total food at a country level, less than five percent went to food of livestock origin. Despite the huge livestock resources the country harbors, its contribution to national economy, poverty reduction and food security has been minimal. This minimal contribution can be attributed to different natural, technical and institutional challenges. Given all the prevailing challenges the sector has been experiencing, the untapped natural potential of the country's livestock genetic resources can be a basis of future development.

1. Introduction

Domestication of farm animal's species was initiated some 10,000-12,000 years ago when people began maintaining animals for work power, food and other agricultural uses. Today about 40 mammalian and avian species have been domesticated and are all-important for food and agriculture. But the majority of the world's livestock production is derived from only 14 species, which comprise some 5000 breeds [10].

Approximately 2 billion people, 40 per cent of the world population, depend on livestock directly to meet part or all their daily needs. An estimated 12 per cent of all people depend almost entirely on products obtained from ruminant livestock - cattle, yaks, sheep and goats. Animals account for 19 percent of the world's food directly. They also provide draught power and fertilizer for crop production, bringing their overall contribution up to 25 per cent, and thus are essential components in achieving sustainable food security. In addition, livestock serves as a very important cash reserve in many of the mixed farming and pastoral systems thereby providing an important form of risk reduction. In total animals meet an estimated 30 percent of the value of human requirements for food and agriculture [10].

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In Ethiopia eight species and their derived breeds of domesticated livestock are involved in livestock production. These species include cattle, sheep, goats, camel, chicken and equine (horse, donkeys and mule/hini) having population estimate ranging between 30-35,13-24, 9-18, 1-4, 52-57 and 7 million, respectively. However, the entire foods of livestock origin are derived from only cattle, sheep, goats, camels and chicken.

Three types of livestock production systems are commonly recognized in the country. The highland mixed crop-livestock production system that covers areas above 1,500 m above sea level, home to 90 percent of human population, harbours 70 percent of livestock population, includes 40 per cent of the total land area. The second production system is the dry lowlands pastoral and agro-pastoral production system, which includes all areas below 1,500 meters above sea level, covers a total land mass of 60 percent, home to 10 percent of human and 30 percent of the livestock population. The private and public commercial livestock is the third category of the production system. The first two production systems are smallholders dominated subsistence oriented where from the majority of the livestock products come. The contribution of commercial livestock production is also getting momentum under the new economic policy, where part of the public livestock sector has been shrinking under the process of privatization.

It has been reflected time and again that livestock is an important and integral component of the Ethiopian agricultural system: a contribution that goes beyond direct food production to include multipurpose uses, such as hides and skins, manure and fuel, as well as capital accumulation. Furthermore, livestock are closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic stability.

The purpose of this paper is to examine macro issues related to the current status, challenges and prospects of livestock in food security.

2. The Role of Livestock in Food Security

Although food availability has increased along with the growing population over the last 30 years, there are still 800 million people suffering from malnutrition. This problem is not the result of insufficient food production and inadequate distribution, but also of the financial inability of the poor to purchase food of reasonable quality in adequate quantities to satisfy their needs (FAO,

1993). Food security is achieved when all people, at all times, have physical and economic access to sufficient and nutritious food to meet the dietary needs and food preference for active and healthy life. This definition encompasses many issues. It deals with production in relation to food availability, it addresses distribution in that the produce should be accessed by all, and it covers consumption in the sense that individual food needs are met in order for that individual to be active and healthy. Food availability is necessary for food security, but it is not sufficient. By the same token, an increase in national food production does not by itself guarantee food security. Availability of food at the national level is but one factor for food security.

Food security embraces food production, stability of supply and access to food. Livestock play a role in all three aspects: they make a significant contribution to food production through the provision of high value protein-rich animal products; they indirectly support crop production through draught power and manure; they stabilize supply and finally are the most significant sources of income and store of wealth for small holders, thereby providing access to food.

3. Contribution of Livestock to Food Production and Supply

3.1 Milk, Meat and Eggs Production and Consumption

As part of the farming system, livestock actively contributes to the sustainability of agricultural system; utilizing crop residues and other feeds, which cannot be used by humans. Livestock transform forage and crop residues, which are inedible to humans, into nutritionally important food products. Approximately 40 percent of the total land available in developing countries can be used only for some form of livestock production.

Livestock are important contributors to total food production. Moreover, their contribution increases at a higher rate than of cereals. Over the past 20 years, meat and egg production have risen by 127 and 331 percent, respectively in the developing countries [15]. Yet, most people in these countries cannot afford adequate animal protein.

In Ethiopia, cattle, camel, goats and sheep are the sources of milk and meat where chicken are the sole sources of poultry meat and eggs. According to FAO (2003), milk production in Ethiopia has increased from about one million in 1997 to 1.5 million metric tons in 2001 (Table 1). Total milk production for the year 2001 has shown an increase of half a million tons or 49 percent over the year 1997. At the same time per capita milk consumption increased from 17. 3 to 23.3 kg per person. The average per capita milk consumption during the year 1997-2001 was 19.25 kg per person. During the year 1997 through 2001 the average annual milk production was increased by11.43 percent with the lowest increment (1.1 percent) being in 1997 and 1999. The highest increase of 32.5 percent was recorded in 1999/2000 production year. During the period under review on the average 94.0, 2.0, 1.6 and 2.4 percent of the milk is milk from cattle, camels, goats and sheep, respectively. Generally more than 95 percent of the milk is coming from indigenous animals and produced by smallholders.

Beef and veal, mutton and lamb, goat's meat, camel meat and chicken meat are the kind of meat produced from indigenous animals in Ethiopia. According to FAO, during the period under review (Table 1) meat production increased from 0.49 in 1997 to 0.55 metric ton in 2001. During the same period the annual average meat production was increased by 2.61 percent. Unlike milk the per capita meat consumption remained steady over the years 1997 through 2001. There has been slight decrease from 8.51 kg in 1997 to 8.20 kg per person in 2000. The average per capita meat consumption during 1997-2001 is 8.35 kg per person. Regarding type, 55.5 of the meat is derived from beef and veal followed by chicken, goat's meat and mutton and lamb.

In Ethiopia eggs are mainly produced from scavenging indigenous chicken kept under traditional practices. During the year 1997-2001 (Table 1) eggs production has increased from 27,957 metric ton in 1997 to 37,764 metric ton in 2001. At the same time eggs production has increased by average of 8.58 percent annually. The percent annual egg production ranges from –0.85 in 1999/2000 to 32.1 percent in the year 2000/2001. Per capita egg consumption increased from 0.48 kg per person in 1997 to 0.58 kg per person in 2001. The average per capita eggs consumption for the period of 1997 through 2001 is 0.491 kg per person.

Table 1: Total Milk, Meat and Eggs Production in Ethiopia (Metric Ton) for the Year 1997-2001

Type of produces	Production Years				
	2001	2000	1999	1998	1997
Milk	1,518,107	1,365,524	1,030,435	1,019,045	1,007,420
Meat	548,211	520,730	515,870	499,410	494,650
Eggs	37,764	28,583	28,826	28,609	27,957

Source: FAO, AGROSTAT, 2003.

Of the developing countries, Sub-Saharan African countries (SSA) have the lowest per capita consumption level in meat and milk. In 1993 Sub-Saharan African people consumed an average of 9 kg of meat and 23 kg of milk compared to 21 kg meat and 40 kg milk for the developing world. Milk and meat per capita consumption level for Ethiopia is lower even than that of SSA countries.

According to Delgado et al (1999) aggregated consumption of meat in SSA will increase from 5 million metric ton in 1993 to 12 million metric ton in 2020, an increase of 3.5 percent per year over the 25 years period. Similarly it is projected that total milk consumption in SSA will increase from 14 million metric ton in 1993 to 31 million in 2020. As a result per capita consumption of milk in 2020 will increase to 30 kg compared to 23 kg in 1993. In Ethiopia the per capita milk and meat consumption has to increase from the current lowest level to feed the projected 120 million human population in 2020.

3.2. Contribution of Foods of Livestock Origin to per Capita Calorie Intake

According to the Central Statistical Authority (CSA) report on Household Income, Consumption and Expenditure Survey (2001) the national average calorie intake per day at a country level is 1,939 and 2,211 for the survey periods of 1995/96 and 1999/00, respectively. During the two survey periods the average share of foods of livestock origin in the daily calorie intake per person could not exceed 2.5 percent. The contribution of foods of livestock origin to the daily calorie intake per person decreased from 2.46 percent in 1995/96 to 2.24 percent in 1999/2000 (Table 2).

The contribution of foods of livestock origin to the daily calorie consumption per person is relatively higher for urban areas as compared to the rural areas during the two survey periods. In terms of contribution, milk, cheese and eggs contribute more both at the national and rural levels followed by meat. In Urban areas meat contribute more than other foods of livestock origin to the daily per capita calorie. This could be attributed to the fact that relatively more income is spent on meat as compared to other foods of livestock origin and continuous supply of meat through butcheries in urban areas.

In the developing countries where diets are composed of only a small number of staple foods, animal products are of great importance in preventing malnutrition, as they are concentrated sources of essential amino acid, available in only limited quantities in the protein of staple vegetable foods. In developed countries, animal products provide about 27 percent of all calories and about 50 percent of all proteins in the diet, while in developing countries this proportion is about 10 and 26 percent for calories and protein, respectively [7]. In sub-Saharan Africa, all products contribute about 7 percent of all calories and 20 percent of all protein in the diet. Apart from containing important amino acids, food of animal origin contains major micro nutrients like Iron, Zinc and Vitamin B12 and A. The contribution of foods of livestock origin to the daily calorie intake per person in Ethiopia is much lower than that for SSA countries where there is no data on dietary protein. This could be attributed to poor supply and low buying power of the people.

Table 2: Daily Calorie Intake per Person at National, Rural and Urban Levels for the 1995/96 and 1999/00 Survey Period

Particulars	National		Rural		Urban	
	1995/96	1999/00	1995/96	1999/00	195/96	1999/00
Per capita daily calorie intake	1,938.6	2,211.2	1,941.7	2,291.5	1,921.7	1,738.1
Share of foods of livestock origin	47.84 (2.46%)	49.6 (2.24%)	40.9 (2.10%)	44.7 (1.95%)	85.9 (4.47%)	78.0 (4.48%)
Meat	14.0	18.1	9.0	14.4	41.3	39.9
Milk, Cheese and Eggs	23.8	24.2	25.2	25.8	16.2	15.1
Oils and fats*	10.04	7.3	6.7	4.5	28.4	23.0

Source: CSA, 2001

* Of the total oils and fats the share of refined, semi-refined and imported butter is 20% as calculated from data on quantity of food, drinks and tobacco consumed by domestic expenditure group in Household Income, Consumption and Expenditure survey, 2001.

3.3. Household Income Spent on Foods of Animal Origin

According to CSA [4], Household Income, Consumption and Expenditure Survey at the country, rural and urban level 52.5 percent, 57.3 percent and 35.9 percent of the total household income is spent on food, respectively. Of the total percentage of income that is spent on foods at the national level, the amount that is spent on foods of livestock origin is less than 5 percent. Among foods of livestock origin comparatively more money is spent on meat followed by milk, cheese and eggs at a national level. When comparing the three sources of foods of livestock origin more income is spent on meat at national, rural and urban level (see table 3).

Table 3: Percent of Household Income Spent on Total Foods and Foods of Livestock Origin at, National, Rural and Urban Level for the Year 1999/2000

Particulars	National	Rural	Urban
Total foods	52.5	57.3	35.9
Share of foods of livestock origin	4.64	4.49	5.10
Meat	*2.49*	*2.19*	*3.50*
Milk, cheese & eggs	*1.77*	*2.01*	*0.95*
Oils and fats	*0.38*	*0.29*	*0.65*

Source: CSA, 2001.

The magnitude of consumption poverty indicators on poverty profile of Ethiopia is clear manifestation of the scope and depth of the food insecurity problems in Ethiopia. The food poverty becomes equally important in both rural and urban areas. The proportion of the population under food poverty are 42 percent in 1999/2000 whereas the corresponding level for urban areas stood at 46.7 percent, reflecting growing problem in urban areas [11].

3.4. Contribution of Livestock in Crop Production

a) Draught Power

The yield-stabilizing and yield-enhancing role of livestock is a main contribution to crop agriculture. It also hosts the promise for future intensification of the mixed farming system. In developing countries, more than half of the arable area (52 percent) is cultivated with the help of draught animal power and more than half of the total fertilizer applied is provided in the form of manure. This proportion can be estimated to exceed 70 percent in Low Income Food Deficient Countries (LIFDCs). This indicates that crop production in these countries cannot take place without fully acknowledging the resource-enhancing and stabilizing role of livestock. Development programs addressing food security must explicitly take this function into account.

Four-fifths of the Ethiopian population is engaged in smallholder agriculture and they are responsible for 96 percent of the total agricultural output [1]. Over 90 percent of the farmers in the highlands depend on animal power for crop production (seedbed preparation, planting, weeding, threshing and transportation). As elsewhere in developing countries [5], use of tractors very insignificant in Ethiopia for reason of economy, topography and highly fragmented land holdings. They are relatively affordable and do not require inputs, which tractors would require such as fuel, repairs and spare parts. This is particularly important in view of the shortage of foreign currency earnings, which Ethiopia has. The traditional system of cattle rearing in the highlands is directed mainly to raising work oxen. About seven million oxen are estimated to be found in Ethiopia, primarily in the highlands [1] the largest number in the whole of Africa.

b) Manure to Fertilize Farm Lands (Soil Amendments)

Rapid increases in human population and the associated environmental changes in many parts of the developing countries including Ethiopia have been challenging the livelihoods of small holder farmers to produce enough. The need to meet the associated demand from declining land holdings has led to an intensification of cropping and the reduction or complete absence of the traditional fallows. This type of production demands for high inputs of both organic or inorganic fertilizers and recycling of nutrients. Animal manure is sources of organic fertilizer and best means of nutrients recycling if properly managed and efficiently used. One tonne of cattle manure contains 8 kg of N, 4 kg of P_2O_5 and 16 kg of K_2O [3]. The chemical composition of manure varies, however, according to species (poultry manure appears to be a more efficient fertilizer than cow manure) and also to the nature of their diet. Adding manure to the soil increases the nutrient retention capacity, increase pH, decreases bulk density, improves the physical condition by increasing the water holding capacity and improves soil structure stability. For many of the resources poor farmers around the world, including Ethiopia, proper use of manure for crop production has economic and environmental advantage over chemical fertilizers.

4. Contribution of Livestock to Income

Food insecure households may live where there is enough food, but can lack income or entitlement to get it. Improving entitlement means expanding economic opportunity making markets work better for the poor. Further food-insecure people may live in food secure households.

Those who failed to produce will have access to the surplus in the country (through the markets) if and only if they have purchasing power. In most countries, however, many people do not have such power. National governments, too, often lack the necessary financial resources to purchase the surplus and to distribute it to the have-nots. Therefore, food availability at the national level does not provide food entitlement to household and individuals. Economic access to supply can be ensured through improved purchasing power or income and access to employment. The contribution of livestock to income can be demonstrated through earning hard currency that contribute to national economy and creating job opportunities and sustain employment.

4.1 Earning of Foreign Currency

In coffee dominated export sector, of the country's economy, hides and skins, live animals and meat are the major commodities of export in the area of livestock. Of the total value of export Birr 3.5 billion earned during the year 2001/2002 the contribution of livestock and livestock products is Birr 488 million. According to the annual report of National Bank of Ethiopia (2003) the share of value of livestock and livestock products export over the year 19995/96 through 1998/99 has declined form 12.38 in 1996/97 to 7.71 percent in 1998/99. In 1999/00 it has shown an increase of 9.3 % over the previous year. In the year 2000/01 even if there was reduction in overall export earnings over the previous year, the share of livestock and livestock products export value increased by 90 percent over 1999/2000. However, according to the same report, in 2001/02 fiscal year the share of livestock and livestock products in export decreased by 22.9 percent over the year 2000/01. This decrease is attributed to the short fall of 23.3 % and 35.4 % that occurred in the leather and meat products, respectively during the fiscal year. Generally over the past seven years (1995/96 through 2001/2002) the average annual contribution of livestock and livestock products was 11.35 percent of the total export value. The average share of skins and hides, meat and live animals over the same period is 10.57, 0.58 and 0.20 percent of the total export value for the same period.

Table 4. Value of Total Export and Share of Livestock and Livestock Products During 1995/96 through 2001/2002 Fiscal Years (In Thousands Birr)

Particulars	1995/96 [1988]	1996/97 [1989]	1997/98 [1990]	1998/99 [1991]	1999/00 [1992]	2000/2001 [1993]	2001/2002 [1994]
Total export	2,607,156	3,891,530	4,141,582	3,637,346	3,957,803	3,679,832	3,499,616
Share of livestock and livestock products	*322640*	*407625*	*387601.5*	*280420*	*333304*	*633111*	*488383*
Hides & Skins	309701	372253	347699	243052	286459	616686	472776
Live Animals	770	11201	10562.15	5724	14137	2360	6522
Meat Products	12169	24175	29340.28	31644	32708	14065	9085

Sources: National Bank of Ethiopia, 2003.

According to the same report, after a significant rebound from the 1999/00 level of Birr 286.5 million to Birr 616.7 million in 2000/01, leather and leather products export slackened to Birr 472.8 million in 2001/02, presumably due to the September 11 terrorist attack on USA affecting some of the country's potential markets in Asia, the US and the world over.

Meat canned and frozen showed 35.4 per cent of decline recording Birr 9.1 million in 2001/2002 fiscal year. The very poor performance of this item was largely the out come of the ban imposed on these export items by the Middle East countries on the ground of health and safety related factors. The decrease in value during the year is attributed to decline both in volume (25.5 percent) and unit value (13.3 percent) of the item.

Regarding export of live animals there is an increase over 1999/2000 through 2001/2002. In 2001/02 the value of live animal export increased by 176 percent over the 2000/01 (National Bank of Ethiopia, 2003. However, the reliability of this figure is very questionable under the situation that ban on live animals export is still in a place.

Of the animal and animal products export, during the year 1995/96–2001/02 the average annual contributions of hides and skins, meat and live animals to the earning of foreign currency is 92, 6 and 2 per cent, respectively. Generally hides and skins hold the lion's share of livestock and livestock products export value and are only second to coffee.

4.2. Contribution of Livestock to Household Income and Livelihoods

At household level income from sales of livestock and livestock products provide purchasing power and thus, access to food. In fact, the value added through livestock production and processing is often the only outlet of smallholders in rural communities to the monetary economy. Furthermore, livestock provide liquid assets, a hedge against inflation and a means of reducing the risks associated with crops when used in mixed farming systems.
In the Ethiopian central highlands, [9] showed that the sale of livestock and livestock products contributed 83 percent to cash income per year. About 52 percent of cash income was from the trade of animals and 31 percent from the sale of livestock products. Manure alone accounted for 25 percent of the livestock products and dairy products over 50 percent. Locally money for purchase of farm inputs (chemical fertilizers, improved seeds, herbicides, pesticides etc.) are mainly money generated from sells of livestock and livestock products.

In arid and semi-arid dry land ecology humans have developed the nomadic pastoralism strategy to enhance their chances of survival. The pastoral community are defined as those people who generate their livelihoods from livestock. Traditional economic definition describes pastoralists as those sustain their livelihood predominately by raising livestock in communal rangelands. In all pastoral systems, livestock production is interrelated with other economic activities. Pastoralism can therefore be described as dynamic interrelationships of particular lifestyles with particular forms of ownership and the use of key resources such as livestock, rangelands, water, etc.

5. Raw Materials and Job Opportunity

Apart from the rural level contribution to the farming communities, products and by-products from livestock are also used as raw materials for many factories that have created job opportunities for many people. Tanneries, leather products manufacturing enterprises, industrial abattoirs, dairy production and milk processing industries etc. are the major enterprises that are using animal products and by-products as raw materials. Butcheries and slaughter houses are the other forms of enterprises that are totally dependent on live animals for their business and operation. There are many citizens that have been employed and working in these enterprises. Thus these enterprises created job opportunities for the employees and contribute to the livelihoods and their families. According to a report from Ethiopia Tanners Association currently the 18 out of the 19 member tanneries have a total of 4281 employees.

6. Conclusion

Despite, the huge livestock resources the country harbours its contribution to poverty alleviation in general and food security in particular are very minimal. The available estimates indicate that production and per capita consumption of foods of livestock origin have been the lowest among the SSA countries. The amount of foreign currency obtained from this sector is much below the existing potential and fluctuates frequently.

There is no single panacea to these constraints. The most significant once are nutrition, animal health, and animal productivity/genetic make-up of animals, extension, researches, marketing and institutional set-up. The provision of adequate nutrition both in terms of quantity and quality to livestock is a major problem in the country. Many animals receive maintenance or below maintenance levels of nutrition resulting in low levels of production. The situation is more aggravated during dry season.

Livestock health is a limiting factor to production. The prevalence of many livestock diseases of list A and B is a major problem. The low level knowledge and understanding of livestock producers of the benefits of disease control is the different magnitude of the problem. Even those who are aware of the benefits had limited access to appropriate animal health services. When animals are fed a low quality rations and are not protected from diseases, genetic traits for survival are more important than those for production. With an increase in nutrition and health, large gains can be made in productivity. Improvements in production traits only become important once conditions in health and nutrition are met and production levels reached. These conditions vary between species.

Genetic improvement of the livestock resources is one among the different development interventions. The indigenous livestock resources of the country are not characterised. They are not classified, described and identified. Their production, adaptation and reproductive characteristics are not studied. The diversity and distribution is not known. The populations size both at species and breed level is not surveyed. Because of the lack of the above mentioned basic data and information it is practically difficult to think of integrated and sustainable improvement plan.

Livestock and livestock products marketing system is very weak and is not organized. Most animals are trekked. There are no live animals' stock routes and resting areas. Livestock markets do not have the required facilities. There is no livestock marketing intelligence and information system. Movement of animals is free. Collection, transportation, processing, packaging and distribution of foods of livestock origin are very limited.

Livestock extension and research have been accorded very low priority. The low level of financial provision and limited number of skilled manpower in the area are the real manifestation of the situation.

Given the low level of trained human resources and limited logistical capability the country has, units or sections that are involved in livestock development are dispersed over many institutes and are given the lowest level of organisational and structural positions in their respective locations. The livestock research, extension, education, training, marketing, genetic conservation, export promotion, etc. are disaggregated into different institutes. There has not been any formal way of communication and working relationship among these organisations. As a result duplication of efforts and competition for limited resources is prevailing. The formal technical link between the Federal and Regional institutes of livestock research, extension and development is practically non-existent.

Generally, livestock is both multifaceted and flexible to be able to react to changes in the national economy. However, it needs strong long-term commitment from all stakeholders.

7. Recommendations

- Livestock should be considered as part of any future household level food security activities and sustainable development, because of their important role in food security and poverty alleviation. Their contribution and role have to be envisioned and realised.
- Livestock development projects and extension packages should focus on improving household level production and productivity of livestock. This would enable effective use of a relatively unproductive resource with a small increase in inputs. Productivity improvement should be integrated with programs to ensure the more effective use of livestock outputs such as effective marketing systems that ensure access to markets and fair prices are paid for animal producers.
- The livestock resources and livestock production systems should be characterised so as to stratify the combination of species and breeds of livestock and their products in a fashion that provides the greatest benefit to farmers under different circumstances and conditions.
- Animal health constraints to livestock production and marketing should be investigated and appropriate and economically viable control programmes be developed. This would involve the need for an innovative approach to be taken to the collection of animal health information and the provision of appropriate animal heath services delivery.
- Emphasis should be given to the improvement of animal feed both in quantity and quality, as feed is a major limiting factor in livestock production and development.

Animal feed security should be ensured to maximise the benefits of livestock and realise the practical contribution of livestock to food security.

- Encourage the involvement of private sector in the livestock and livestock products production, collection, processing, handling, packaging and distribution. Moreover, facilitate conditions for the private sector to take part in production of important inputs at affordable and reasonable prices.
- The establishment of autonomous and full fledged livestock institute that would be responsible for all livestock development, research, extension, marketing, credit services and legal issues is the fact that can be learnt from countries that have best benefited from their livestock resources.
- Any livestock based development program has to make sure the involvement of women. Because, development programs that are not engendered would be endangered.
- The establishment and strengthening of livestock based professional associations and their involvement in the design, plan, analysis and evaluation of livestock development, research and extension policy, strategy and programs have to be encouraged and realised.
- Environmentally friendly, socially acceptable, ecologically sound, economically viable, technically efficient and sustainable and integrated livestock development strategies and programs have to designed and implemented. .

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Dairy Development for Food Security and Improved Livelihoods: Experiences from Ada'a-Liben Woreda Dairy and Dairy Marketing Association, Debre Zeit Ethiopia

Azage Tegegne*

Abstract

Ethiopia has the largest ruminant livestock population in Africa estimated at about 32.8 million tropical livestock units (TLU). The highlands of the country cover about 40% of the total area and in this area 88 % of the country's human population and 73% of the cattle population are found. Livestock are sources of multipurpose uses such as meat, milk, draught power, skins, fiber, fertilizer, fuel and cash for smallholder farmers. Livestock products are also very important and accounts for 40% of agricultural economy of Ethiopia. Furthermore, livestock are closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership ensures varying degrees of sustainable farming and economic viability thus contributing to and providing income, food security, social status and livelihoods. Today the human population in developing countries is growing at an unprecedented rate. Urbanization is advancing at a much more rapid rate and it is estimated to grow by over 6 per cent per annum in Ethiopia. In Addis Ababa, the high rate of population growth has significantly contributed to fast deforestation, swallowing of agricultural lands, massive unemployment and huge economic and social problems including shortage of housing, poor social and infrastructure services, and mounting sanitation and environmental problems. Along with this rapid increase in urbanization, there is anticipated income growth among the different segments of the urban population. This will lead to increased demand for protein of animal origin, particularly milk and meat products. A number of urban and peri-urban dairy farms are evolving in response to the opportunities. However, most of the farmers do not have the basic education and training in dairy production in order to remain viable in a competitive market and ensure their survival and livelihoods. The complex nature of livestock production, coupled with a low technical base, has slowed down progress in dairy development. Apart from policy and institutional factors, shortage of improved dairy breeds, shortage of feed, diseases and low level of management have hampered production and productivity of dairy animals. This paper explains the efforts of the International Livestock Research Institute (ILRI) and its partners in providing technological options and training to improve the capacity of dairy farmers. In addition, the activities and best practices of the Ada'a-Liben dairy and dairy marketing Association will be presented in order to learn from their experiences and to create an enabling environment for sustainable urban and peri-urban dairy development in Ethiopia at large.

1. Introduction

Ethiopia has the largest cattle population in Africa, estimated at about 35 million tropical livestock units (TLU). The highland of the country covers about 40% of the total area, and is home for 88% and 73% of the human and cattle population, respectively. Livestock have multipurpose uses and serve as a source of meat, milk, skins, fiber, fertilizer, fuel and cash for smallholder farmers. The contribution of livestock to the agricultural economy is significant, accounting for 40% and this figure could be higher if the non-monetary contributions are taken into account. Furthermore, livestock are closely linked to the social and cultural lives of several million resource-poor farmers for whom animal ownership

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ensures varying degrees of livelihoods, sustainable farming and economic viability. At the household level livestock enhances income, provides food security, social status and improves livelihoods [4].

However, productivity of animals is low compared to improved breeds. For example, total milk production is very low, estimated at about 1.5 million tons per annum and growing at a rate of only 1.4% per year. On the other hand, the human population, currently estimated at 67 million, is growing at a rate of over 3 % per annum. This shows that the per caput consumption of milk in Ethiopia is about 16 kg/year, which is extremely lower than the world's per capita average of about 100 kg/year. Hence, it requires about 6 million tons of additional milk to feed the population as per the world's standard [1]. This indicates the existence of a wide gap between the potential demand and supply of milk in Ethiopia. In order to meet the demand of the growing population of Ethiopia, milk production has to grow at least at a rate of 4% per annum [2]. Milk is usually produced in small herds that are scattered under smallholder production systems. Due to the highly perishable nature of milk, it causes problems in its safe collection, transportation and distribution to rural communities and urban centers. Moreover, milk passes through several channels from production to consumption and therefore there is a considerable deterioration of its hygienic and nutritional qualities and consequently its monetary value [1].

With the recent changes in government policies featured by liberalization and encouragement of the private sector to participate in the development of almost all aspects of the national economy, there exist immense opportunities to develop and improve the agricultural sub-sector. With the increasing demand for diverse and quality animal products, prices are to escalate unless production increases proportionally. To bridge the wide demand-supply gap, it calls for the designing of appropriate and sustainable dairy development strategies based on specific agro-ecology and felt needs of smallholder farmers. Development intervention is therefore needed to optimize the dairy industry through providing enabling policy environment, organizing milk production, processing, preservation and marketing in a well-coordinated way [1]. Currently, a number of smallholder and commercial dairy farms are emerging mainly in urban and peri-urban areas. Smallholder rural dairy farms are also increasing in number in areas where there is market access. However, the transaction cost of milk marketing is a major problem for individual smallholder farmers. The natural evolution resulting from such problems is the formation of milk units and dairy marketing associations where farmers can collect, processing and market milk and milk products. One of the pioneer associations recently established in Debre Zeit town is the *Ada'a Liben Woreda Dairy and Dairy Products Marketing Association (PLC)*.

2. Establishment of the Association

The association was established in September 1998 with 34 founding members who purchased a single share of 100 Birr each and an additional Birr 10 for registration fee (Figure 1a). The initial capital of the association was only 3,400 Birr (USD 400). An Executive Committee was elected (Figure 1b) and the first two years were devoted for organizational arrangements to ensure effective operation. The main objectives were to:

1. Minimize the high transaction cost for the sale of milk and reduce price fluctuations over season, particularly during fasting
2. Reduce wastage of products due to poor handling procedures and lack of processing facilities to increase shelf-life of products
3. Increase production and productivity of dairy farms and improve the overall incomes of member farmers

4. Supply inputs such as feed, health services, etc. to member farmers at reasonable prices
5. Provide training in dairy cattle management, milk hygiene and milk handling and milk processing to member farmers
6. Ensure urban-rural linkage for dairy development in the Woreda, assist farmers to form milk units and establish milk union at Woreda level.
7. Introduce saving and credit system to member farmers
8. Collaborate with other dairy associations (nationally, regionally and internationally) to enhance dairy development

With the above objectives, membership certificate was issued to members (Figure 2a) and milk collection and marketing activity started in January 2000. The amount of milk collected from founding members was 308 litters per day or about 24,319 litters per month. The association, although informally established in 1997, got its legal Certificate of Registration from the Oromiya Regional State in September 2000 (Figure 2b).

A B

Figure 1: Founding Members of the Association Having the First Meeting Under a Tree (A) and the First Meeting of the Executive Committee (B)

A B

Figure 2: Issuance of Membership Certificate by the Chairman of the Association (A) and Official Certification of the Association by Oromiya Regional State (B)

3. Current Status

Over the last few years, the association has made a significant progress with about seven collection centers in and around the town and has taken significant strides in development (Tables 1 and 2). Currently there are 428 full members, composed of 245 male and 183 female (Figure 1). In addition, 181 non-member dairy farmers supply milk to the association.

Members of the association now have a total of 1716 dairy cows and a capital of 500,000 Birr (USD 58 823.5). The numbers of milk collection sites have increased to 7 around Debre Zeit town. The association has employed 25 regular staff, with salary ranging from 60 to 300 Birr per month. Recently, the association purchased 2 coolers with 25,000 liters capacity. The current milk collection has increased to 5,500 liters per day or about 175,000 liters per /month. A small cream separator, a butter churn, a 3,800 liters milk tanker, 60 milk cans with 65 liters capacity, milk quality testing devises and a 2.80 m x 5 m prefabricated house have also been purchased by the association. The association supplies grass hay and concentrate mix to members at reasonable prices. The numbers of the shares have also increased. It is hoped that many rural dairy producers will join this association thus providing markets for their milk and milk products.

Figure 3: Quality Control on Delivery at a Collection Canter

Table 1: Milk Collection Centres, Number of Suppliers and Amount of Milk Supplied Per day

Milk Collection [illegible]	No. of Suppliers	Amount Collected (l/day)
1	49	516
2	88	1229
3	81	956
4	25	416
5	57	906
6	19	329
7	17	727
Total	336	5812

Table 2: Achievements of the Dairy Products Marketing Association (1998-2002)

Activity	1998	2002
Number of members	34	543
▪ Male	34	295
▪ Female	0	248
Share sales, Birr	3,400	120,400
Capital, Birr	3,400	684,679
Number of cows	729	>2000
Milk collected, litres	288,000[a]	1,800,000

1 USD = 8.5 Ethiopian Birr; [a]Milk collected in 2000

3.1 Financing

A number of financing institutions and collaborators have contributed to the establishment and development of the association. The Bureau of Cooperatives has been instrumental for the establishment and legalization of the cooperative. The Bureau of Agriculture has provided technical assistance. The ILRI Debre Zeit Research Station has played an important role in the project preparation and general advise on organization of the association. ILRI has also contributed in training particularly in dairy cattle management including feeding strategies, animal health, milk handling, milk hygiene and milk processing. The major source of financing for the association has been from purchase of share and profits from sale of milk and milk products. The government has provided land for free to implement planned projects for establishment of a dairy plant and a feed processing mill. A number of dairy farmers have expressed interest in expanding their dairy activity. However, shortage of funding and access to credit have been limiting factors. Volunteers Overseas Cooperative Assistance (VOCA)-Ethiopia, an NGO, has financed the training program so far. Another NGO, known as Genesis Farms, has been instrumental in provision of loans for the purchase of a mini truck and cooling tanks.

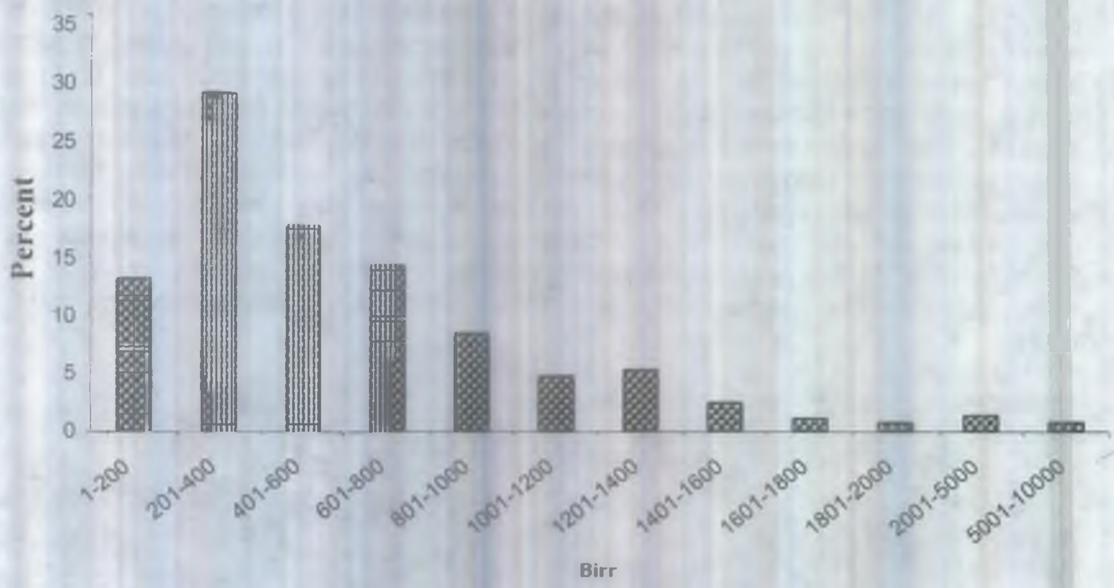
Figure 4: A small Milk Processing Unit (a) and a Milk Transport Mini Truck (b)

Figure 5: A Milk Outlet Shop in Debre Zeit (a) and Supply of Concentrate Feeds to Members (b)

3.2 Socio-economic Benefits and Impact

Figure 6 shows distribution of average gross monthly income of members from January to May 2003. In addition, the association pays dividends at given intervals. The proportion of members with different levels of dividends for the period from 1992 to 1994 (E.C.) is presented in Figure 6. As can be seen from the two figures, the monthly gross income of a household with two improved milking cows averaging 15 liters per day and sale price of Birr 2 per liter, is estimated at Birr 1,800 (212 USD), and members are paid twice a month; ensuring continued cash flow. In addition to this members get dividend at the end of the year which ranged from 10 to 8,226 Birr and averaged about 425 Birr. The association also supplies concentrate and roughage feeds at reasonable prices and provides animal health and artificial insemination services at no profit basis. Members can also access these services on credit basis.

Figure 6. Average monthly income (Birr) for members of the association (Jan-May, 2003)



The socio-economic benefits of the establishment and development of the association to the country, the people and the Government of Ethiopia is difficult to quantify in economic terms. Currently, the direct beneficiaries are the 543 households, with 45% women headed households and non-members who supply milk to the cooperative. The current members of the dairy cooperative include poor women, farmers, retired civil servants, retired military personnel, elderly people, young girls that are vulnerable to food insecurity and economic pressure. These households totally or mostly depend on their small-scale dairy production owning about 1 to 3 cows and solely depending on income generated from the sell of milk. Considering average members of a household to be five, this totals to over 2,700 people. Employment opportunities have been also provided to 33 young (50% women) people. The urban-rural linkage will also stimulate a relatively large number of dairy farmers, particularly women, to participate and benefit from the project. Target groups are rural and urban and peri-urban dairy producers that are scattered and trying to survive at individual level.

Moreover, the consumer community, particularly women and children, have benefited greatly from the availability of safe, hygienic and quality milk and dairy products in all seasons at reasonable prices. The market pull and income generation from dairy farming has also impacted on the environments in terms of improved animal management, products quality and waste management. The input services provided will also strengthen the benefit to members in terms of cost effectiveness and in efficiency of farm operation. The association intends to expand its activities to the rural community establishing strong rural-urban linkage and could stimulate and enhance dairy development in over 155,000 rural communities in the Ada'a Woreda alone. The association will contribute to training and developing the dairy sector among smallholder farmers and will impact on the livelihoods of smallholder farmers through contributions to securing assets, technology adoption, participation of the poor (both men and women) in markets and hence ensuring food security and economic development. In so doing, it will bring attitudinal and behavioural changes among the community. It will also serve as an example in transforming subsistence mode of production into market-oriented system and will vividly demonstrate the implementing the agriculture-led industrialization process. The non-monetary benefits and contributions of the existence and development of the association in the development of livestock agriculture are difficult to quantify in economic terms. However, the following have been observed over the last two years:

- Improved livelihoods and quality of life of marginalized people (women and children)
- Improved environment: animal and waste management, product quality, reduced public health risk
- Relevant –community based and problem-driven
- Good leadership – Financial and institutional
- More participation & employment of poor women
- Good practice and can be scaled-up

3.3 Relevance of the Project

This is among the top priorities set in the national development strategy. Quality nutrition is the basis to build up a healthy and strong nation. Particular note will be the benefits to child and women nutrition and health, generation of productive employment and introduction and development of new technologies in dairy sciences. There will also be significant contribution to training and developing the dairy sector among smallholder farmers through contributions to food security and improved livelihoods.

3.4 Beneficiaries

This project will provide a great opportunity for dairy development in Ethiopia. The direct beneficiaries at the moment are about 500 households, with an average household member of five, totalling to 2500 people. Employment opportunities have been provided to 25 people. Moreover, introduction of quality control system has ensured that the consumer the benefits of safe dairy products. It is envisaged that through establishment of more collection centres in the Woreda, particularly in remote rural communities, the number of beneficiaries will increase. This will strengthen rural-urban linkage in market orientation of smallholder farmers. The socio-economic benefits to the country, the people and the government of Ethiopia are difficult to quantify in economic terms.

4. Future Plan

The association would like to strengthen and expand its activities in an organized and well-structured manner. As a result, it has developed a project proposal worth 12 million Birr with expanded objectives. The components of the project include expansion of milk collection centers, establishment of a dairy processing and feed processing plants, provision of animal health and artificial insemination services, construction of association shop and a recreation center, offices, conference room and training center and strengthening rural-urban linkages.

5. Roles of ILRI in Capacity Building Through Appropriate Technologies and Training

5.1 Appropriate Technologies

a) Improved Dairy Breeds

Numerous indigenous breeds and their crosses with exotic sires are found across the different agro-ecologies of Ethiopia. Genetic improvement of indigenous cattle breeds for dairy production involves crossbreeding of indigenous breeds with exotic dairy cattle. Maintenance of pure stock of exotic dairy breeds in Ethiopia is very rare. The indigenous breeds have been subjected to natural selection mainly for survival traits. Subsistence communities continue to use these breeds under low-external input management for multiple production, input and asset functions. As a result the level of milk production is relatively low compared to specialized dairy breeds. Under the prevailing environmental challenges some indigenous breeds manifest considerable variation in dairy performance, providing the basis for genetic improvement either through selection or crossbreeding. Some examples are the Boran under arid and semi-arid environments; the Fogera under wet, marshy and warm environments; the Horro under warm and sub-humid conditions, the Sheko under warm and humid climate and heavy fly burden, and the Arsi under cool temperate-type highland climate. Market-oriented smallholder urban dairy operations may have the economic incentive to invest in improved indigenous breeds such as the Boran or their crossbreds with exotic dairy breeds such as the Holstein (Figure 7).

b) Improved Feeds

The livestock revolution [3] presents urban livestock producers with significant opportunities to increase income through markets, build assets and improve their livelihoods. However, the inability of producers to feed their livestock adequately throughout the year remains the most critical technical constraint. Forages, herbaceous legumes and multi-purpose trees (Figure 8) are major sources of feed for livestock kept under smallholder conditions. Forages are important to maintain the natural resource base, useful for soil stabilization, providing ground cover and wind-breaks to prevent soil erosion, and contribute to soil fertility through decomposition of organic matter from leaf litter and microbial nitrogen fixation, thus increased use of forages would benefit both livestock keepers and their environment. ILRI and its partners have identified promising forage technologies for use in a range of farming systems and trained young technicians and scientists in forage seed production (Table 3).

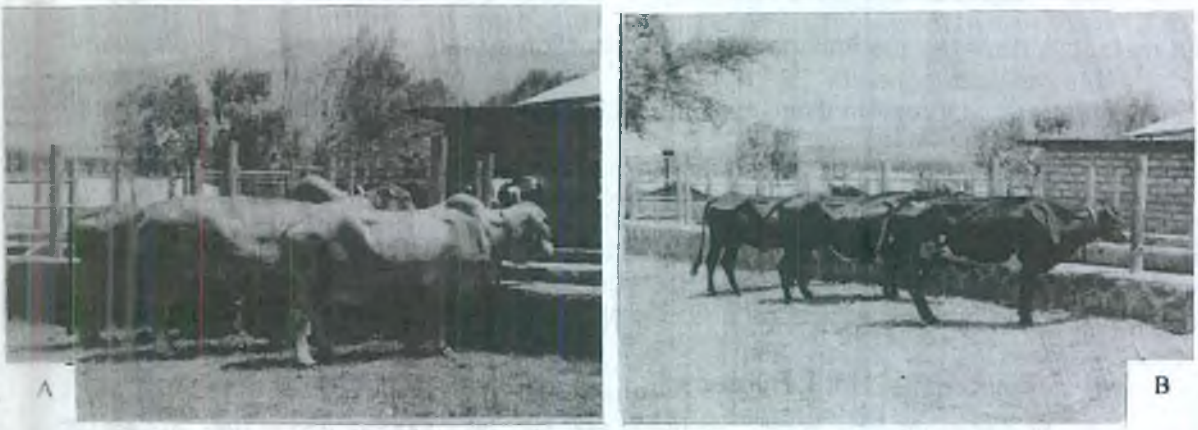


Figure 7: A Group of Improved Boran (a) and Holstein x Boran Crossbred Cows (b)

Figure 8: Forage Legumes, Grasses and Multi-Purpose Trees at the ILRI Debre Zeit Research Station

Table 1: Training in Forage Seed Production at ILRI Debre Zeit Research Station

Year	Institution	Education	Number of Trainees		
			Women	Men	Total
1998	Ministry of Agriculture	Diploma/BSc	1	6	7
	EARO	Secondary		4	4
	Farmers	Secondary		1	1
2000	Oromiya Bureau of Agriculture	Diploma/BSc	3	38	41
2001	Oromiya Bureau of Agriculture	Diploma/BSc	3	17	20
		Total	7	66	73

c) Disease Control

Animal diseases, particularly infectious diseases that pose death to animals, are major threats to the assets of urban livestock keepers. One of the major problems associated with dairy production systems is disease that cause mortality and reduce productive and reproductive performance [5]. The mean annual incidence of all major clinical diseases of intensification in urban dairy farms in Ethiopia could be as high as 45%. Reproductive diseases, mastitis, gastrointestinal disorders, respiratory tract diseases, locomotor disorders and metabolic diseases are important in this production system with significant implications and threats for public health [5]. Appropriate disease control measures and hygiene management are important in these systems as the risks associated with livestock keeping and public health are great.

5.2 Training In Dairy Technology

Training in milk hygiene and milk processing at ILRI is tailor-made to respond to the requirements of the client and is geared towards development of skills. About 80% of the training is practical and only 20% is theoretical to allow participants gain immediate skills.

a) Milking and Milk Hygiene

Some of the bacteria that grow in milk are useful and play an important role in milk processes (souring) that add taste to milk. However, some of the bacteria (*Mycobacterium, Listeria and Brucella*) are pathogens and may cause dangerous diseases to both milk handlers and consumers. Other bacteria may not transmit diseases but cause milk spoilage causing economic losses. ILRI's courses for farmers include (Figure 9) awareness of the causes of contaminations (cow, udder, milking utensils, milk storage areas); methods for preventing contamination (washing the udder and milking and milk storage utensils before milking, keeping the milking and storage areas free from dust); methods of destroying bacteria already present in the milk (boiling, etc).

Figure 9: Training of Women Dairy Farmers in Milking and Milk Hygiene at ILRI Debre Zeit

5.2.2. Improvement of Traditional Milk Processing Methods

In Ethiopia, there are a number of traditional milk handling and processing equipments (Figure 10) Milk processing is done in traditional clay pot (Figure 5), which is churned for several hours to produce butter. The method is time consuming and adds to the work burden, particularly for women. ILRI has improved the churning time by introducing an internal agitator with paddle blades (Figure 11), which is fitted into the clay pot. The milk is churned using a nylon string. With this agitator, there is no need for prior homogenization because the blades will break the curded milk as part of the churning process. The introduction of the internal agitator has greatly improved the processing method (Tables 4 and 5).

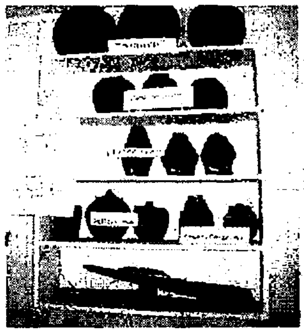


Figure 10: The Starting Point: a Collection of Traditional Milking and Milk Handling Equipment

Table 4: The Effect of Internal Agitator on the Efficiency of the Traditional Butter Churner.

Variables	[illegible]	[illegible]
Cost	3 Birr	103 Birr
Time	2 –3 hours	30-40 minutes
Butter recovery	60%	90-93%
Income	Low	High
Gender	Only women	Both women and men
Hygiene	High contamination	Non to Low contamination

Table 5: Results from the Survey on the Efficiency Butter Making with the Improved Churner

[illegible]	[illegible]	[illegible]	[illegible]
Traditional	2.5 hours	245 grams	14.7
Improved	40 minutes	337grams	20.2
Difference	1hour 50 minutes	92	5.5

Table 6: Internal Agitators Purchased (2001-2002) & Distributed to Farmers through Support by Partner Institutions

[illegible]	Agitators
Save the Children Ethiopia	190
Menschen fur Menschen	22
World Vision	10
Self Help Development Ethiopia	10
Private Individuals	25
Ministry of Agriculture	2

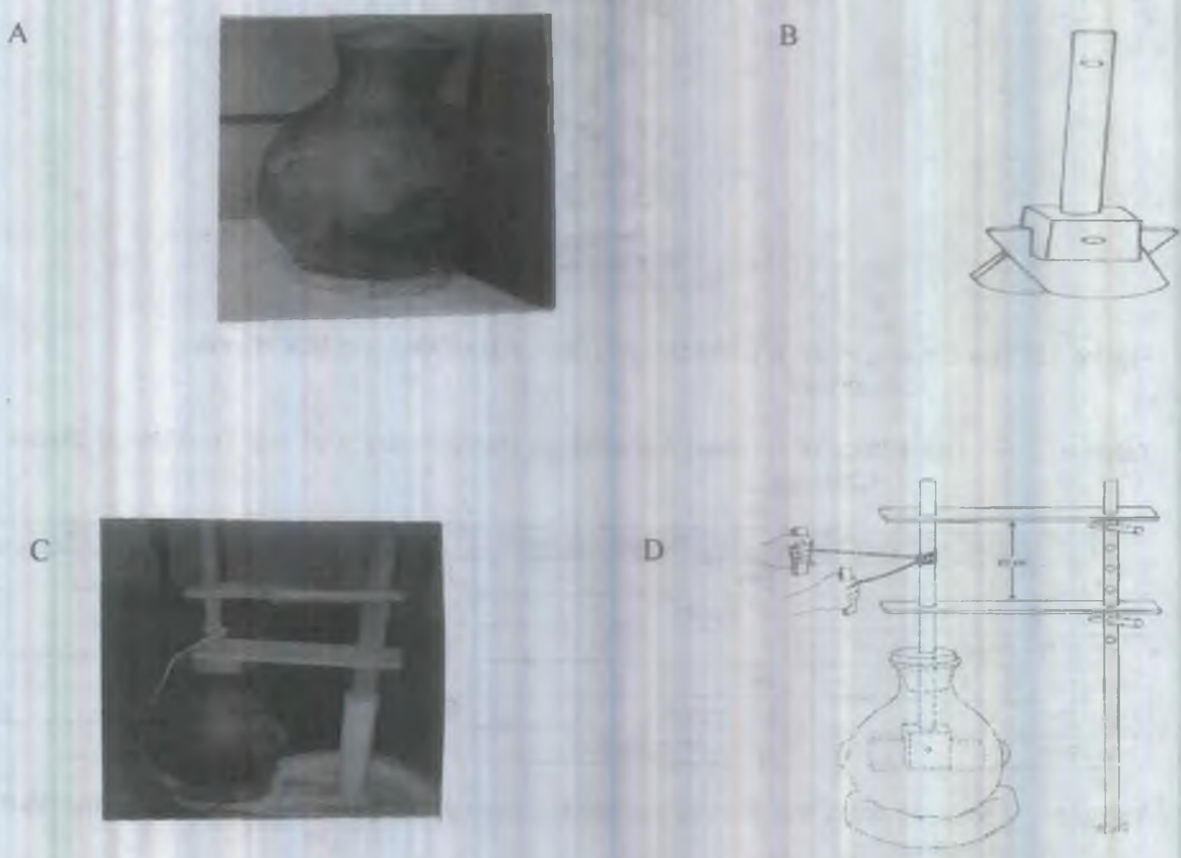


Figure 11: Traditional Clay Pot Butter Churn (A), Internal Agitator with Paddle Blades (B), Traditional Clay Pot Butter Churn with the Agitator (C And D)

ILRI through its partners disseminates technologies to the beneficiaries to alleviate poverty. To promote the use of the internal agitator, ILRI manufactures the item and sells it to the partners at a very low price. Between the years 2001 –2002, various partners (Table 6) working in Ethiopia have purchased the internal agitators and distributed to various members of community.

b) Processing Milk into Various Products

In Ethiopia sour milk is processed into various products to save the milk from spoiling and diversify its use. The understanding of the processing methods used for different products is the key to improving the processing efficiency and the quality of the products. ILRI has prepared several training modules for milk processing techniques. These modules take the participants from the souring of milk to the production of butter, various cheeses, ghee and yoghurt (Figure 12). The training uses both improved traditional implements and modern equipment. Dairy farmers, sponsored by various organizations, take these courses (Table 7).

Figure 12. Training on Milk Processing at the ILRI Debre Zeit Research Station

Table 7. Training in Milk Hygiene and Processing into Various Products in 2001 and 2002

Region	Trainees		Sponsor
	Women	Men	
Ahmara	36	69	Volunteers for Overseas cooperative Assistant-Ethiopia
Oromiya	7	34	Volunteers for Overseas cooperative Assistant-Ethiopia
Southern Peoples	17	43	Volunteers for Overseas cooperative Assistant-Ethiopia
Alemaya		1	Alemaya University
Addis Ababa	25		United Nations development program
Total	85	143	

5.3 Marketing of Milk and Milk Products

The major demand for animal products comes from big urban areas such as Addis Ababa. With a population of 2.3 million it is estimated that the present demand of 65 million liters of milk per annum will rise to 120 million liters in the coming 10 years (Azage and Alemu, 1998; Belachew, 2002). From the prevailing conditions, it is obvious that there is going to be a serious shortage of milk and milk products in the city. The demand of milk and milk products in the city creates market opportunities for urban farmers. However, the transaction cost of milk marketing is a problem for individual smallholder farmers. To solve such problems milk units are being formed where farmers establish associations for quality control, processing and marketing of milk and milk products. Farmers use all sorts of transport to deliver milk to collection centres (Figure 13).

Figure 13: Dairy Farmers use Various Means of Transport to Market their Milk

In summary, development of appropriate and sustainable dairy systems, such as improving the productivity of dairy animals, milk processing and preservation techniques, quality of dairy products and improved marketing infrastructure are paramount in order to improve their livelihood. These technologies include animal genetic resources, feed and feeding strategies, disease control, milk processing and storage and access to markets. Policies to support the development of urban and peri-urban dairy are also critical.

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Ethiopian Pastoral Systems and Food Security Issues: Experiences of GL-CRSP PARIMA in Southern Ethiopia

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Abstract

Pastoral systems in Africa are characterized by increasing instability, food insecurity, poverty, and environmental degradation. Loss of key grazing lands to cultivation, land annexation to government and private interests, drought, inappropriate development policies, population growth, and supposed inappropriate pastoral exploitation strategies have been advanced as causes of such trends [3,4]. The pastoral areas in Ethiopia are one of the most droughts vulnerable with chronic food deficiencies. Between 1981 and 2000 most of the pastoral areas of Ethiopia suffered at least three major droughts. Moreover pastoralists in Ethiopia are the most marginalized in terms of access to modern services such as education and human health [9]. In the context of East African pastoralism, improved risk management is proposed to offer ways to promote wealth conservation, reduce poverty, mitigate conflicts, and enhance food security at the various levels. This paper characterizes the pastoral systems in Ethiopia and looks at the system trend, risk factors, and coping strategy based on the empirical evidence primarily from southern Ethiopia. It also highlights the issues and entry points to improved food security in the context of the pastoral production systems. Covering the periods 1997-2002, this paper builds on the experiences of the Pastoral Risk Management Project (PARIMA), which is a multi-disciplinary effort funded by USAID from 1997 to 2006. The two main components of the project include research and outreach. The study area represents an intact eco-marketing region, hosts 10 major ethnic groups, and is beset by pervasive poverty, violence, food insecurity, poor infrastructure, and inadequate public services. Research has focused on risk mapping, household survey, and community-level case studies to identify prominent risks for pastoralists, clarify pastoral coping strategies, and reveal possible development interventions. Outreach disseminates research information among researchers, development agents, policy makers, and communities. Outreach has also engaged in efforts to build awareness and capacity of pastoral communities and development agents to implement risk-management interventions using pilot projects. One development vision of the PARIMA project is based on how to reduce vulnerability and increase resilience to shocks and promote household wealth accumulation and conservation via asset and income diversification. The process could involve encouraging households to become involved in more timely livestock sales before crises occur, putting some revenue in drought-proof alternative investments, and then focusing on how to achieve a degree of sustainable livelihood diversification. This paper reviews some general findings and experiences from the PARIMA project over the period 1997 to 2002, with a focus on work conducted in southern Ethiopia.

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Introduction

The Ethiopian lowlands, which are homes to 7-10 million pastoralists and agro-pastoralists occur below 1500-meter elevation and comprise 61% of the national land area. The lowlands constitute the warmest parts of the country with annual mean temperature ranging from 20 to 25 degree Celsius and with annual average rainfall less than 700 mm. The natural settings of the Ethiopian lowlands are more suitable for extensive livestock production than for rain fed crop production.

Climate in Ethiopia where pastoralism is the major production system is dominated by arid and semi-arid zones largely defined by rainfall and temperature regimes whose interactions determine differences in vegetation and primary production that influence human and agro ecology. The rainfall pattern in these areas is either unimodal as in most parts of Afar or bimodal as in Borana plateau. In general very arid climates tend to occur under unimodal rainfall and warmer temperature, while the semi-arid climates occur under bimodal rainfall and cooler temperature [4].

In unimodal system human lifestyle is highly mobile involving frequent movements of animals and households. Cultivation is risky and often confined to early maturing drought tolerant grain crops planted in depression and flood plains. Vegetation species in such areas include shrubs and bushes. Livestock composition is diverse but tends to emphasize browsing species such as camel and goats that forage from woody vegetation. In bimodal system human life style is less mobile so do livestock movement. People tend to practice more cultivation, but with high probability of poor harvest. Vegetation species include savanna grassland with acacia wood cover. Grazers such as cattle and sheep dominate livestock composition in such systems [4].

Pastoralism is a mode of production and way of life for people who derive most of their income or sustenance from keeping domestic livestock using natural forage. In most cases pastoralists devote the bulk of their time and energy to looking after livestock [11]. In pastoral systems livestock are regarded as income generators, stores of wealth, and producers of milk and meat. Pastoral people subsist off their animals both directly through drinking milk and eating meat, and indirectly by exchanging livestock or their products for grains and other goods and services. Livestock also provide pastoralists a means of cultural expression and security.

The pastoral areas of Ethiopia are regarded as drought-vulnerable with chronic food deficiencies (Federal Democratic Republic of Ethiopia, unpublished data). Similar to other pastoral systems in Ethiopia, the Borana pastoral system traditionally based on cattle husbandry for wealth storage and milk production and which has been regarded as one of the best examples of a sustainable rangeland production system for East Africa [4] has come under increasing pressure as human populations grow and per capita availability of natural resources decline. In particular, recent increases in human and livestock populations, decreases in availability of grazing lands, and a decline in adherence to social mores and weakened traditional safety nets have eroded the effectiveness of traditional means to stem risk of livestock losses during drought which compromised the food security situation of herders [4, 5]. Increasing conflict, increasing incidence of livestock and human diseases, market uncertainty, and low economic development aggravated the food insecurity situation of Borana.

The Pastoral Risk Management (PARIMA) project of the Global Livestock Collaborative Research Support Program (GL-CRSP) has operated in East Africa since 1997. The project primarily operates in the arid and semi-arid regions of southern Ethiopia and northern Kenya. The project has two components, traditional research and an emphasis dealing with community outreach and "action research." The main goal of the traditional research arm of the PARIMA project is to conduct social, economic, and ecological and policy research on the various risks faced by pastoralists, their responses and propose intervention concepts useful for pastoral development. The outreach arm is conducting pilot risk-management intervention projects among pastoral and agro-pastoral communities in southern Ethiopia. Action research is used to monitor the outcome of interventions. The overall goal of PARIMA's interventions is to develop a sustainable approach for risk-management intervention that will help empower pastoral communities to conserve wealth and diversify their income and assets away from a sole focus on livestock over the longer term. We believe this can strengthen their livelihoods to better cope with droughts, food insecurity, and chronic resource restriction, especially if the people have an opportunity to sell less-productive stock before drought impacts are manifested and use the revenue to support viable alternative investments—this option also depends on viable market channels.

This paper focuses on work done among Borana pastoralists in southern Ethiopia by PARIMA and other affiliated scientists. Major findings from the various works, experience and lesson learned as related to food security situation in pastoral systems have been discussed. Attempts have been also made to describe the traditional strategies employed by pastoralists and their efficacy given to changing situations in population pressure and resource availability.

Pastoralism and Traditional Strategies to Cope With Food Insecurity

Pastoralists the world over are exposed to many risk factors such as drought, thievery, or epidemic disease that can decimate their livestock holdings and thus potentially destroy their livelihoods. Pastoral systems in Africa are characterized by increasing instability, food insecurity, poverty, and environmental degradation. Loss of key grazing lands to cultivation, land annexation to government and private interests, drought, inappropriate development policies, population growth, and supposed inappropriate pastoral exploitation strategies have been advanced as causes of such trends [2].

Similar to other African pastoral systems, the pastoral systems in Ethiopia have recently experienced destabilization. It has been evident that increases in human and livestock population, decreases in availability of grazing lands, and a decline in adherence to social mores have eroded the effectiveness of the traditional means to withstand drought and mitigate livestock asset losses and compromised the food and livelihood security of pastoralists. Among all other factors drought remained to be the most prevalent and least manageable source of system shocks in most pastoral systems in Ethiopia.

Species diversification, spatial segregation of herds, mobility, herd accumulation, and herd dispersal over a wide range of grazing lands and social networks were the most commonly used mechanisms to spread and mitigate risks of food insecurity in pastoral systems in Ethiopia. By segregating herds according to age and sex, and spreading them over accessible areas, the Borana pastoralists in southern Ethiopia were able to derive the maximum use of available grazing resources. Elders had authorities to enforce traditional rules for water use and grazing management. The Borana split their herd into home based (warra) and satellite (forra) herd. Depending on availability and distribution of forage and water they shift on the size and composition of warra and forra herds. As drought persists they move a portion of warra herds to join the forra herds as long as forage is available in the forra area. Desta S. [4] observed that the pre-drought allocation of 71% of cattle to warra and 29% to forra in pre drought in 1982 had shifted to 34% warra and 66% forra by November 1983, after the onset of the drought that decimated large herd to Borana. The Borana supplement the calves and milking cows with 'cut and carry' grass collection and acacia pod collection to take them through the drought. There are also various safety institutions practiced by Borana to help one another in times of need. However, the effectiveness of these traditional organizations and institutions to manage the pastoral system had been weakened as resources are depleted and competition among households for scarce resources intensifies and social traditions decline. Given to the emerging situation, pastoralists in Borana are increasingly looking for new means to stabilize their food supply and income. Similar situation has been observed among the Orma pastoralists of Kenya. [10] documented a declining trend in the practice and effectiveness of mutual assistanceship among the Orma pastoralists of Kenya. The effectiveness of the social networks used by Orma pastoralists as insurance mechanisms to protect households from consequences of drought and other adverse shocks has gradually declined over time. New institutions such as incorporation of the government administrative apparatus and other alternatives to spread risk have emerged. Similar trend is observed among the Borana in southern Ethiopia. Attempts were made unsuccessfully to replace the traditional elders led pastoral management system by modern systems such as ranching, introduction of Pastoral Associations and limitation mobility by promoting settlement in drought reserve areas.

Borana Pastoral System Trend and Cattle Population Dynamics

The growing destabilization of the Borana pastoral system and increasing poverty and food insecurity among the herders have been well documented by many researchers. In a research work partially sponsored by USAID/CRSP, Desta S. et.al. [5] conducted a broad socio-economic survey with 336 households randomly selected from Borana in southern Ethiopia aimed at capturing the perception of herders towards the state of their production system and their degree of confidence in pastoralism to support them in the future. Herders' perceptions towards system trends are summarized in Table 1. The overall view strongly supported the idea that availability of grazing land had declined as had quantity of milk for people and calves. Standard of living reportedly had dropped for most households. The vast majority of herd owners perceived that the need for pastoralists to sell dairy products had increased, growth in the size of the human population had occurred, the need for cash income had increased, and that there was a heightened availability and demand for grain for human consumption.

Opinions regarding production trends for livestock species were mixed, however. Production of small ruminants was generally thought to be in decline, while camel holdings were perceived to be increasing. Despite periodic reductions in the regional cattle herd (Fig. 1), survey respondents tended to feel that the overall number of cattle had actually increased over the longer term. Deta s. et.al [5], ranked income sources for 56 households have shown that livestock, as the traditional source of income remained to be dominant, although non-traditional pastoral activities such as sales of dairy products and grain were also commonly mentioned. Non-pastoral or non-agricultural income sources were rare. In general, economic links of pastoralists to town-based economies were very limited. Income from remittances was virtually nil. Although there is an 80% probability of crop failure, cultivation remained to be the most common form of activity diversification away from traditional livestock production. Comparisons were made among population data for cattle and people collected in 1996-7 with that of previous studies. Patterns indicate that the number of people per household significantly increased between 1988 and 1996-7 by 36% overall. The percentage of households that were ranked as wealthy (7%) in 1996-7 was about one-third of the figure for 1988. One outcome of a decline in cattle numbers per capita is decreasing wealth. Most respondents perceived they were becoming poorer. Almost 50% of households reported a decline in wealth status in recent times, while only 7% reported an increase [5].

Table 1: Trends in the Borana Pastoral System as Perceived by 317 Herd Owners (% who Agree)

Feature	Decreasing	Increasing	No Change
Access to grazing land	91	7	2
Milk for people	97	1	2
Milk for calves	97	1	2
Standard of living	55	11	32
Grain in Markets	22	76	0
Pastoral grain consumption	1	99	0
Pastoral dairy sales	29	71	0
Human population	0	98	0
Need for cash income	0	99	1
Cattle production	24	74	2
Sheep production	74	24	2
Goat production	59	38	3
Camel production	14	84	2

A detailed survey followed with a sub-sample of 56 households to quantify how cattle holdings had changed over the period 1980-97 and to understand the nature of the cattle herd dynamics. The study focused on cattle because they are the dominant species in the area and the species most valued by the Borana [4]. The 17-year period was needed to have a sufficient time to capture droughts in 1984-5 and the early 1990s. Between 1980 and 2000 the Borana suffered three major droughts in which pastoralists lost 35-67% of their livestock inventory with a monetary value of hundred of millions of USD [7]; [17]. Cattle population dynamics for 17 years (1980-97) exhibited a downward trend in cattle holdings per household as well as a "boom-and-bust" cycle (Fig. 1).

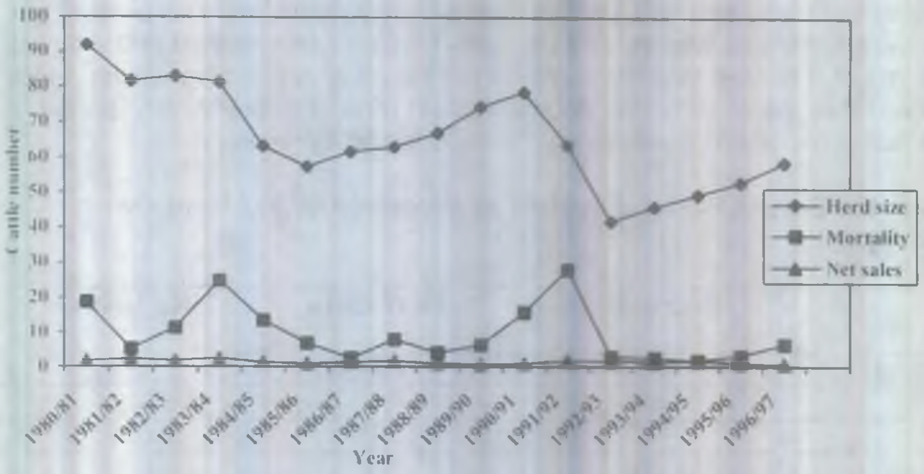

Figure 1: Southern Rangelands Borana Pastoralists Cattle Herd Dynamics (1980/81-1996/97)

On average, households reportedly lost 67 head of cattle to drought-related mortality over 17 years, largely due to starvation [5]. Death losses were 10 to 15 times greater than net sales, indicating that natural factors—not marketing—regulated the population size. The Borana tend to postpone cattle sales during drought until they have no choice. Initial sales usually coincide with a sudden need to buy large amounts of human food and this happens after the cows have ceased to lactate. This can occur 6 months to even a year after a long drought is underway. This collective behavior that resists capital asset depletion under stress can have disastrous consequences, because by the time cattle are marketed the body condition is poor and the numbers are too large to be readily absorbed by marketing channels. Cattle prices therefore collapse compared to pre drought situation and an accompanying decline in the terms of trade of livestock for grain contributes to food insecurity and famine risk [4]. Unfavorable terms of trade are the aggravating factors for the decline of per-capita livestock holding, particularly during drought time. The higher cattle sales rate (14%) that was reported in Borana in 1999 [1] was found as a general consequence of adversely affected terms of trade by drought. Shibru has estimated out of total cattle sales, sales rate of immature females was very significant (36%). This uncommon trend was evidence to the idea that the Borana were selling due to poverty. This trend will have a serious repercussion in reproductive performance and herd recovery after drought.

Borana are becoming poorer and poorer as their per capita cattle holding dwindles. Further more, [4] Desta (1999) documented a declining trend in average livestock holding per person in the region from 4.1 TLU/person in 1988 to 2.25 TLU/person in 1997. He also indicated a declining trend of livestock to people ratio, which has an implication on the pastoral welfare and food security situation. It has been estimated that, in order to meet subsistence needs, pastoralists need approximately 4.5-4.7 TLUs per person. Below this, herders must diversify their production base to provide [12] enough food. It is also true that the estimate of a minimum number of livestock units needed for pastoralists to be viable is highly dependent on the exchange rate between cattle and grain.

Despite the negative trend (Table 1) prevailing in the Borana pastoral system, livestock remains the dominant source of income and means to accumulate wealth. Contributions of non-pastoral income sources to the total household income are negligible [4]. However, survey respondents commonly expressed a need for opportunities to diversify their economy given pressures on traditional resources. Hogg, R. [12] concluded that, Borana in northern Kenya that had diversified away from a sole reliance on traditional livestock production were better able to endure drought perturbation. Results from Desta's survey revealed that diversification among Borana pastoralists was most typically expressed in the form of increased involvement in cereal cultivation and camel husbandry in response to dealing with a growing level of food insecurity. The recent PARIMA preliminary HH survey results further indicate still lower income/activity diversification levels among pastoralists despite compelling situation.

Summary of Preliminary Findings from PARIMA's Ongoing Research and Outreach Works

Below is a review of some general findings and lessons learned from the ongoing PARIMA field research and outreach activities over the period 2000 to 2003, with a focus on work conducted in southern Ethiopia [1].

Lack of Food and Water are Commonly Mentioned Risks for People on the Borana Plateau

It was found considerable local variation in the prominent risks that people face in northern Kenya and southern Ethiopia. Lack of food and water were seen as the most common problems, however. One interpretation of this pattern is that the human population exceeds their carrying capacity. When this happens, lack of food and water would always be the issues of greatest concern.

Public Service Delivery is Extremely Limited

In terms of public service delivery, pastoralists have been marginalized in both Ethiopia and Kenya. This is despite growth in pastoral populations, increased size and numbers of settlements, and increased incidence of poverty [14]. Large policy gaps exist for pastoralists, although Ethiopia appears committed to bringing more services to the local level in rural communities as a result of the new federal system [ibid].

Livestock Marketing is Risky for Pastoralists

When herders have ready access to viable livestock markets, however, they use them more. Conventional wisdom suggests that pastoralists tend to avoid market involvement, but increased population pressure may tend to force pastoralists to sell more stock to buy grain [3], [15]. Preliminary findings related to pastoral marketing systems [13] show that annualized off-take rates for livestock vary from 4 to 7% in northern Kenya from 1 to 3% in southern Ethiopia. These rates are low in relation to the natural fluctuation of animal numbers due to births and deaths [4]. Pastoralists, however, tend to use markets when they have more access [13].

Alternative Income-Generating Strategies Vital

Our work suggests that income diversification–where pastoral households engage in non-traditional means of income generation—is not a substitute for traditional pastoralism, but rather a complement. Some households in peri-urban localities appear to effectively optimize returns from the pastoral and non-pastoral sectors. Some family members pursue wage employment in towns, while others maintain the family herds in distant locations. Diversification of income streams, however, has been shown in general to be valuable for mitigating shocks that arise from drought. Our research shows that those households in Kenya having the highest levels of welfare (i.e., the highest levels of non-pastoral income) generally suffered the least from food insecurity in a recent drought. Finally, we have observed that access to education likely plays a very important role in promoting diversification of household income-generating activities. Returns to education likely vary, however, depending on when education is completed in relation to the national economic status and where households reside. The more remote the locale, the more difficult it may be for a household to realize significant returns from investment in primary education.

Use of Information Limited

In general, rates of literacy are low throughout our study region—and especially low for the inhabitants of southern Ethiopia who maintain a considerably lower standard of living compared to that for northern Kenya in many cases. Low rates of literacy may be expected to hinder effective delivery of various forms of modern communication to the population. For example, our surveys of 11 pastoral communities indicate that only a minority (20%) of rural people receives modem weather forecasts. This information is received most commonly via radio or newspapers. However, it also appears that pastoralists who receive such information often don't use it to support routine decision-making. Rather, pastoralists appear to heavily rely on local eyewitness accounts to make livestock production and resource use decisions based on rainfall patterns and green-up of vegetation. These observations discount the notion that efforts to promote weather forecasts are an effective means to improve pastoral risk management.

Summary of Preliminary Outreach Results in Southern Ethiopia

As mentioned above the Borana pastoral and agro-pastoral societies in southern Ethiopia are enduring a downward spiral of increasing poverty and food insecurity. The situation is exacerbated by a lack of economic development, as pastoralists and agro-pastoralists remain heavily dependent on an increasingly unstable base of traditional livestock production for their survival. Without some form of economic diversification away from livestock production, a more regular emigration of people out of the pastoral system, and/or large investments in the rehabilitation of grazing resources, the fate of people in this region is destined to become worse.

The Outreach Unit of the Pastoral Risk Management (PARIMA) project has been conducting a pilot outreach and intervention project since 2000 in the southern Ethiopian rangelands among Borana and Guji communities to develop a sustainable, participatory capacity for effective risk management intervention in the region. This involves transfer of information and capacity building for communities, development agents, and policy makers. Such intervention is intended to heip empower pastoral and agro-pastoral communities better conserve and create wealth as well as to diversify and increase their incomes and assets.

These factors, in turn, should enable these people to cope more effectively with drought and chronic problems related to an increasingly restricted access to natural resources. Specific intervention options include a focus on rural savings and credit associations and facilitating local investment in micro-enterprise and rehabilitation or enhancement of key local resources. These activities have implications for enhancing food security and market involvement of pastoralists as well as contributing to the alleviation of resource-based conflicts between neighbors.

Five pilot risk management projects have been implemented since 2000. Four of the pilot projects consist of the establishment of savings and credit groups among Borana pastoralists in Yabello, Moyale and Liben Weredas, which are involved in savings and credit schemes, petty trade and micro-enterprise development. Women pastoralists dominate the savings and credit groups. The other pilot project is a non-formal education project, also among the Borana in Yabello. As part of the capacity building exercise the project facilitates trainings, tours and cross border interaction between pastoralists in southern Ethiopia and northern Kenya to enhance knowledge transfer, harmonize activities and share experiences [7,8].

Although it will take time before the ultimate outcomes of the pilot projects become apparent, we have learned a lot over the past two years. The pilot interventions are all based on giving communities the opportunity to lead on problem identification, project design, and project implementation and we found that the approach is working well to ensure sustainability. We have also seen that, with appropriate technical oversight and training, people such as the Borana at Dida Hara—who have little formal education—appear quite capable of implementing small-scale activities dealing with rural finance and income diversification. We have also observed that human capital development, in the form of non-formal education, intensive training and exchange tours for project beneficiaries, promotes sustainability of interventions [8]. We have also witnessed the high operational effectiveness of pastoralist-to-pastoralist extension modes that contribute to rapid transfer of knowledge and skills. The approach pursued by PARIMA to implement its program in partnership with local development organizations also promotes continuity of effort when PARIMA phases out. The action research carried out by PARIMA to help monitor and document intervention outcomes can help guide larger development initiatives in the future. There has been a decided lack of such documentation of local pastoral development experiences in the past.

Conclusion

Coppock D.L. [3] concluded that, given population pressures, the main way the situation could improve for people like the Borana is to develop human capital via education and diversify the production system. He felt that investment opportunities that provided some complementary opportunities to livestock could be important to help conserve wealth that is otherwise periodically lost as massive livestock mortality.

Desta S. [4] argued that, risk management strategies are needed to assist the pastoralists to mitigate the situation and break the vicious cycle of poverty and food insecurity. One idea has been to encourage ways for the Borana to diversify investments to include non-livestock options and promote wealth conservation and human capacity building so that the people can better protect themselves against economic and ecological shocks. Results from a portfolio analysis that considered 17 years of cattle population dynamics (1980-97) in Borana demonstrated risk-mitigation and food security benefits of including non-pastoral investments such as savings and credit facilities along with cattle [4].

The PARIMA project is looking for long-term and sustainable solutions to the problems of pastoral systems in East Africa. We believe that more attention to risk management processes will reveal viable intervention concepts. One fundamental vision of PARIMA is to find ways to better create and conserve pastoral wealth. We believe that one means to approach this problem is to encourage more timely sales of animals and investment of proceeds in endeavors that enhance human capital and diversify local economies where possible. Such strategies will only be possible if marketing channels can be improved and rural financial services are made more accessible and if true participatory, bottom-up approach which give due considerations to traditional knowledge system is employed to unleash the energy, enthusiasm and heart of communities for positive change. Where conditions allow, we also strongly advocate efforts to promote the mobility of pastoral herds, restore key ecological resources, and support traditional systems of land use and social security. Perhaps the greatest lesson so far is that a true participatory approach can unleash a tremendous amount of energy and enthusiasm for positive change, even in a pastoral setting.

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New Approaches for Food Security through Sustainable Management of Natural Resources

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Abstract

The GTZ/ Integrated Food Security Programme South Gonder (GTZ/ IFSP) aims to improve the situation of food insecure households in South Gonder and selected areas in Tigray Region by the development and dissemination of innovative agricultural production methods and techniques on the basis of a sustainable management of natural resources. The proved and most successful innovations and approaches have been concentrated into an "Integrated Watershed Management" approach. This include the cultivation of triticale (a cross between rye and wheat) is disseminated in the project area, especially in high altitude and low productive areas. Vetiver grass (Vetiveria zizanioides) for is disseminated in the project area. The grass is planted for erosion control along contour lines on arable land. Also, Vetiver grass is alleviating the prevalent fodder shortage considerably due to its strong vegetative growth, realised immediately after the first rainfalls. Farmers even started to apply cut and carry system. Gully rehabilitation is undertaken by building physical structures (check dams/ loose stones or gabions, arc weirs/ masonry work). Right after the start of the rainy season, and when the water content of the soil is sufficient, trees, shrubs, and grasses are planted in the gully bed, at the gully side walls and the gully offsets. An improved plough was developed, cutting the ploughpan (hardpan), which is found in large parts of the project area in a depth of 20 – 25 cm. The appearance of the plough is close to the traditional Maresha, and is the metal parts are fabricated from spring steel. Production costs are estimated to ETB 120. It is expected, that yield increases of up to 50 % are achievable with the continuous use of the Tenkara Kend.

Introduction

The German Technical Cooperation/ Integrated Food Security Programme South Gonder (GTZ/ IFSP) is implemented in 6 woredas of South Gonder zone of Amhara region. The project area is part of the Ethiopian Central Highlands with altitudes ranging from approximately 1,500 to above 4,000 m altitude. The average yearly rainfall ranges from 700 – 1,300 mm. The average daily temperature is 17°C. Cambisols, regosols, lithosols, and andosols are the predominant soil types.

South Gonder has a history of food shortage and has experienced several serious famines, also in recent years. A large number of farm families are even in normal years hardly capable to produce sufficient food or to generate sufficient income for the subsistence needs. This has progressively impoverished the population and exhausted its productive capacity.

The main causes of the insufficient food production are repetitive droughts, but also crop damages due to hail attacks, frost and pests. Nevertheless, the root causes of the problem are shortage of productive land, inappropriate means and techniques of production, and improper agricultural and natural resources management practices, [1]). Poor infrastructure, inadequate extension services and limited off-farm as well as on-farm income generating

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and marketing opportunities, among others, are also factors limiting the households' purchasing power.

Most obvious is the soil loss due to water erosion, which is estimated to about 119 million tons per year in Amhara region, amounting to 70% of the total soil loss in the country as a whole. This has already resulted in a reduction in agricultural productivity of 2-3% p.a., taken a considerable area of arable land out of production. The situation is exacerbated because more and more marginal land is being cultivated, even on very steep slopes. Consequently grazing land is becoming scarce. Water bodies are prone to rapid sedimentation, thus reducing the storage capacity for irrigation and drinking water.

For the past thirty years, the Ethiopian government and NGOs have made great efforts in tackling the problem of soil loss with physical structures such as stone bunds, soil bunds, fanya juu and hillside terraces on farmland and on degraded land respectively. Despite the fact that this form of conservation has not proved popular with farmers, experts have persisted in their deployment. Farmers often agree to build these structures so as to get the benefit of Food for Work or Cash for Work respectively.

Reasons for the resistance by farmers to the erection of physical soil conservation structures include, that arable land is "consumed", that physical structures harbour rodents, and that physical structures hinder ploughing operations.

GTZ/ IFSP South Gonder

Background/ History

After some years of project implementation, GTZ/ IFSP South Gonder has concentrated all interventions into an "Integrated Watershed Management" since 2001. Accordingly, all project components have been implemented in micro-watersheds of 250 - 300 ha. With an average population of 400-600 people, watersheds are reasonable planning units. As watersheds follow natural boundaries, the selected catchment can cross kebele boundaries.

The following components/ activities proved to be most successful and effective to achieve the project objective:

- Introduction of triticale;
- Gully rehabilitation incl. nursery development;
- Stabilization of field bunds by vetiver grass in combination with leguminous fodder shrubs;
- Introduction of the Tenkara Kend plough.

In addition, GTZ/ IFSP South Gonder is supporting road construction and maintenance, and water development activities (protection of springs and hand dug wells).

In practice, watershed development and rehabilitation is achieved by a "bio-physical" soil and water conservation approach. This form of rehabilitation combines the use of physical structures with biological treatment by utilization of multi-purpose trees and shrubs, legumes, and grasses. This biophysical approach includes all land-use types, be it cultivated land, grazing land, forest areas, or degraded lands. The guiding principle is to increase rainfall infiltration into the soil by increasing the water holding capacity of the soil, resulting in greater soil moisture availability for crops and natural vegetation, as well as enhanced ground-water replenishment.

Project Approach

The "Integrated Watershed Management" of GTZ/ IFSP South Gonder is based on a participatory approach:

1. The population in the project area is informed about the possibility to request project support for the rehabilitation and the development of their watershed.
2. Interested communities submit their requests to the respective Office of Agriculture (OoA), and OoA undertakes further prioritisation.
3. In each selected watershed, planning according to the "Local Level Participatory Planning Approach (LLPPA)" is undertaken by Development Agents (DA) and Experts of the OoA.
4. An integrated watershed development plan is prepared, a watershed committee elected by the local population, and an agreement made on the activities to be undertaken, including the required contribution of farmers.
5. The watershed development plan is submitted to IFSP for technical assistance and funding of activities.
6. The activities according to the watershed development plan are implemented.
7. Training is given in the sustainable utilization (management) of the rehabilitated areas, with an emphasis on "cut and carry" systems.

Triticale

The Problem

Approximately 6.5 million people are chronically food insecure in Ethiopia and more millions can only afford one meal a day. The productivity of Ethiopia's main staple food grains, teff, wheat and barley are decreasing due to soil erosion and soil mining. This is a great concern since the population is increasing 2.7% per year on average.

Over the last decade, an average of about 800.000 metric tons of grain per year has had to be imported to meet the country's food deficit. Most of this has gone to the highland areas. The food gap is rapidly widening.

The Solution

The Bureau of Agriculture of the Amhara Region and GTZ/ IFSP has introduced triticale as a high potential grain crop to the project area. Triticale *(Triticosecale Wittmack)* is a cereal resulting from a cross between wheat (*Triticum aestivum*) and rye (*Secale cereale*).

In January 2002, two triticale varieties have been officially released in Ethiopia. Var. Sinan (short season) proved to be a viable supplementary crop to teff in moisture deficit areas, and in instances where there is a late onset of rains. Var. Maynet (long season) proved to have a superior yield performance over wheat and barley under marginal (high altitude, depleted soils, irregular rainfall, water-logging, hail-prone) conditions.

Characteristics:

1. In South Gonder, Triticale has shown outstanding yield performance. On farm trials with farmers, yields of 20 to 25 quintals (unfertilised) and up to 45 quintals (fertilised have been recorded. This is an increase of more than 100 percent. This is related to a higher

accumulation of nitrogen during heading and physiologic maturity than wheat. The difference is maximum under low levels of N application, indicating that triticale is a better crop for soils with low nitrogen fertility" [2].

2. Triticale carries more seeds per spike and has a high tillering (number of stems per seed) ability.
3. Triticale combines the positive aspects of both parents, e.g. the deep rooting ability and drought tolerance of rye combined with the high yielding ability of wheat. Due to the deeper and more extensive root system than either wheat or barley, triticale is able to access nutrients at deeper levels of the soil profile. Furthermore, this extensive root system ensures that greater amounts of organic matter remain in the soil, contributing to increased microbial activity, and to a greater PH buffering capacity.
4. In comparison to wheat Triticale shows a higher tolerance to diseases, drought, water logging, acidic soils and frost. The strong stem can even withstand heavy hail much better than wheat. In general, superior performance is found under unfavourable production conditions.
5. Triticale shows a wide range of adaptability, growing from sea level to altitudes above 3,000 meters.
6. Triticale is not genetically engineered, but rather a result of conventional breeding methods.
7. Triticale has more balanced nutrional value than wheat or barley. It has higher amount of metabolizable energy and is lower in fibre than barley. And it has a higher content of digestible amino acids than wheat.
8. Some varieties of Triticale show a high carotin content, a precursor to Vitamin A. In Ethiopia many people become blind because they lack Vitamin A in their diets.
9. Triticale shows high biomass production and re-growth capacity after grazing.
10. Various traditional dishes as injera, dabo, kollo, quita, nifro, kinche, and ginfo (staple "pancakes", bread, roasted grain, unleavened bread, boiled grain, coarsely ground porridge, and porridge) can be made out of triticale without any problem.

The Outlook

Foremost, Triticale is meant as a supplementary grain crop to wheat and barley in climatically disadvantaged areas like the highlands and drought prone areas. Triticale is not meant to replace wheat or barley in Ethiopia. The choice is entirely left to the farmers. However, Triticale has the potential to overcome the chronic food shortage in many areas of the highlands.

Seed multiplication with farmers started in 2001 on exchange basis by equivalent amount of wheat and/or teff. In 2002, 600 farmers were each supplied with 30 kg of seed for cultivation of 2,000 square meters of arable land. From the estimated harvest of approximately 750 kg per plot, 40 kg were expected to be refunded to GTZ/IFSP. This strategy proved to be highly successful.

Taking into consideration both experiences, that farmers had withheld the bulk of their harvest in order to exchange and/or trade with other farmers, it is believed that the spread of triticale cultivation has dramatically exceeded expectations. Therefore, it is estimated that between 2,000 and 3,000 farmers in South Gonder alone had access to triticale seed in 2002 season, and at least double that number in 2003 season.
Due to an increased demand, GTZ/ IFSP multiplied under irrigation the var. Sinan during the dry season 2002/ 2003. Although the harvest was high, the overwhelming demand could not be satisfied.

Nowadays, triticale has been successfully cultivated in Amhara (South and North Gonder, South and North Wollo, Gojjam, Shoa, Sekota) Tigray (Mekelle, Mlazat), Oromia (Shoa, Illubabor, Bale, West Wollega), Southern Nations, Nationalities, and Peoples Regional State (Konso, Guraghe).

Biophysical Soil and Water Conservation

The Problem

Every year, Ethiopia experiences losses of about 170 million tons of soil due to water erosion. The consequences are serious: there is a reduction in productivity of 2 – 3 % per year. Also, land degrades at an alarming rate and has to be taken out of agricultural production. These factors create an increasing pressure on the remaining land. The situation gets worse because more and more marginal land is being cultivated. Consequently grazing land is getting scarce and is exposed to extreme grazing pressure. Even in good years livestock appears to be undernourished, a clear sign of insufficient availability of fodder.

Over the past 20 to 25 years enormous efforts have been made by government and donors alike to reduce this rampant erosion by means of physical structures, such as stone and soil bunds and other designs. The success rate, however, is not very encouraging.

The physical structures take between 10 and 20% of the arable land out of production. To remain functional they need constant maintenance. Stone bunds especially harbour rodents causing crop losses of up to 25% in highly infested areas.

The Solution

Vetiver can be planted alongside existing physical structures such as stone bunds, and also on farmland without SWC structures along the contour. The labour requirements for hedge establishment are low, as well as the minimal maintenance needed in comparison to physical structures.

GTZ/ IFSP South Gonder has tested the use of Vetiver Grass in all project sites over the past four years, and has achieved significant success. Regardless of differences in rainfall, altitude, and soil type, vetiver has in all cases performed well. The only provision was found to be that the correct propagation techniques should be followed, that planting out should be done at the very beginning of the rainy season, and that the correct spacing should be adhered to.

Consideration should also be given to the fact that growth and tillering rates are lower at high altitude ranges, and that establishment in termite-infested areas may prove to be problematic.

Characteristics:

1. Vetiver grass, planted in a single line and with proper spacing along contour, forms a dense hedge within two years, trapping sediments above. Over time it then forms a natural terrace.
2. Vetiver is not taking away arable land and requires practically no maintenance once established.
3. Vetiver grass does not encroach farmland.

4. Its root system, which reaches as deep as 6 meters, is extremely drought resistant and can also withstand seasonal water logging and even burning.
5. It has a wide range of adaptability from sea level to above 3,000 meters in altitude.
6. Vetiver grass can be successfully grown in the Highlands, regardless of steepness of slope. However, it needs sufficient soil depth.
7. Vetiver grass hedges show a substantial reduction of rodent infestation.
8. Vetiver grass can be used as livestock feed, mulch and roof thatching.

Future Prospects

In South Gonder, vetiver grass is in high demand by farmers. Not only are the soil erosion control effects clearly visible, but also higher yields are realised due to decrease of rodent infestation and the cultivation of additional land. Since some years, farmers are even removing physical structures on their land after the vetiver hedges are sufficiently established.

Vetiver Grass is propagated in nurseries using poly bags for efficient production of seedlings. Bare rooted multiplication of Vetiver grass is successfully done in areas of Ethiopia with higher precipitation than South Gonder zone of Amhara region, or under irrigation.

Until present, Vetiver hedges have been planted on about 2,500 hectares of arable land with GTZ/ IFSP South Gonder assistance, and an additional 500 hectares by farmers' own initiative without project assistance.

Interventions and innovations developed by GTZ/ IFSP South Gonder have been extended to other areas of Amhara region, and to Tigray and Oromia regions. In relation to the Ethiopian Government, high officials were paying a visit to GTZ/ IFSP South Gonder, resulting in the inclusion of vetiver hedge technology into the national agricultural extension package.

Gully Rehabilitation

The Problem

Deforestation, cultivation of steep slopes, limited fallow or vegetative cover, over- grazing, insufficient soil conservation measures following road construction or earthworks, and low soil organic matter content are the root causes of gully formation [3].

Gullies considerably reduce farming land, and even hinder the communication between villagers due to the destruction of footpaths and access roads. Gullies in Ethiopia may not be as significant as rills and sheet erosion. Nevertheless, gullies are found everywhere in Amhara region, and in some pocket areas like North Wollo, 15 % of the total land area has been lost to gullies.

The conventional approach to gully treatment consists of physical structures without biological support. Especially loose stone structures, which are most common, are highly susceptible to damage by livestock. They are also not strong enough to resist the force of the run-off at peak periods. The gullies do not provide any immediate benefit, and reshaping of sidewalls encroaches on arable land.

The Solution

Gully treatment measures should break the force of the run-off, effectively trap sediment, reduce and finally stop the movement of soil from sidewalls, gully heads and offsets, and provide immediate and long-term benefits to farmers.

The GTZ/ IFSP South Gonder approach to gully treatment comprises of the construction of physical structures being complemented by biological methods reinforcing them, including the treatment of the gully bed, the sidewalls and the offsets.

Characteristics:

1. Physical structures such as arc weirs, gabions and loose stone check-dams are constructed according to the characteristic of the location.
2. Appropriate plant species for biological stabilisation are utilized according to specific position within the gully.
3. Multipurpose plant species with immediate and long-term benefits in form of fodder and tree products are utilized.
4. Moisture retention and stream flow are increased, which allow the protection of springs and the application of traditional irrigation methods.
5. Exclusion of cut-off drains as well as reshaping of gully walls minimise the decrease of arable land.
6. Farmers are trained in "Cut and Carry" system for forage harvest.
7. Specific attention is given to the full participation of the owners of the gully during all stages of implementation. No other group of the village is involved.

The Outlook

The GTZ/ IFSP South Gonder approach of gully rehabilitation is still based on external support, which is inevitable due to the utilisation of industrial products (gabions, cement, skilled labour, etc.) for the construction of physical structures. Also, comprehensive co-operation of all farmers owning the gully is required which is only achieved with payment in one form or another.

Nevertheless, GTZ/ IFSP South Gonder believes that effective and sustainable gully rehabilitation can only be attained by a farmer-driven approach, including technical requirements within the scope of farmers' skills and abilities, and the utilisation of locally available materials. Also, farmers are to be trained/ oriented for further improvement and management of the gully.

In the aspect of reducing technical requirements, and increasing the utilisation of locally available materials, GTZ/ IFSP South Gonder started to test gully stabilisation with gabion boxes fabricated from bamboo and Shambokko (Spanish reed). Also, poplar and willow boxes as in situ structures are used, as well as reinforced bundling with poplar and willow branches, and layering of vegetative material.

Gully walls are stabilised by bundling and pegging along the contour of the sidewalls, plugging of gully sidewalls with crown vetch, screening and seeding, planting of trees and shrubs, and direct sowing or broadcasting.

The gully offset is treated by trees and shrubs to prevent a further encroachment into the arable land.

Newly Developed Sub-Cultivator (Tenkara Kend)

Problem

In Ethiopia, the prevalence of water logging and extensive run-off and even soil-slippage in farmers' fields during the rainy season is widespread. Closer inspection reveals the existence of a ploughpan (hardpan) below 20 to 25 cm depth. Effective soil depth for plants is restricted therefore to 20 to 25 cm, even when the real soil depth is more than e.g. 2 m. Soil water infiltration is impeded.

Because of this impenetrable layer, increased surface run off of water is evident and soil erosion increases. Crop roots have no anchorage, and even exhibit horizontal rather than vertical growth, and no access to nutrients below the compacted layer,. The thin fertile soil layer starts to show signs of drought stress already within a few days of no rain. Inorganic fertiliser applied is easily washed away.

The Solution

GTZ/ IFSP South Gonder has developed a sub-cultivator called "Tenkara Kend" that is able to cut into the compacted layer by way of a "knife" attached to the plough. It ploughs about 15 cm deep like the Maresha, but the attached "knife" cuts another 6 – 12 cm into the compaction without turning the soil. These cuts enable more water to infiltrate into the soil, therefore reducing run off. Crop roots can penetrate deeper and eventually crack more of the compacted layer. Microbiological activities also increase and the roots can reach more nutrients.

Characteristics

1. The Tenkara Kend is designed along the lines of the traditional Maresha.
2. The operating principles are comparable to the Maresha.
3. Typical local oxen meet the draught requirements easily.
4. The Tenkara Kend weighs about the same as the Maresha, and is therefore light enough to be carried by farmers.
5. Manufacturing of the Tenkara Kend is done in Ethiopia, and the manufacturing costs are about ETB 120.
6. The water infiltration is increased into the deeper layers of the soil (water harvesting), and also the soil moisture holding capacity, leading to finally minimal run-off. Also, water logging is decreased, and therefore, soil-borne and fungal diseases on crops.
7. Oxygenation of the subsoil, leading to increased microbial activity in the soil, and consequently, leading to an increase in the availability of soil nutrients.

Outlook

Extensive field trials were conducted with the Tenkara Kend over three cropping seasons. All trial plots were ploughed 3 or 4 times according to soil conditions, and then sown to wheat, barley, or teff. Yield increases showed that the frequency of ploughing operations over the years was a determining factor. Another determining factor proved to be inherent soil fertility: poorer soils tended to exhibit superior yield increases in comparison to more fertile soils.

After four years of technical improvements and field trials, the yield increases in all crops grown were between 10 and 15 % in the first year, and between 25 and 40 % in the second year. It is expected, that yield increases of up to 50 % are achievable with the continuous use of the Tenkara Kend.

Comparison of Yields: Tenkara Kend vs. Maresha (Year 2000)

Name of Farmer	Plot Size (m^2)	Crop Species	Yield (kg)		Ploughing Frequency	Yield Increase (%)
			Tenkara Kend	Trad. Maresha		
Azeze Terence	300	Barley	23.0	18.9	1	21.7
Woreta Alebachew	300	Wheat	66.0	52.5	3	25.7
Mulat Mequanint	300	Teff	21.3	15.3	2	39.2
Assefa Gebre	300	Teff	52.2	38.4	3	35.9
Melesse Belay	300	Teff	69.3	63.6	1	9.0
Eshete Ayele	300	Wheat	42.6	30.0	3	42.0
Wale Sendeke	300	Wheat	57.6	43.5	3	32.4
Wubu Zeleke	300	Teff	39.9	36.0	1	10.8
Gebru Tsegaye	300	Wheat	64.5	51.0	3	25.5

Over the time, lower manufacturing costs and a more culturally acceptable appearance were achieved. Manufacturing of the Tenkara Kend is done in Ethiopia. It is estimated that the Tenkara Kend could be manufactured with costs of ETB 120. With an expected lifetime of 10 years, this investment would result in an annual cost of ETB 12, which is comparable to the costs of the Maresha.

The concept of "water-harvesting" rightly enjoys great priority in Ethiopia, and the practices include the collection and storage of surface water in water bodies such as ponds, dams, and reservoirs, as well as methods, techniques or structures that re-charge of natural ground-water reserves. GTZ/IFSP South Gonder likewise supports efforts directed towards water harvesting. It also believes that any appropriate cultivation implement that vastly increases infiltration of rainfall into the soil would make a very positive contribution to the water harvesting efforts that are being pursued in the country.

Conclusions

The GTZ/ IFSP South Gonder approach of "Integrated Watershed Management" includes four major components/ activities directed each to a potential area for improving food security. Synergistic effects and increased efficiency is experienced, as the components/ activities are complementary one to another. The most important advantage of the combined effects of all conservation and development efforts is the one on land management. But also the combined effects on soil and water retention result in a more equal distribution of rain induced water-flow, and reduced soil erosion in the local river drainage system.

The effects and benefits of the GTZ/ IFSP South Gonder applied approach of "Integrated Watershed Management" can be stated:

- Assurance of sustainability and increment of the economical benefit of natural resources utilisation.
- Introduction of adequate mechanisms to promote and guide individual economical activities.
- Improvement of the quality of life of the rural population, and promotion of a sustainable development.

Recommendations

To achieve the best economical and social benefit, and to assure best dissemination of proved development efforts, GTZ/ IFSP South Gonder recommends the implementation of activities contributing to a sustainable development through the responsible utilisation of natural resources in watersheds by combining project activities which are tackling different root causes of food shortage, but also contributing to the alleviation of the problem with synergistic effects.

In addition, GTZ/ IFSP South Gonder recommends that the interventions must include all stakeholders in the respective area meeting the level of understanding, capacity for change, and skills and abilities. Consequently, the combinations of the following activities/ performances are regarded to be most effective to achieve the project goal:

- Advisory activities to institutional development and capacity building of participating groups and organisations at all levels (e.g. local farmers, line government offices, NGOs).
- Support of the institutional collaboration and co-operation between line departments/ offices and all groups involved in the utilisation of the natural resources.
- Advisory activities to increase the economical profit/ benefit from natural resources.
- Development of adequate and attractive allocation of financial support.
- Introduction of adequate practices of the water, land and forest resources in the watershed areas.
- Establishment of monitoring systems and advisory services during the development and implementation of adequate strategies and plans of land use management.
- Implementation of awareness raising programmes.

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Rainwater Harvesting Technologies and Their Contribution to Household Food Security in Dry Land Areas of Ethiopia

*Hune Nega**

Abstract

To increase the agricultural production in Ethiopia and to keep pace with population growth requires focus on water productivity in both rain fed and irrigated agriculture. Risk of reduced or no return on invested capital in rain fed semi-arid farming is directly related to rainfall availability and distribution. The entry point could be to manage water. It is evident that if only crop water access is secured, investments in other agricultural activities will pay off in terms of substantially increased soil and water productivity. In drought prone and moisture deficit areas food security is acute at household levels. Primary focus and improvement of agricultural sector in this area would be the best solution. To address the severity of drought and famine and to attain food self-sufficiency in the country, complementing of rain fed agriculture with farmers oriented small-scale irrigation and rainwater harvesting technologies seems to contribute the much needed sustainable solution and to effectively utilize the scarce water resource in food insecure arid and semi-arid areas of Ethiopia. Many studies indicate that rainwater harvesting can be viable in areas with as low as 300mm of annual rainfall, and a more conservative range of annual rainfall between 500-600mm. Nevertheless, rainwater-harvesting technology has been used to sustain food production in many areas of the world with annual rainfall of about 100mm [10]. As a matter of fact, most of the drought-affected areas of Ethiopia receive much more than 100mm annual rainfall. The effective utilization of rainwater harvesting technology however, requires in depth planning, appropriate institutional setup, capital inputs, genuine community participation, skilled human resource, commitment, and conducive policy environment. To bring change and sustainability, the impacts also need to be assessed and evaluated in relation to technical and economic viability, and policy perspectives.

1. Introduction

The Ethiopian economy is dominated by subsistence agriculture. The agricultural sector accounts for 46% of the GDP, 80-90% of the export revenues and employs over 85% of the population. The Yearly growth of food production in the country could not exceed 1 percent for several years while the average population growth rate is nearly 3% every year [9]. As a result, chronic food shortage, and drought-induced famines have been common phenomena in the country. One of the latest estimates shows that 45% of the Ethiopian population is living in absolute poverty [4].

For all the water supply development activities achieved so far, the average access (20 liter /capita/day) to clean and safe water supply In Ethiopia is about 31% of the total population and 23% and 74% of the total rural and urban population respectively. The sanitation condition in the country is much worse where more than 92% of the population do not have access to adequate sanitation facilities.

Ethiopia is much known for its huge water resources potential. Studies indicate that the country has annual surface run off close to 110 billion cubic meters. Fresh water resource

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use in the country is estimated at about 2.5% which is mainly used to irrigate about 0.2 million hectare [5] and to provide water supply for approximately 31% of the total population.

The estimated surface water resource potential of the country and the current estimated population (65 million) matches at approximately 4500 liter per person per day, and this is much higher when it is compared to the estimated average water use, 20 liter per capita daily water consumption rate in the country. This clearly indicates that the water resource of Ethiopia seem to have a potential of supporting a far greater number of people. Nevertheless, the use of these water resources to meet the socio-economic needs of the country and its people are very limited- due to various constraints. For example, 80 to 90% of the total surface water resource in found in the area where the population is no more than 30 to 40% and 10 to 20% of the water resource is found in the area where the population is over 60%. Therefore this un even distribution of the available water resources with respect to the agro-ecological and settlement patterns in the country can be mentioned as one of the most outstanding water resource problems in Ethiopia.

Moreover, Ethiopia receives plentiful annual rainfall on the average, which could support optimum level of agricultural activities. However, it falls either too early or too late as well as with variation in quantity and in terms of the spatial and temporal distribution of the seasonal rainfall.

The increased population density in the high land areas and cultivation of marginal lands for survival has eventually resulted in the severe degradation of agro-ecological resource bases and decline of agricultural production. Consequently, population expansion increased towards the extensive dry land areas. Un fortunately, these areas are usually constrained by shortage of rainfall for optimum agricultural production.

The dry land areas of Ethiopia account for about 67% of the total landmass of the country and it covers a wide range of agro-ecological zones [3]. Because of many uncertainties, agriculture in dry land areas is a risky enterprise. Farmers are subsistence and they are economically weak with low ability to with stand risks. The average land holding per household is generally less than a hectare and often in fragments.

The dry land areas are characterized by low and variable rainfall, which rarely exceeds 800mm, with most areas receiving from less than 500 to about 750mm annually. The area is also characterized by high intensity usually greater than 15mm/hr of rainfall leading to accelerated soil erosion. There is also high annual evapotranspiration rates ranging from 1400mm to 3000mm owing to high temperature normally greater than 25^{oc}. Monthly potential evaporation (PET) rates usually exceeds rainfall in most parts of the dry land areas [3]. Thus, the atmospheric demand for water in dry area is high. The soils are often shallow in depth and mostly light textured with low organic matter content particularly in the highlands. The soils are therefore, drought sensitive due to the limited water holding capacity.

To address the severity of drought and famine and to attain food self-sufficiency in the country in general, complementing of rain fed agriculture with farmers oriented small-scale irrigation and rainwater harvesting technologies seems to contribute the much needed sustainable solution and to effectively utilize the scarce water resources in food insecure arid and semi-arid areas of Ethiopia.

Recent research results indicate that incorporating rainwater harvesting in soil storage (in situ), supplemental irrigation through artificial reservoir and moisture conservation techniques can lead to increase in water productivity, crop yields and food security. Therefore, incorporating rainwater harvesting with land husbandry can have a great impact on agricultural water management and productivity. Integrated rainwater management can narrow the gap and difference between irrigated and rain fed agriculture.

2. Irrigation Development and Water Management In Ethiopia

Ethiopia has an irrigation potential of 3.5 million hectares, but so far the actual area under cultivation is estimated to be 4.6% of the potentially irrigable lands. Irrigated agriculture is practiced traditionally in Ethiopia for over a century, mainly by gravity irrigation. The area under modern irrigation schemes in Ethiopia is very small and mainly concentrated in state farms.

The current status of modern and traditional small-scale irrigation agriculture in Ethiopia is characterized by severe shortcomings that have resulted in many communal irrigation schemes. The following are some of the major problems associated with irrigation development in Ethiopia [1]:

- Absence of developed cost recovery mechanisms (irrigation water is treated as a social commodity other than an economic commodity).
- Supply driven approach, low involvement of users in the process of construction and maintenance
- High investment costs
- Farmer's dependency syndromes and sustainability (farmers demanding government help even for small maintenance work which they could manage by themselves)
- Insufficient coordination among various stakeholders in irrigation development
- Lack of sustainable watershed management strategies
- Insufficient research for upgrading and strengthening of traditional irrigation.
- Lack of efficient irrigation extension structures and strategies
- Inadequate marketing strategies (low market price of agricultural products)
- Poor management performance (water utilization, maintenance of structures, and sedimentation, etc).

The present challenges of drought, declining agricultural production and the ever-increasing population pressure necessitate turning attention to improved water resource management and small-scale irrigation development to sustain food production at household level in the country. Ethiopia has its national food security strategy in place providing the country with a direction guideline of water resource development in the country. The strategy includes promotion of irrigation where rainfall is more reliable to allow development at reasonable cost. The focus in this area would be on creating condition for year- round agricultural activity, and for diversifying to higher value added enterprises.

To complement irrigation development, especially in drought-prone areas promotion of appropriate rainwater harvesting technologies at house hold- level are seriously considered.

3. Rainwater Harvesting Techniques

3.1 Principles of Rainwater Harvesting

Runoff water is the greatest agent of soil erosion, which subsequently gives rise to other forms of land degradation including desertification. Rainwater harvesting technique therefore serves the dual purpose of preserving the environment and providing water, the most needed commodity.

Rainwater harvesting is a collection of rainwater from direct rainfall or in the form of surface runoff and concentration of it in the soil profile or in artificial reservoir from which it can be directed to various uses, ranging from supplementary irrigation to water supply for domestic, animals and other productive uses. Runoff water can be harvested form roofs or ground surfaces as well as from seasonal water sources, in principle, 1mm of rainfall on an impervious catchments area, can generate 1 liter of runoff water per square meter.

3.2 Where to Use It?

Rainwater harvesting techniques can be applicable in all agro climatic zones and it is more appropriate in moisture deficit areas where other permanent water sources are not available or uneconomical to use them.

3.3 Rainwater Harvesting In Ethiopia: An Overview

In large parts of the world rainwater harvesting is best known and practiced in the semi-arid areas where annual precipitation ranges between 500-600mm. In Ethiopia, there is evidence that ancient churches, monasteries and castles used to collect rainwater from rooftops. During the Axumite kingdom which dates back as early as 560 BC, rainwater was harvested and stored in ponds for agriculture and water supply purposes [6]. Other evidences include the remains of one of the oldest castles in Gondar, constructed in the 15-16 century which has a pond built for rainwater harvesting for drinking. Also by the king Lalibela (over 800 years ago), ponds and underground water tanks were used both for drinking and religious rituals. As of the start of the 20th Century in small rural towns where there is shortage of water, houses made of corrugated iron sheet roofs are fitted with gutters to collect rainwater. The system, however, is not leading to fixed reservoirs or tanks, but makeshift facilities like clay pots, oil drums, to collect the rainwater. Cisterns have also been introduced in very few places. In Ogaden areas of eastern Ethiopia, underground birkas are used for storage of run off water collected from ground surfaces.

In semi-arid low lands, run off irrigation (spate irrigation) is widely practiced in Chercher plains around Mehoni and Wja near Alamata in Tigray, the Gato valley in north Omo, many parts of eastern and western Hararge, and many places in the country. The people in Konso, Gidole, Gato and many parts of the north and south Omo zones have been exercising the art of conserving soil and water. This traditional, rainwater-harvesting technique includes the use of many moisture conservation techniques.

In Ethiopia, through the government initiated soil and water conservation programs, some efforts have been made for construction of farm ponds and micro dams as alternative intervention to respond the 1971-74 drought in Tigray, Wollo and Hararge. Since then, however the interventions have been extended to the other parts of the country with very limited coverage. The Low level of community participation in the food for work program and un targeted mass mobilization and the gradual decline of attention until recently were some of the major reasons. In recent years, water management in particular promotion of rainwater harvesting technology and management is included as one of the most important package components in the national agricultural extension program.

In the area of small-scale household water harvesting program, Ethiopia has made considerable progress in terms of capacity building and demonstration of technologies particularly over the last five years. In some places it has been demonstrated and there are obvious benefits from promoting and adopting promising rainwater harvesting technologies and systems. Some of these techniques are based on local and others similar countries land users innovation in their efforts to cope with persistent food in security and famine.

The rainwater harvesting interventions intended for moisture stressed and paternalist areas include both on-farm rainwater conservation and off-farm rainwater harvesting technology. Regional agriculture Bateaux, non-governmental organizations and water sector institution and organizations in many parts of the country are also involved in the promotion process.

3.4 Rainwater Harvesting Potential for Improving Agricultural Production

Water in Ethiopia is regarded as one of the principal natural resources opportunities for the country's future economic development. The nature of the country's geographical and climatic condition offers numerous locations where interventions could be made to tap the resources and make productive use of it in terms of hydro power generation, enhanced food security and other benefits. These prospects make water the most viable natural resource to be developed for the well being of our people.

Relatively less attention has been paid to the opportunities at hand to improve agricultural water productivity in the on- farm water balance and the hydrological cycle at catchments level [8]. Recent studies suggest that there are opportunities to produce more food if the focus is changed from the down stream runoff water resource to up stream position where the rainfall enters the soil-plant system. Hence the shit forwards rainwater harvesting and management is a critical issue for integrated agricultural water management.

Moreover, the shift towards up stream water and watershed focus is crucial particularly for resource poor and food deficient smallholder farmers, as it provides them with labor and energy saving water management practices. Rain water is all about capturing rainwater in their farms, either in the soil profile or small artificial reservoirs, instead of following the water down the valley stream. Water related problems in rain fed agricultural in the water scarce arid and semi-arid areas can be improved with rainwater harvesting.

Rainwater harvesting is most appropriate and viable option to address the moisture stress problems in arid and semi-arid areas of Ethiopia. The following are some of the advantages and benefits:

- In moisture stress area rainwater is more available compared to other permanent water sources such as rivers, springs and shallow wells.
- No external energy is required for its extraction or transportation and most of the labor and materials are locally available.
- Rainwater harvesting technologies can be easily implemented with family labor using locally available materials. They are socially acceptable and have positive environmental impact.
- Low cost, and simple to manage and maintain.
- Small-scale household water harvesting in Ethiopia has the advantages of being relatively simple in design, management as well as being less laborious and time saving [7].
- Household rainwater harvesting projects could be self-continuing through local demand and that the necessary technical advice and assistance will be in place and readily available.
- The collection and safe storage of rainwater for water supply purpose could save time

and labor that may be used profitably in other activities

- The technical know how in the rural areas could eventually create substantial employment opportunities for rural youths
- The ever-increasing shortage of water from the conventional water sources, shallow wells, perennial springs and streams would be improved through rainwater harvesting.
- Soil fertility can be improved through reduced soil erosion.

3.5 Opportunities and Prospects of Rainwater Harvesting In Ethiopia

The following are some of the opportunities and prospects for rainwater harvesting promotion in Ethiopia:

Rainwater harvesting and small-scale irrigation techniques are not new in Ethiopia

- Attention is already given to rainwater harvesting by policy makers, planners, professionals, farmers, and donor agencies.
- Many government and non government organizations have already involved in the promotion of water harvesting for crop production and water supply for domestic and livestock purposes.
- Most arid and semi-arid areas receive adequate amount of annual rainfall that can support plant growth.
- Communal water supply and irrigation schemes in Ethiopia remain a challenge owing to the unique and rugged terrain, small and fragmented farm land, scattered settlement patterns, etc.

3.6 Issues about Promotion of Rainwater Harvesting in Ethiopia

Key issues on rainwater harvesting development and promotion in Ethiopia can be summarized as follows:

- Low-income level of the community to afford household water harvesting technologies even though technologies are considered low cost options,
- The wide spread dependency syndrome throughout the country,
- Low level of community participation in the promotion and adoption of technologies,
- In Some places ignorance of other technological options such as development of shallow wells, spring development; manual and motor pump irrigation along river courses, and upgrading of traditional irrigation practices, etc,
- Low level of technological standard as well as site selection problems as a result of long stayed and culturally adapted quota system dissemination approach,
- Low level of credit facilities,
- Lack of uniform institutional setup for implementation process,
- Low level of commitment at all levels,
- Poor linkage among relevant institution and disciplines.

4. Conclusion and Recommendation

4.1 Conclusion

The majority of rural people in Ethiopia depend entirely on rain fed agriculture [2] for their livelihoods. Farmers earn their livelihoods from the available land resources while manipulating elements of the natural environment. Most of the farmers in the country are not users of improved technologies or inputs. Both crop and animal production are carried out according to the centuries old traditions. Farm implements and tools are still in their original designs. As a result, agricultural production in the country has remained at a subsistence level. This level, as it has been seen so far is highly liable to disturbance by occasional and frequent droughts and other local conditions. As a result, external interventions such as food aid and famine relief has been a common practice in Ethiopia.

Several drought and famine that hit the country as reported at different times were results of a sequence of rain failures. Water in arid and semi-arid areas of Ethiopia is much of all a scarce commodity. Rural people usually females travel an average of about 20 kms per day, which could reach about 6000 kms per year to fetch the household water demand. Animals also get water every three days after traveling long distances. Therefore, under these circumstances, rainwater harvesting is a necessity and not an option in alleviating food crises and water problems in Ethiopia, particularly by in arid and semi-arid areas. The long-term solution for food shortage should not lie in famine relief, but in crucial change at the land-users' level.

It is evident that various types of rainwater harvesting technologies exist in Ethiopia for crop and fodder production, tree establishment, water supply for domestic, livestock and other productive uses. Most of the techniques are low cost options and operating at small groups or household levels. There is knowledge and innovation on rainwater harvesting at land users' level that could be tapped and improved. However, for this potential to be realized, appropriate techniques and extension approaches need to be identified for a particular area within the country.

4.2 Recommendations

For better adoption and replication of rainwater harvesting in Ethiopia, the following points are suggested:

- Rainwater harvesting technology needs to be considered as one of the many options for improving food insecurity in the country.
- Rehabilitate existing (what has been done in the past) community farm ponds, micro- dams, etc, in the selected food insecure areas.
- Technical improvement of land-users innovations and traditional system,
- Building strong linkage among various stakeholders in research, policy advocacy and development partners to promote rainwater harvesting.
- Awareness creation and capacity building among land-users and other stakeholders through mass media, formal and informal seminars, workshops, demonstration trainings, exposure visits, etc.
- Facilitate of financial support on a systematic credit basis.
- Food for work, for on-farm water harvesting activity should not be encouraged.
- Formulation and implementation of comprehensive policies to include rainwater harvesting in the curriculum of the education system from primary school to higher training institution
- Conduct a study on the socio- economic impacts of water harvesting in the country (social acceptance, risks, labor constraints, economic viability, cost recovery potentials, etc.)
- Carry out on-farm research to validate, improve and adapt effective rainwater harvesting technologies and systems.
- More focus for proper planning of land management at water shed level

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Agro climatic Analysis of Ethiopia with More Emphasis on Policy Perspectives

Tesfaye Gissila[*]

Abstract

Food security, unless it is import oriented, is highly determined by the agro-climatic potentials and constraints found over a country. Thus there is a need for agro-climatic analysis by examining both the resources and the risks, which can affect the status of food security of a country. Ethiopia is largely characterized with a spectrum of climate types, ranging from the moisture deficit arid areas to the moisture surplus humid areas, including the transition zones. There are areas with crop growing period of eight to nine months and there are areas with a growing period of barely 60 days and less than that. Moreover, the effect of climate variability on different types of agro-climatic zones is not the same. A dry spell extending for a few weeks during the rainy season may result in total crop failure, and thus ending with no agricultural production over marginal areas with a shorter number of growing period days, where as those areas with a longer number of growing period days may be forced to switch from the high yielding long cycle crops to the low yielding short cycle crops resulting in a decrease in agricultural production, but having more chance of survival than their compatriots found over areas of short growing period days. Thus it is important to note that climate variability problems addressed by food security policy perspectives may not be the same for different agro-climatic zones. There is a great need for development of different strategies for different agro-climatic zones, as the problems encountered may need different solutions. However, it is also important to note that there are also problems common to some of or all of agro-climatic zones, which can be tackled on the basis of policy perspectives. For example, long-term policy perspectives should attend to the development of sustainable agriculture, where the problem of ecological degradation should be addressed and it is important to note that this is a common problem to all agro-climatic zones, though the immensity of this problem may vary from one agro-climatic zone to the other agro-climatic zone. Soil conservation activities may be critical in one agro-climatic zone, where as mountain afforestation may be indispensable in another agro-climatic zone. Thus in general it would be wise to address the problems of land degradation, deforestation, climate change and desertification, which can become catastrophic to the long-term food security prospect, if left unattended.

Introduction

The major objective of the undertaking of agro-climatic analysis should be to assess the agro-climatological potentials and constraints that can exist over the country. There have been various works on the agro-climatic classifications of Ethiopia in the past [8]. To cite a few, zonation of agricultural climatology of Ethiopia was conducted in 1984 by Land Use Planning and Regulation Department (LUPRD) of the Ministry of Agriculture in collaboration with FAO. However, this was reported as suffering from a number of weaknesses that restricted its usefulness and thus have necessitated modifications in subsequent studies for the particular objectives they wished to achieve. Later on Agro-climatic zones classification was undertaken by [2] in collaboration with NMSA and LUPRD of Ministry of Agriculture. The

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principle underlying this study was the estimation of dependable growing period for a given earliest planting month under four levels of soil water holding capacities (50,100,150 and 250 mm). Fourteen broad growing period zones were identified over the country. Though this classification is a very important advance in understanding the agro-climatic potentials and constraints over the country, one major drawback of this classification was that the time unit was a month and it did not take into account intra-monthly variabilities such as the occurrence of dry spells (within the month). Moreover it did not consider the importance of the onset or planting dates in the classification process. Another approach to agro-climatic classification of Ethiopia [7] indicated that the country can be classified into 21 growing season zones that are categorized into 4 growing season belts based on three main parameters which include the type of growing season, time of onset of the growing season and the length of the growing season, where the time unit taken is ten days.

The length of the growing period (LGP) concept is one method of assessing rainfall evaporation relationships that define the period in which agricultural production is possible from the viewpoint of moisture availability in the absence of temperature limitations. However, in temperate/elevated areas, where temperature may be an important limitation to crop production, the LGP concept must be tagged to the temperature. The LGP concept is widely used in the land evaluation and agricultural planning.

The main implications of agro-climatic classifications over Ethiopia is that the country is largely characterized with a spectrum of agro-climatic types, ranging from the moisture deficit arid areas to the moisture surplus humid areas. The crops grown are diverse following the complicated mosaic of agro-ecologies derived from soil types ranging from vertisols to sand and cropping altitudes ranging from more than 3000m to less than 600m above sea level. There are areas with crop growing period of up to ten months and in the other extreme, there are areas with no growing period, where the length of the growing period is too short to be adequate for crop production. Moreover due to the rugged topography over the country characterized with mountains, escarpments and valleys, the orientation of the moisture bearing winds during the rainy seasons can bring about large differences in agro-climatic features within a short distance. For example, the central mountain range enhances dryness on the lowlands of Tigray and Amhara. The southern mountain range induces high rainfall over the highlands and dryness over the lowlands of eastern Oromia and SNNPR. Thus it is important to note that local-variations can become more important when we undertake agro-climatic analysis.

The major points to be addressed in agro-climatic analysis of a country are largely determined by the objectives and tasks for which the agro-climatic analysis is undertaken. Thus, identification of the main objectives and tasks for undertaking agro-climatic analysis vis-à-vis food security prospects is undertaken in the agroclimatic potentials and constraints.

Attempt has been made to classify the country into eight classes of regions combining the principles of Agro-climatic Classifications of [2] with food self-sufficiency prospects for assessing the potentials and constraints of crop production. Thus eight classes of Agro-Climatic Belts are identified in this paper, based on reliability of the rainfall for rain-fed agriculture, on length and dependability of the crop growing period, and susceptibilities of the area to climate anomalies such as the ENSO phenomena to facilitate analysis of potentials and constraints. Out of the eight classes of agro-climatic belts, three classes (Class 1, Class2 and Class 3) are identified as more dependable for sustainable crop production, and thus can become surplus food producing areas, with the necessary agricultural input. However, it is important to note that population factor may become an important factor to determine whether an area is going to be a surplus producing area or not. Consideration of climate variability indicates that one of the three classes in this group (Class 2) is highly sensitive to ENSO (El Nino and Southern oscillation phenomenon) and thus may experience food insecurity as the result of crop failure due to inadequate distribution of rainfall during the growing season in ENSO episodic years. This is an example of an area, which is food sufficient to food surplus during normal years, but can become critically food insecure during ENSO years.

Four classes (Class 4, Class 5, Class 6, Class 7) are identified as highly susceptible to high inter-annual variability of the annual rainfall and thus different types of rainfall harvesting technologies including river diversion have to be devised to decrease food insecurity over these areas and possibly make some of them food sufficient to food surplus regions, where as Class 8 is normally not a crop growing area, except over places near the banks of rivers and the major occupation of the people over these areas is pastoralism.

In general, Agro-climatic analysis of a country cannot be complete unless it considers the instabilities, which may lead to a change, resulting in the degradation of an agro-climatic system. More-over, future projections in food security prospects must take into account of the changes and the variabilities that could occur over a given agro-climatic zone. Thus it should be stressed that agro-climatic systems are not fixed and they can become unstable due to various natural and man-made factors. The major causes of these instabilities can be ascribed to deforestation, land degradation, desertification, Global warming and Climate change. Instabilities exhibited over a given agro-climatic zone may sometimes become irreversible resulting in changes which may necessitate land use changes, i.e. changes in crop types to be cultivated.

Major Tasks and Objectives

The major objective of agro-climatic analysis of a country should be to facilitate agricultural planning at the national, regional and if possible at woreda levels so as to contribute for the improvement of land use planning, for better and sustainable crop production and quality, for improved conservation and rehabilitation, for higher agricultural incomes and more efficient use of agricultural inputs. For example, greater agricultural inputs can be allocated to areas of high potential and marginal land can be taken out of production and allocated for conservation. Agricultural activities can be linked with rehabilitation works over transitional areas where there is a problem of degradation of the Agro-climatic system. Conservation strategies can be linked with sustainable agricultural activities over moisture surplus agro-climatic zones. In general, Agro climatic and Agro-ecological analysis over a country vis-à-vis food security prospects must address the following major tasks (http://www.fao.org):

- Identification of the potential food-deficit areas that cannot attain self-sufficiency.
- Identification of areas, with high production potentials, which could provide food for, or support people moving from, food-deficit areas.
- Identification of crops, which are best, suited to the soil and growing conditions that exist in different parts of the country.
- Identification of areas with the best prospects for expanding production including cash crops.
- Assessing the need for the development of rain-fed and irrigated land resources over specific areas.

- Assessment of the levels of farming inputs and soil conservation needed to be developed to meet specific targets for sustainable self-sufficiency and crop exports.
- Assessment of the amount of production and land that will be lost if adequate soil conservation programmes were not implemented.
- Identifying research priorities and areas where current research findings should be safely applied.

Moreover agro-climatic and agro-ecological analysis, when combined with population data input can be used to address the following major tasks:

- The areas where population-planning program is most urgently needed.
- Assessment of the future requirements for seed, fertilizer, pesticide and agricultural input to meet future population demands.

Undertaking more refined activities for each agro climatic zone based on the above tasks, can follow to assess and design strategies for national food sufficiency targets. These include determination of potential production of food and cash crops for crop growing agro-climatic zones, identification of degradation hazards and conservation requirements for the most critically affected agro-climatic zones, determination of potential population supportive capacities of administrative areas, identification of self-sufficient and food deficit areas under different levels of input assumptions and identification of the major constraints to food self-sufficiency and the alternative strategies to overcome these. (http://www.fao.org)

In general, the first task of an agro-climatic analysis vis-à-vis food security prospects over a given area should be to examine the length and dependability of the crop growing period, reliability of the rainfall for rain-fed agriculture and the susceptibilities to climate variabilities and drought and the sensitivity to ENSO phenomenon so as to develop suitable strategies for assuring sustainable crop production.

Agro Climatic Potentials and Constraints

Assessment of agro-climatic potentials and constraints can help in identifying potential food deficit areas and areas of high production potentials and their susceptibility to food insecurity by taking into account of information on the reliability of the rainfall for rain-fed agriculture, on length and dependability of the crop growing period, and susceptibilities of the area to climate anomalies such as the ENSO phenomena.

In the Agro-climatic classification of Depau and Breuggman, there are 14 broad growing period zones over the country. However, we have found that some of the zones can be grouped together from the viewpoint of identification of suitable strategies and policy perspectives for food security. (Please refer to Appendix 1 for understanding how the grouping is done), and in this way we have identified eight classes of agro-climatic belts, which can be used for this analysis.

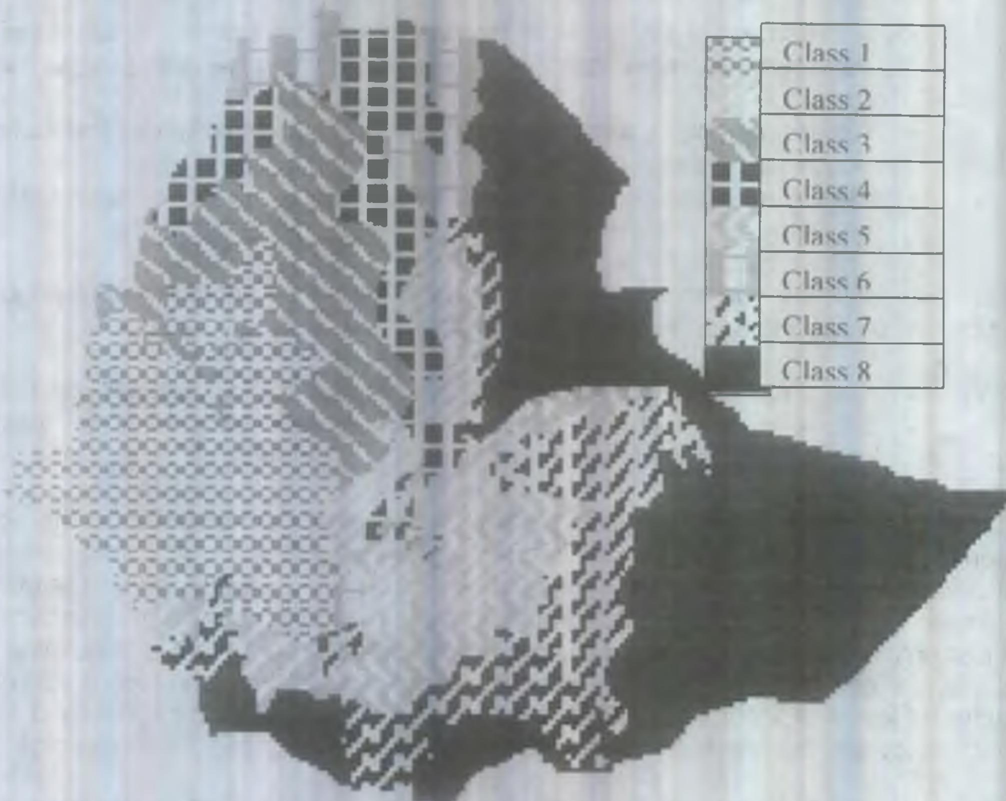

Figure 1: Agro-Climatic Belts Based on the Rain-fed Crop Production Scenario and Supplementary/Full Scale Irrigation Need.

Class One: Areas, which, in average conditions, are characterized with single dependable growing season and adequate for long cycle crops and which can become food self sufficient to food surplus regions, where the reliability of the annual rainfall is much larger as compared with the other parts of the country though uneven temporal distribution of the rainfall in the rainfall season may be the main problem to be overcome. The areas with the highest relative bio-mass productivity based on rain-fed agriculture are found in this class. (See Relative Bio-mass productivity map, Figure 4 in Appendix I).

Class Two: Double rainfall season areas where from the long-term point of view (in average conditions), both seasons are dependable and areas where both seasons show the tendency of merging and thus are suitable for long cycle crops and thus which can become food sufficient to food surplus producing areas.

However, they are susceptible to climate variability problems during El Nino and La Nina episodic years and may face food security problem during episodic years. It is important to note that if the frequency of the occurrence of ENSO episodic years increases, these areas would be bound to be susceptible more to food security problems.

Class Three: Areas, which, in average conditions, are characterized with single dependable growing season and adequate for medium cycle crops, which can become food self sufficient to food surplus regions, but which are also affected by climate variabilities which usually results in the shortening of the crop growing period.

Class Four: Areas, which in average conditions, are characterized with single dependable growing season adequate for short cycle crops only and which may face crop failure, due to the occurrence of a dry spell of a few weeks and/or a delay in the onset and/or early cessation of the rains or a degradation in the water holding capacity of the soil, which are thus susceptible to food insecurity problems.

Class Five: Two growing season areas, which, in average conditions, have a dependable growing period in one of the seasons and require supplementary irrigation in the other season for crop production and thus face food insecurity risks over some years, unless greater inputs are applied.

Class Six: Single growing season areas, where the growing season is not dependable and thus which may depend on supplementary irrigation for sustainable crop production.

Class Seven: Two growing season areas, where, in average conditions, both seasons are in-adequate, and thus which require supplementary irrigation in both seasons and thus may face chronic food insecurity risks with rain-fed agriculture.

Class Eight: No growing Areas, where from the long-term point of view, the length of growing period is too short to be sufficient for crop production without the utilization of full-scale irrigation and thus which for survival must buy their crop need from the market with business as usual scenario.

Out of the eight major classes, most of the areas under class 1, class 2 and class 3 can be included in the food self-sufficient category and may become surplus food producing areas, if the necessary agricultural inputs are assured, however it is important to note that population factors including population growth rate, the labor ratio engaged in agricultural activities and agricultural productivity can become important limiting factors. Areas in class two are greatly affected during ENSO episodic years, which thus may limit their potential as food surplus producing areas from the long-term point of view. Most of the areas in Class one and Class three are areas where there is surplus moisture and thus have more capability of turning to surplus food producing areas and can be categorized as green belts of the country where environment friendly agricultural activities should be greatly encouraged and intensified. Climate variability problems over these areas are usually associated with the shortening of crop growing period in the case of the occurrence of shortage of rainfall and/or the occurrence of a few weeks of dry spell and/or late onset and early cessation of the rains resulting in the decrease in the production of long to medium cycle crops. Strategies of minimizing impacts of climate variability should be examined over these areas, so as to minimize the loss in agricultural production during years of inadequate rainfall. For example, building rainfall harvesting structures may be considered as important in these zones to counteract the problem of the occurrences of dry spells during critical growing phase of crops, however, here, it may not be necessary to use the same type of rainfall harvesting closed structures used for moisture deficit agro-climatic zones where moisture loss through evaporation is considered as the major problem. In contrast these areas are characterized with less amount of evaporation, which may indicate the sufficiency of open rainfall harvesting structures. However, other environmental effects should be examined here such as the impact on malaria incidence when these types of open structures are built.

Areas under class 4 and class 5 usually suffer the problem of climate variability and thus experience both years of good harvest and years of crop failure due to the high variation of the rainfall from year to year, but where improvement of crop production can be achieved by using different types of closed rainfall harvesting structures to minimize evaporation loss and by choosing or developing a suitable type of crop variety plus the use of seasonal weather forecast for determining agricultural inputs over these areas.

Areas under class 6 and class 7 are areas where susceptibility to food insecurity is high and chronic due to climate characteristics and variabilities, land degradation, impact of climate change due to Global warming and thus require further inputs in the form of supplementary irrigation, higher inputs in the form of rainfall harvesting technologies etc. and may need river diversion operations for sustainable crop production and conservation and rehabilitation measures should be incorporated for attaining sustainable crop production. Moreover the high variability of the rainfall from year to year can also play on the memory of the farmer over these areas. For example, if there are years (probably once in four years or twice in five years), when the seasonal rainfall becomes above average and thus becomes sufficient for crop production in one of the seasons or sometimes in both seasons. The danger is when the farmer expects this type of scenario every year over these areas. Thus it is important to stress the importance of making supplementary irrigation technologies sustainable over these areas. Improved seasonal meteorological forecasts can become vital over these areas for identification of priorities in the type of agricultural input needed, for the identification of crop type to be cultivated and for the proper management and conservation of soil moisture at the start of the growing season. Critically affected areas in terms of land degradation, exhaustion in terms of soil minerals due to drought induced wind erosion are usually also found over these areas. There are also areas, which are already turning to no growing zone and proper study is needed to come to the decision of determining whether a specific area should be taken out of agricultural production and be assigned for rehabilitation programs, hand in hand with conservation projects to be undertaken by the people living over these areas.

Class 8 is a no growing zone where high temperature and high evapo-transpiration demand with low rainfall amount is inadequate for rain-fed agriculture in most years. Normally, these are livestock areas inhabited by pastoralists and their need for food crop is met through the market where they usually trade livestock and their products. Strengthening of the market relation between these areas and nearby surplus crop producing areas can be an important tool for ensuring food security over these areas. Various methods of conservation of vegetation cover should be undertaken here to address the problem of desertification. Some areas under Class 8 can become crop growers depending on the type of the soil and the amount of evapo-transpiration demand of the atmosphere, using full-scale irrigation through river diversion and probably, considering the influence of market forces, it may be preferable to cultivate cash crops like cotton. The major problem of denudation of land and overgrazing over these areas should be addressed with out which the risk of desertification would become a serious problem.

Vulnerability of Agro-Climate Systems

The major agro-climatic instabilities which should be considered as the challenges for food self sufficiency at the national level are the results of climate variabilities in the form of drought, floods and the occurrences of dry spells and climate change in the form of Global warming and the increased occurrences of extreme weather events. Thus it is necessary to tag Agro-climatic resource assessments with long-term climate outlook projections.

Climate change study undertaken shows that, there is an indication of a clear trend of a decrease in the annual rainfall amount over the northern half of the country and over the south-western parts of the country. Furthermore in the last 50 years these studies indicate that, the annual average minimum temperature over the country has been increasing by about 0.2^{0}C per decade. The warming period indicated over the country for the last fifty years shows that the average annual minimum temperature over the country has been increasing by about 0.25^{0}C every ten years while average annual maximum temperature has been increasing by about 0.1^{0}C every decade. Climate change scenarios done for different parts of the country indicate that there can be reduction in the crop maturity period for rain fed agriculture there by resulting in a decrease in agricultural yield. Thus, increase in mean annual temperature leading to increasing evaporation rate and a decrease in the rainfall amount clearly shows the unreliability of rain-fed agriculture over the drought prone areas of the country. Moreover this may lead to more requirement of irrigation water and thus conservation of soil moisture and proper management of water may become increasingly crucial in the future.

Climate variability studies undertaken have indicated that the rainfall in the summer or Kiremt season of June to September over significant parts of Ethiopia is greatly affected by the ENSO events. The influence of ENSO episodic conditions on rainfall variability over Ethiopia has been discussed and investigated by different researchers. The immediate use of this knowledge is bound to be related with the improvement of seasonal weather forecasting. The other important issue is however, to develop long and short-term development planning options based on the available knowledge of the influence of Global and regional teleconnection patterns over rainfall variability in Ethiopia. Recently increasing evidence has started to emerge that the investigation of the influence of Global ENSO events over Ethiopia is best understood by considering each rainfall season separately and by finding homogeneous rainfall regions, which have similar response to the teleconnection signals in terms of rainfall anomaly.

Rainfall anomaly analysis for the February to May rainfall season shows that in general, areas along the rift valley, the escarpments and to the east over the country are likely to be affected negatively (high probability of below normal rainfall) during strong Lanina years and positively (high probability of above normal rainfall) during strong Lanina years. In contrast, ENSO signal is weaker over the southwestern parts of the country (T.Gissila, 2001).

Principal Component Analysis of the February to May standardized rainfall anomaly indicates the possible existence of dipole areas during this season between the western and eastern parts of the country. Time series of analysis of simple arithmetic mean of the standardized rainfall anomalies over a group of stations over the south-western parts of the country and the central including the eastern parts indicates that there are years, which show this dipole tendency (T.Gissila, 2001).

Similarly, analysis of June to September rainfall season shows that different parts of the country show different sensitivities to the ENSO teleconnection, which may indicate different planning options for different parts of the country during strong episodic years.

Thus one possible recommended agricultural planning option for strong la Nina years encompassing both seasons, would be to encourage long cycle crops, which can be planted in March/April so that maximum water requirement of the crop would coincide during the June to September rainfall season period. In contrast, during strong El Nino years encompassing both seasons, the possible recommended, planning option would be to encourage short cycle crops (two to three months) for crops planted during March/April, since the characteristic of the June September rainfall season would be more uncertain during strong El-Nino years. It is important to note that this is a very simple model where as in reality there are more complications due to locations of sea surface temperature anomalies over the adjacent Indian Ocean so that close monitoring of atmospheric and Oceanic conditions would be the only option during the growing season in ENSO episodic years so as to minimize the impacts of the of the anomalous behaviour of the rainfall distribution.

In general, during any episodic year of El Nino and La Nina years, some part of the country would experience drought, where as in some episodic years, we may observe opposing tendencies between the eastern and the western half of the country.

Conclusions and Recommendations

In general, identification of priority areas to achieve food self-sufficiency should be the result of comprehensive assessment of the agro-climatic potentials and constraints including the variabilities and instabilities that can occur over a given agro-climatic zone. This requires the development of food security programmes over three major areas of the country, namely the moisture surplus regions, transitional sub-humid zones and over the drought prone areas including marginal degraded lands. Moreover long-term climate projections should be judiciously used so as to determine future impacts of climate change on crop production, so as to develop adaptive strategies.

The need for encouraging the *increase of food crop production over moisture surplus areas* should be the first priority to attain national food self-sufficiency (For example over areas in Class 1 and Class 3). However it is important to note that the pace should be synchronized with conservation activities as the soil is a limited quantity and thus care should be taken not to repeat the same mistake of land and soil degradation, which occurred over the drought prone areas of the country.

The need for developing suitable food security strategy over areas, which are normally food sufficient to food surplus during years of normal atmospheric circulation patterns, but which become food insecure during ENSO episodic years should be one area of research (For example areas in Class 2). One possible option over these areas would be introducing *agricultural insurance practices* as these areas are supposed to be food self sufficient to food surplus areas over the majority of the years. However, as these areas are food self sufficient to food surplus regions during the majority of the years, they may also be characterized with high population density, which can make the problem more complicated and more critical.

The need for making transitional zones (areas over Class 4 and Class 5) to greater level of food self-sufficiency in the long run should be the long-term policy option, where the use of *supplementary irrigation technologies* can sustainably be applied. However, climate variability issues have to be addressed well and the use of seasonal weather forecasts may become important over these areas to minimize the uncertainties in the use of agricultural inputs, that is whether to determine high or low agricultural input.

Rehabilitation of marginal lands so that in the long run they can become agriculturally productive should be the other option to be undertaken over the chronically drought prone areas of the country (Class 6 and Class 7). In general, diagnosis of the problem of degradation and change that has occurred over a specific agro-climatic system on a given area should be a priority area of research so as to develop different adaptive strategies. The main type of agro-climatic change to be examined is the shortening of the crop growing period and this can happen either when there is an increasing trend in average temperature or a decreasing trend in the expected normal rainfall or when there is a decreasing trend in the water holding capacity of the soil as the result of land degradation. What usually occurs is that a farmer in such an area would try to continue cultivating the same crops as if nothing has happened though facing more hardships in the form of crop failures and it is here that adaptive strategies play a greater role for lessening the impacts of the agro-climatic changes that could happen over a given place.

There is a great need for the formulation of *adaptive strategies tailored for the type of agro-climatic change that is exhibited over a given area*. Some of the propositions given to be used for adaptive strategies for marginal transitional areas where climate variability and climate change and land degradation have become a serious problem include development of drought tolerant varieties, breeding of early or extra early maturing genotypes, educating farmers on effective low input soil and water competition practices such as conservation tillage, educating farmers to plant in low population densities so as to reduce competition for scarce or limited soil moisture, farm level adaptations such as shift in planting dates and modifying the amount and timing of fertilizer application, changing cropping sequences etc. Shifts in production patterns may be advisable where replacement of maize by sorghum or cowpea is possible, since these can withstand drought conditions better than maize. Others suggest the importance of mixed farming, because, whenever there is an indication of crop failure, the farmers should not wait for the millet or sorghum to set seeds but cut the crops in their green stage and convert them to either hay or silage to feed the livestock which would serve as a source of income for the farmers to purchase food and other needs. Moreover, the other important value of mixed farming is that the cereals would benefit from the manure produced by livestock.

Policies to set up *more efficient irrigation systems* such as drip and micro-spray techniques in drought-prone areas to make efficient use of limited water available for irrigation needs should be explored. However, it is important to note that an adaptive measure may not lead to sustainable production. For example, using irrigation as an adaptive measure may lead to soil salinization. In general, artificial modifications of the agro-climatic system to increase crop production should be explored more in the future though some may be currently expensive. Rainfall enhancement through cloud seeding is one important option, which can be considered as an area of research in the future.

The basis for long to medium term agricultural planning options, both for moisture surplus and moisture deficit regions, should be the *development of a good data base on agro-climatic information* for different agro-climatic zones. The assessment of frequency and probabilities of dry spell occurrences over specific areas during the growing season can be used to determine the mode of utilization of rainfall harvesting schemes. For example, the most frequently occurring length of dry spell in the growing period at a particular area can be used to determine the size of rainfall harvesting structures. Inventory of soil type and texture in terms of water holding capacity for a given area is informative on the likelihood impacts of short dry spells of a few weeks in the midst of a wet growing season on the crop. Assessment of reliability of growing season onset rains can be informative for determining planting risk. Determination of drought probability at a given place can help to design short, medium and long-term drought planning activities. Determination of irrigation requirements for different crops over moisture deficit areas using agro-climatic information of the place can be vital for efficient use of water. Moreover, periodic updating of agro-climatic classifications of the country with the most recent agro-climatic data is important for detecting newly emerging agro-climatic changes. Ethiopia's economy mainly depends on agriculture, which is very sensitive to climatic variations. A large part of the country is arid and semi arid and is highly prone to desertification and drought. The country has also fragile highland ecosystems, which is currently under stress due to population pressure. Forest, water and biodiversity resources of the country are also climate sensitive. Thus a strengthened agro climatic monitoring network is important for the existence of a sound agro-climatic information database to be used for identifying priorities, which will be used in the development of sustainable agriculture.

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Appendix I

Figure two shows the fourteen Agroclimatic broad growing zones according to De Pauw, E. and Bruggeman, H.Y., 1988. In the grouping done for this work, Growing period zone S5 and

Growing period zone S6 are grouped under Class 1, which can represent greatly moisture surplus areas suitable for long cycle crops, and also less susceptible to climate variability problems. D4, D5 and D6 and D7 are grouped together under Class 2, considered as potentially food surplus producing areas, which contain as well moisture surplus areas. However, these are vulnerable to food insecurity during ENSO episodic years and which thus may require a different strategy such as agricultural insurance practices, Food Bank etc for bad years of climate anomaly and changing cultivation practices during years of climate anomaly. S4 is taken as Class 3, where climate variabilities are usually associated with the shortening of the crop growing period and thus which may require a separate strategy, but which also contains moisture surplus areas. S3 is taken as Class 4, which though characterized with short dependable growing season and suitable for short cycle crops, is vulnerable in the case of the occurrence of a few weeks of dry spell and thus which may require rainfall-harvesting technologies as supportive measures to assure sustainable crop production. D3 is taken as Class 5, though characterized with one dependable growing period can become a potentially food surplus area with the application of rainfall harvesting technologies in the second season but also contains areas highly susceptible to climate variabilities characterized with higher incidence of drought (See figure 3, drought probability map over Ethiopia). S1 and S2 are grouped together under Class 6, highly vulnerable to climate variabilities, drought and food insecurity and where the use of supplementary irrigation is necessary for sustainable crop production. D2 and D1 are grouped together under Class 7, where the use of supplementary irrigation is an important option for improving crop cultivation. Some of the areas under this class are also highly susceptible to climate variability in the form of drought. N Growing zone is taken as one class, Class 8, where the length of the growing period is not adequate for crop production in most years.

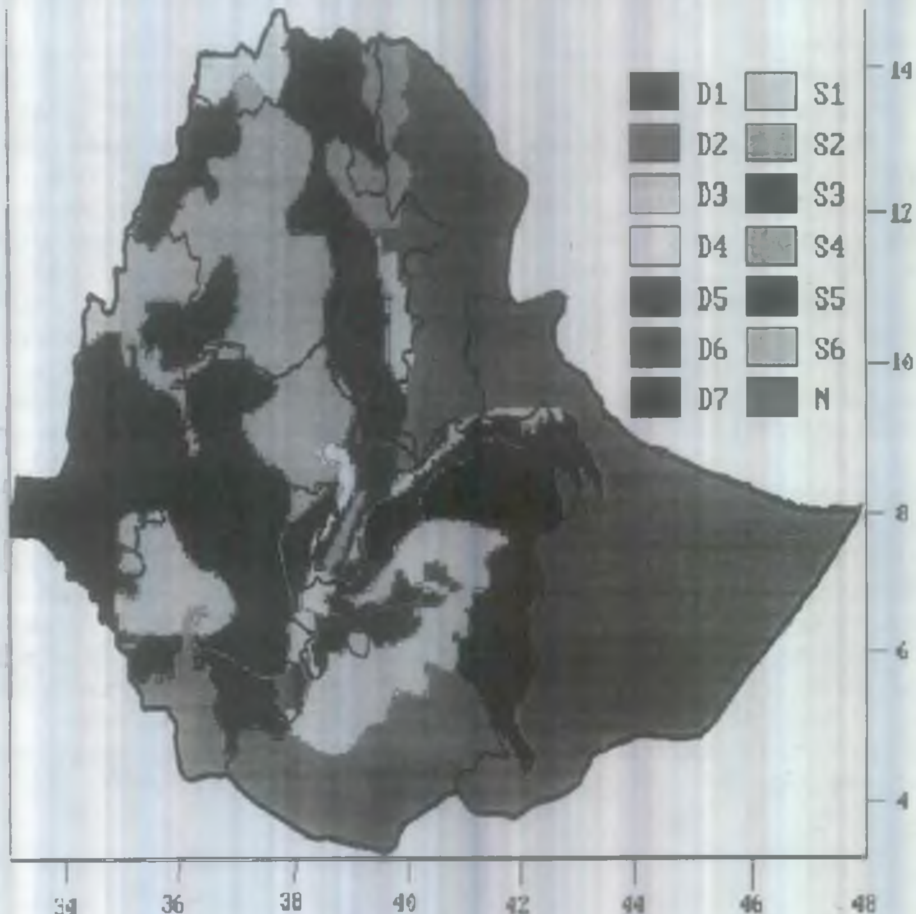

Figure 2: Broad Growing Period Zones

Growing Period Zones Description

N: - No growing period in most years due to short length of growing period.
S1: - Single and short growing period, inadequate, supplementary irrigation is needed.
S2: - Single growing period, short, supplementary irrigation is desirable.
S3: - Single growing period, adequate, for short maturing crops.
S4: - Single growing period, adequate, for crops with medium cycle to maturity.
S5: - Single growing period, adequate for long maturing crops.
S6: - Single growing period, adequate for long and very long maturing crops, less suitable for annual crops.
D1: - Two growing periods, neither is adequate, supplementary irrigation is necessary.
D2: - Two growing periods, neither is adequate, supplementary irrigation is desirable.
D3: - Two growing periods, the first can be considered adequate.
D4: - Two growing periods, both are adequate, for rain-fed crop production in most years, but double cropping is usually unfeasible because of interference between the two growing periods.
D5: - Two growing periods per year, of which both are adequate for crop production in most years.
The second growing period is the most important.
D6: - Two growing periods, both are adequate. The first is important.

D7: - Two growing periods, both are adequate; including areas in which the two growing periods merge into a single long growing period.

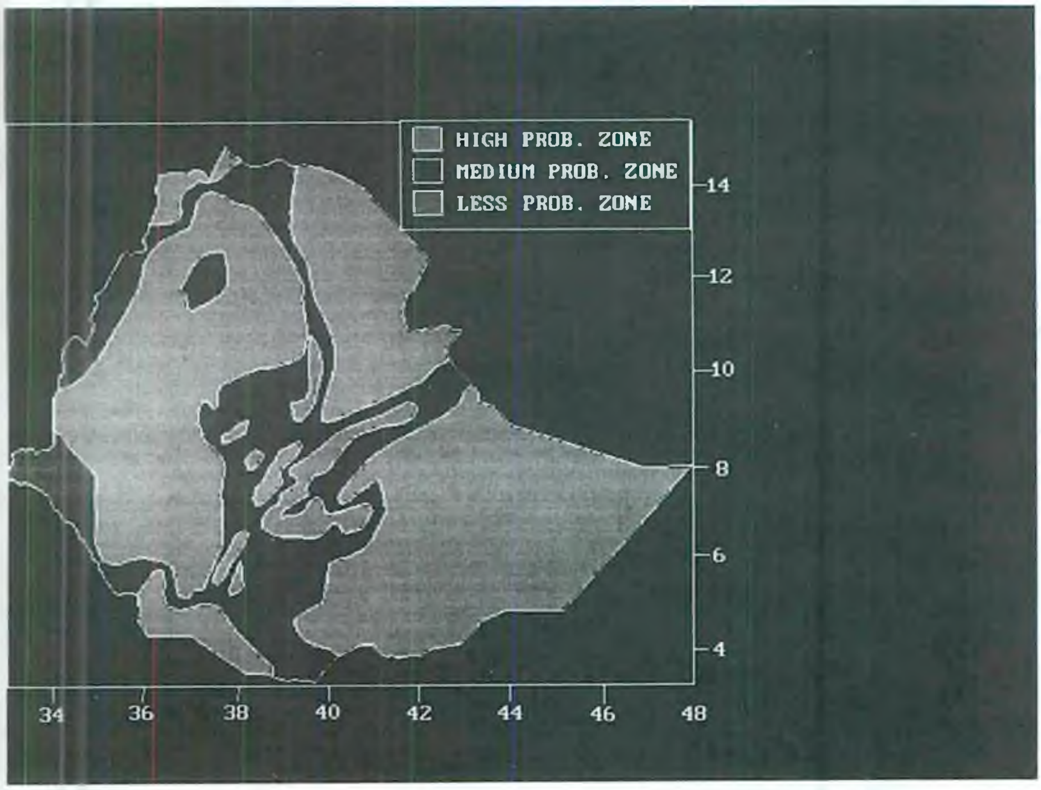

Figure 3: Drought Probability Map

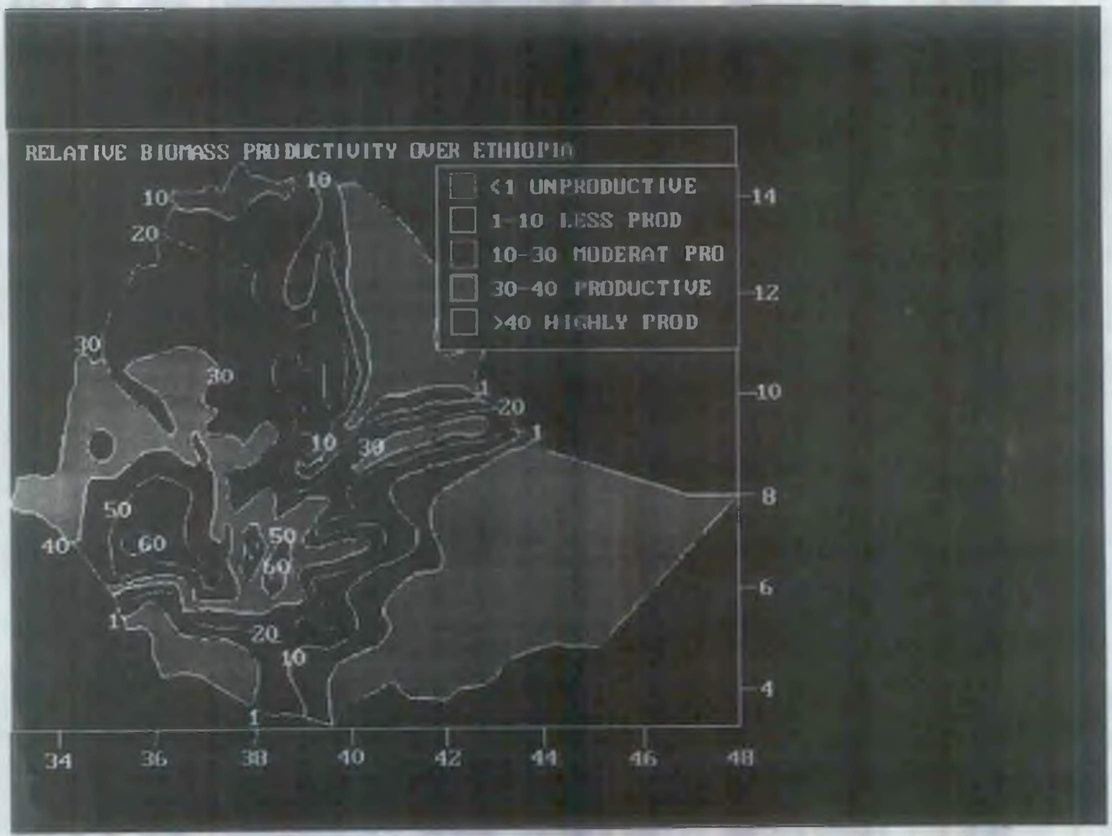

Figure 4: Relative Biomass Productivity Based on Rain-fed Agriculture

Do Forests and Trees Have a Significant Contribution to Food Security?

*Tesfai Mebrahtu**

Abstract

About 4-6 million people suffer from chronic food insecurity every year in this country. The number of acutely food insecure population can rise up to 8 million as in the case of the present crisis. A concerted effort is needed from the government, donors, NGOs and civil society to extricate people from such dire food crisis. The federal as well as the regional governments have developed policies, strategies and programs to tackle the problems of food insecurity and poverty. Land degradation was cited as one of the major causes of food insecurity in the food security program documents of Amhara, Oromia, SNNPR and Tigray regions. The main reason for land degradation is the removal of trees and forests (deforestation) from landscapes. This deforestation is still continuing at an alarming rate and little effort is being made to replace the removal of trees. Trees and forests have direct and indirect benefits for farming households which contribute significantly to their food security situation. The roles of trees and forests towards the effort in improving food security will be reviewed with respect to the three aspects of food security: food availability, food access and use & utilization of food. Agro-forestry has been given due consideration in the food security and rural development strategies as well as the food security programs of the four regions. The other areas of forestry development and management are left for the regular intervention activities of the Ministry of Agriculture. Assuming that enough resources are allocated for agro-forestry, the practice of agro-forestry is faced with a major stumbling block. This stumbling block is the free animal grazing culture in most if not all parts of the country. This issue will be discussed in detail.

1. Introduction

The number of people suffering from food shortages is ever increasing reaching as high as 14 million in the current year. Food aid requirement up to the end of the year is estimated as 1,553,096 tons including cereals, blended food, vegetable oil and pulses [8]. The food shortage will continue to haunt millions of people for the coming many years. A recent prediction by USIAD/FEWS indicated that the current Meher season crop production will be better than last year, but would not obviate food aid for 8-10 million people [1]. Considering the severity of the food crises, the Government of the Federal Republic of Ethiopia has taken the task of extricating the country from dependence from food aid as its main objective in its development objectives [4]. Strategies have been developed to promote development and assist the people who suffer from food insecurity. These strategies include the National Food Security Strategy [6], the Rural Development Strategy [5] and the Sustainable Development and Poverty Reduction Program among many others. Implementation of new programs based on the strategies is underway.

The main objective of the paper is to analyze the roles of trees and forestry in the effort towards alleviating food insecurity and poverty of millions of rural households. The potential contribution of trees and forests to household food insecurity will be discussed. The significance given to forestry in terms of strategy development, program design and resource allocation will be examined in the paper.

* GTZ/Food Security Capacity Building Project.

2. Food Security

Food security is defined as "access by all people at all times to the food needed for an active and healthy life". The definition embodies the three aspects of food security: availability, access and food use & utilization at individual, household, regional and national level. People may suffer from either temporary food insecurity or chronic food insecurity. Temporary (acute) food insecurity arises from failures in food production, markets, income due to seasonal shocks, while chronic (structural) food insecurity exists because of inadequate food production and income because of poverty. Food aid is an instrument to assist people during acute food shortages (emergencies) while chronic food insecurity has to be overcome through long term development efforts.

According to the Central Statistics Authority (CSA) 2000 Demographic and Health Survey, 52% of the children under five were stunted indicating the severe chronic food insecurity in the country [6]. The main reasons for food insecurity are:

- Severe land degradation
- low input agricultural systems
- Lack of capital for investment
- Poor rural infrastructure
- Inadequate and erratic rainfall
- Small land size and fragmentation
- Low level of private investment
- Low off-farm employment

Note that land degradation is considered as one of the major causes of food insecurity in Ethiopia. Land degradation is a result of the removal of natural vegetation for different purposes and because of various reasons. Annually up to 200,000 hectares of high forests are converted to other land uses in Ethiopia causing massive soil erosion [7]. Soil loss from the country is estimated at 2 billion tons per year resulting in loss of productive land [3]. This deforestation is continuing un-abated which further accelerates land degradation and consequently food insecurity. Soil erosion also removes fertile areas from production because of gully formation. The short life of the dams constructed in the country is because of accumulation of silt which is a result of deforestation. It is not in fact the cutting of trees and shrubs, but the failure to replace the vegetation removed through planting or natural means that is detrimental to land degradation. Trees and forests can be utilized properly for the benefit of the rural people as far as the utilization is combined with development and management in a sustainable way.

The strategy for Ethio-German co-operation in the priority area of "Sustainable Utilization of Natural Resources for Improved Food Security" underlines the fact that the inadequate management of natural resources is the major cause of wide-spread chronic food insecurity in the highlands of Ethiopia. That is why restoration of the natural resources basis is considered as the main objective of improving food security in the three regions of Ethiopia included in the cooperation.

3. Contribution of Forests to Food Security

3.1 The Sector

The forest cover of Ethiopia is dwindling from year to year. The remaining forest area of the country has gone down from 40% in the 1950s to as low as 2.7 % in the late 1990s [10].

Many countries have utilized their forest resources to build their economies and still depend on the sector for the improvement of the livelihoods of their citizens. It is unfortunate that Ethiopia has not used the sector to build its economy in a significant way. The main reasons for this alarming rate of deforestation are:

- Conversion of forestland to agriculture and other land uses
- Cutting of trees without replacement to satisfy the demand for firewood, charcoal, poles and construction
- No sufficient planting programmes
- Non existence of forest and land use policies
- Improper implementation of the proclamations on forests
- "No man's land" attitude towards forests

There is consensus in the forestry community that the forestry sector is not contributing its share in the national economy as well as livelihood of the rural people. This is attributed to the low regard given to the sector by the government. The contribution of the sector to the national economy has not been properly studied and could be one of the reasons for the neglect of the sector. The estimate of 2.5 % contribution to the GDP between the years 1981/82 and 1991/2 has underestimated the contribution of the sector to the national economy [11]. The frequent changes of the institutional set up of the sector, the downsizing of the forestry institution to a team level and negligible allocation of budget are some indications for the neglect of the sector by the government. The neglect and alarming rate of forest destruction has resulted in the:

- Destruction of the remaining forests
- Acute shortage of forest products particularly firewood
- Land degradation due to soil erosion
- Loss of valuable plant species which could provide a diverse set of benefits to the communities and the country
- Loss of biodiversity
- Extinction and loss of wildlife due to habitat loss
- Loss of interest of professionals to work in the sector

The neglect of the sector has always been a discussion point in many of the workshops/meetings related to forestry. The participants of the annual meeting of the Ethiopian Foresters' Association which was held between 14 and 15 January 2001 passed a resolution at the end of the workshop regarding the actions to be taken in order to revitalize the sector for the benefit of the people and the country [9]. The first resolution called for relentless effort to the public and policy makers using the mass media and other public events. The resolution also included actions that should be taken to minimize forest destruction, increase wood supply, encourage private investment, enact forest policy, improve institutional arrangements and integration of the sector in sectoral policies and programs.

It should be noted however, that there are encouraging signs towards the awareness of the problem of the sector. Here are some encouraging trends:

- *The institutional reforms in the Amhara, Oromia and Tigray regions.* New organizational structures have been developed for natural resources and forestry and are separated from Bureaux of Agriculture in Amhara and Oromia regions.
- A workshop was organized by IBCR on the problems related to the sector in March 2003. The workshop was attended by about 30 members of the Rural Development Standing Committee of the House of Peoples' Representatives, research institutions, higher learning institutions, and participants from federal and regional offices.
- A second workshop was organized by the Rural Development Standing Committee of the House of Peoples' Representatives and held at the Parliament Hall, which was

attended by many of the members of the parliament. Issues on history of forestry, deforestation, uses of forests, forest policy and proclamation, research, education, institution, budgeting, wildlife and experiences of Amhara and Oromia regions were discussed. The workshops have given ample opportunity to the members of the House of Peoples' Representatives to familiarize themselves with all issues related to the sector. The members vowed to do their best in awareness creation to their constituency as well as support to the development of appropriate policies and resource allocation to the sector.

- Participatory forest management approaches are being tested in Oromia region with the support of GTZ, Farm Africa, SOS Sahel and Ministry of Agriculture. These different approaches acknowledge the importance of participation and benefit sharing with the communities as the entry point to forest protection and development. The GTZ assisted approach known as WAJIB which is being tested in the Adaba-Dodola Regional Forest Priority Area has already received acceptance by the Oromia regional government and there are plans to test the approach in two other Regional Forest Priority Areas.
- The enclosure management effort in the Tigray region has increased vegetation cover of the different areas and is a widely accepted approach by the communities. Adoption of such management in other areas will undoubtedly improve the vegetation cover of the country.
- There is an increased coverage of the problems of the sector in the mass media.

3.2 Contribution to Food Security

The potential benefits of forest and non-forest products to household food security are presented in relation to the three aspects of food security discussed above.

a) Contribution to Food Availability

- Leaves, roots, tubers and fruits/seeds serve as food for many communities in Ethiopia. Examples are Beles (*Opuntia indica*) in the northern part of the country and leaves of Shiferaw (*Moringa* spp.) and mushrooms in the southern part of the country. Fruits/seeds of many woody plant species contribute to the vitamin and mineral requirement of the population. Examples are fruits/seed of wanza (*Cordia Africana*), gaba (*Zizyphus* spp.), dokma (*Syzigium africanum*), eshe (*Mimops kummel*), sholla (*Ficus sur*), koshim (*Dovialis abyssinica*) and enjori.
- Edible oil can be extracted from seed of *Balanites egyptica.0*
- Wildlife from forests are traditionally hunted and eaten in many parts of the country
- Forests protect soil from erosion in the upper catchments which otherwise washes productive agricultural land
- Trees growing and planted in different settings are a good source of forage for animal seeds. The legume trees and shrubs are a source of high protein and nitrogen forage.
- Legume trees enrich the organic matter and minerals of farmlands
- Farmers need the forests to prepare their farm tools
- Forests regulate stream temperature making it favorable for fish

b) Contribution to Income

- Farmers get income from sale of fruit/seeds of shrubs and trees (wanza, gaba, dokma, eshe, enjori)
- Income from sale of bamboo sticks, firewood, charcoal, poles and sawn timber
- Income from sale of forest honey

- Income from sale of spices (e.g. Korerima, ginger) and wild coffee
- Wages from employment in wood industries
- Income from the sale of and employment in collection and processing of gum Arabic and incense
- Income from eco-tourism related activities when the eco-tourism industry is well developed
- Income from sale of Civet musk
- Income from sale of fur from animals
- Income from sale of essential oils

c) Contribution to Food Use & Utilization

- Medicinal values, e.g. kosso (Hygenia abysinica) and Tikur enchet (*Pygium africanum)*
- Energy for cooking of food
- Purification of water, e.g. *Moringa* spp.
- Seed of *Balanites egyptica* and *Phytolacca dodecandra* kill snails which are intermediary hosts bilharzias. Chemical for malaria control are also being formulated from *Phytolacca dodecandra*

Although trees and forests provide a diverse source of food and income, there is no systematic effort to develop and utilize them to maximize the benefits towards the effort of alleviating household food insecurity.

3.3 Potential Significance of Forestry

Hundreds of thousands of people in the country are using forest and non-forest products for their livelihood. This fact combined with the availability of the resources in different parts of the country indicates the huge potential available in the sector. There are also for opportunities for the development of specialization in the different areas. For example, the western part of the country can specialize in bamboo while the central parts of the country can specialize on eucalypt for energy and poles.

This potential can be realized if concerted efforts are made in the reduction of rate of deforestation as well as the processing and manufacturing technologies for better use. The development of plantations for different purposes should assist towards this effort.

4. Review of The Strategies and Programs in Relation to Forestry

4.1 Regional Food Security Programs

The regional governments of Amhara, Oromia SNNPR and Tigray developed their food security program based on the 1998 food security program of the federal government. The programs were not implemented as planned because of lack of financial commitment from the donors. However, some regions were putting effort to integrate food security interventions into programs supported from other sources.

The food security programs from 1998 are obsolete as there is a new national food security strategy developed in 2002 which will be discussed below. The food security programs are expected to be adopted from the new national Food Security Strategy and the national program to be developed. Any way, the earlier program design from 1998 is a good indication of the importance given to forestry. The allocation for forestry by Amhara, Oromia, SNNPR and Tigray regions was 1%, 17%, 4% and 8%, respectively, of the total allocation for the programs. The allocation for Oromia and SNNPR was for natural resources management and the allocation for forestry could not be determined from the documents. It was obvious that most of the allocation for the forestry was for the area of agro-forestry. The Amhara program covers many aspects of forestry including agro-forestry, plantations, incense and gum and land use.

4.2 National Food Security Strategy

A food security strategy for Ethiopia was issued in November 1996 by MEDaC. The strategy was followed by a comprehensive federal food security program in 1998 to be implemented with the support of donors. The program was an aggregation of food security programs developed by four regions. The program could not be implemented as planned for lack of adequate dialogue with the donor organizations. The program was developed a little while before the Eritrean aggression and it is understandable that the GoE was preoccupied with the war effort.

The food security dialogue took pace after the restructuring of the government in 2001. The newly established Federal Ministry of Rural Development was given the responsibility of food security. The Department of Food Security was established and staffed before any of the other bodies of the Ministry considering the urgency of the food security agenda and to revitalizing the discussion with the donors. The Department managed to issue the revised national Food Security Strategy in [6] with significant contribution of the donor community. The strategy addresses the supply and demand sides of the food equation and rests on three basic pillars.

- To increase the availability of food through increased domestic production
- To ensure access to food for food deficit households; and
- To strengthen emergency response capabilities

The Food Security Strategy has many new elements compared to the first one, but lack a system for prioritization of interventions for a given resource. The prioritization may be clear during resource allocation when the strategy is translated into a program. There is information that a committee has been established with the task of developing the food security program of the nation for the coming three years. The components of the program are household livestock packages, water harvesting, irrigation, agro-forestry, commercialization of small farms and resettlement.

Is Forestry Included in the Strategy?

The areas of natural resources and forestry (particularly agro-forestry) are mentioned in many parts of the document. The introductory part of the document clearly indicates the importance given to forestry and natural resources management as described below.

> *"A clearer focus on environmental rehabilitation as a measure to reverse the level of degradation and also as a source of income generation for food insecure households through a focus on biological measures marks a deviation from the 1996 strategy. Water harvesting and the introduction of high value crops, livestock and agro-forestry development further inform its content."*

The strategy document emphasizes the high regard to be given to agro-forestry and natural resources management in resettlement and drought prone areas. The importance of the planting of multi-purpose fruits and trees as a source of income, livestock feed and soil fertility management for drought prone areas has been included in the agriculture element of the strategy.

The communities are expected to take the greater responsibility for natural resources management in the resettlement programs. The communities will have the right to benefit from the forests by harvesting firewood, honey, medicinal plants, incense and wildlife as well as income from eco-tourism. The document did not indicate how this community management will be possible and the rights and obligation associated with the responsibility.

4.3 Rural Development Strategy

The rural and agriculture development policies and strategies of the government are based on the following major directions.

- Human labor extensive utilization approach
- Proper use of agricultural land
- A foot on the ground approach in which development should be based on the existing practice
- Compatible approach with different agro-ecological zones
- Integrated development strategy

The strategy underlines the efficient use of labor and land to achieve rapid rural development. The strategy document clearly outlined the importance of forests and planting trees. The dangers of clearing forests on steep slopes and converting them to agriculture and the need for proper land use policy have been discussed. Forests and tree planting are expected to provide economic benefit to the communities in terms of cash and animal feed. Farmers will have the opportunity to get income from selling products from the forests and plantations. Agro-forestry is the recommended approach in forestry development so that farmers get maximum benefit from the trees. The contribution of forests and tree planting to animal feed has been highlighted particularly for drought prone areas.

4.4 Sustainable Development and Poverty Reduction Program

The Federal Ministry of Finance and Economic Development issued the Sustainable Development and Poverty Reduction Program in July 2002 [4]. The program was developed after intensive consultations with communities, government officials, experts and policy makers in the whole country. The program has been developed based on the different sector strategies already developed such as the national Food Security Strategy and Rural Development Strategy which were discussed above. Therefore, the concerns and directions related to the forestry sector provided in the strategies are also included in the program.

5. Is Agro-Forestry Possible?

As discussed above, the importance of agro-forestry is acknowledged in the strategy and program documents. However, apart from the indigenous agro-forestry systems and homestead woodlots, no viable agro-forestry systems are being practiced in Ethiopia. The efforts by the extension system in the promotion of the integration of woody plants (trees and shrubs) in to the farmlands have not resulted in visible establishment of trees on the farms because of the free animal grazing.

The free animal grazing culture in which domestic animals are allowed to wander and graze/browse in the pastures and the farmlands (after crop harvest) is a major problem for the implementation of natural resources management activities including tree planting.

Animals damage physical soil and water conservation structures constructed with the investment of a substantial amount of resources and labor from the communities. The damages from the animals has necessitated the frequent maintenance of the structures which is always very difficult considering the very large number of activities communities have to be involved in. Lack of maintenance of the structures may aggravate soil erosion even worse than an un-treated area. The effect of free animal grazing is graver for the establishment of plants in farmlands and pasture. There is a common understanding these days that the construction of physical soil and water structures is not good enough for the conservation of soil and water. Experts are increasingly convinced to plant grasses, annuals, shrubs and woody plants on the structures to maximize the benefit from the structures and plants (biological conservation).

The application and practice of agro-forestry systems are recommended in areas where land holding is too small and degraded such as the highlands of Ethiopia. The practice of agro-forestry would allow farmers to improve the fertility of farmlands, the production of animal feed, wood production, and food (from woody plants) combined with crop production as farmers in the degraded highlands do not have the luxury of producing these products in different lands. It should be noted that indigenous agro-forestry systems are practiced in many parts of the country with varying success. Most farming households allow the growth of naturally growing important trees (mostly legume trees) in their farm permanently to benefit from soil fertility amendment and cutting of branches for animal fodder, fire wood or fencing. These trees were already established and not affected by animals. However, the establishment of new woody plants in farmlands and pastures had become impossible because of the pressure from a large number of animals beyond the carrying capacity of the areas available within villages. That is why it is rare to see recent woody plant integration in the farmlands although the introduction of agro-forestry was proposed by the Ethiopian Forestry Action Program and was also part of the regional food security programs.

The many questions which are raised with regard to free animal grazing and agro-forestry should be answered before one makes a conclusion whether agro-forestry systems should be encouraged. Shall we forget about agro-forestry because of the free animal grazing? How come agro-forestry is considered as a solution to food insecurity? Is it possible to convince communities changing their habits? What has to be done to change the culture of free animal grazing? Is it possible to practice integrated watershed management the proper way under free animal grazing? How are the watershed development programs supported by WFP, EU, GTZ and others possible?

Most agricultural experts and farmers express that free animal grazing is a major problem for natural resource management and believe that it would be very difficult if not impossible for farmers to change this culture. They are not even trying to discuss about this issue. However, there are recent experiences in some parts of the country in which farmers have changed this culture because of the damages caused by animals to their favored crops. Restricting animals from entering irrigable areas where forage trees are planted has been possible in some communities in Tigray. The vast enclosure areas in Tigray were possible because of the willingness of farmers to keep their animals from these areas [2]. Therefore, it is possible that farmers can confine animals in other areas so that they do not damage newly planted seedlings. Of course, this is only possible if the farmers attach higher values to the trees to be planted under the agro-forestry system chosen.

As discussed above, it will be impossible to escape from the vicious cycle of natural resources degradation, food insecurity and poverty if the free animal grazing issue is not tackled and serious measures are taken to reduce its effects on practicing agro-forestry. It should be noted here that the issue cannot be resolved with the will or cooperation of the farmers alone. The highlands of Ethiopia are overused and are currently being used by livestock beyond their carrying capacity. Farmers are facing an acute shortage of animal feed even in good rainy seasons. They are letting their animals to fetch for feed out of this desperation. Therefore, unless efforts are stepped up to improve the animal feed production, it does not make sense to talk about restricting free animal grazing. The encouragement of livestock development in the food security and rural development strategies can only be realized if animal feed production in agro-forestry and other settings is possible.

6. Conclusions and Recommendations

The Government of the Federal Democratic Republic of Ethiopia is putting its utmost effort in the improvement of the food insecurity situation and poverty in general of the millions of people who suffer from food shortages. There is also an intention to avoid dependence on food aid, which has become a logistics nightmare. The Government is developing new policies, strategies and programs to create the favorable situation for enhanced development. The concerns of land degradation are addressed in all policy documents, but are always difficult to strike a balance between economic growth and natural resources protection. The efforts so far are encouraging, but need to prioritize the interventions during program development based on the problems and potentials of the specific areas. The strategy documents address all issues related to agricultural production and marketing and would be difficult to handle unless objective criteria are put to prioritize the intervention areas. It is also important for participatory development of such policies in the future to benefit from the experience of a diversity of professionals and institutions. It is also important for participatory development of such policies in the future to benefit from the experience of a diversity of professionals and institutions.

The importance given to environmental rehabilitation in general and to agro-forestry in particular is also encouraging if translated into action. The commitment to the sector can be assured if relatively adequate resources are allocated to it during program development. It should be noted, however, that agro-forestry does not represent the forestry sector. The institutional problems of the sector should also be seriously addressed if forests and forestry professionals are to play their roles in the improvement of the livelihood of people. Trees and forests have a big contribution to food security directly and indirectly. The huge potential of trees and forests has not been tapped so far. Trees and forests can be harnessed to contribute to the foreign currency earning apart from their contribution to household food security by providing food, income and employment opportunities.

The most limiting factor for the integration of trees to farmlands and pastures (agro-forestry) is the free grazing system. Unless measures are taken to control the free movement of animals, it will be very difficult for rural households to benefit from agro-forestry practices. The very few experiences so far are indicative of the possibility of managing the problem.

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The Paradox of Forest Conservation and Food Security in Ethiopia

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Abstract

Through human history forests have played an essential role to the well being of human society. They play an important role in ensuring that hundreds of millions of people in the developing world go to bed without eating something or with empty stomach. Forestry has a large and an indispensable role to play in improving conditions that affect the present and future food security mainly in developing countries. Food security is defined as the physical and economic access to food for all people at all times. It also when poor and vulnerable households have physical and economic access to food, and when they have sustainable source of food. Food security is greatly influenced by physical, economic, natural resources, socio-cultural, gender and ethnic factors; and could be chronic or transitory. In Ethiopia, the contribution of forests and forest products to household food security and to the national economy is indispensable. However, deforestation has already affected the lives of many living in the forest regions in the country and has resulted in environmental problems such as forest biomass reduction, decline in the productivity of the land, soil erosion, loss of biodiversity which subsequently led to frequent socio-economic problems. Many of the socioeconomic problems in Ethiopia are associated with deforestation. However, interrelation is still poorly recognized. It is difficult to seek fast and comprehensive rural development options in Ethiopia in such a frustrating situation of environmental crises leading to deforestation. The extent and the level of land degradation owing to severe deforestation is increasing sporadically, and challenging the livelihoods of rural communities. Loss and/or alteration of forest habitat through grazing, agriculture, logging and fire could not only lead to the decline in local biodiversity but also affects food security of local communities as many people are directly or indirectly dependent on forest and forest related activities. Forest resources are generally undervalued in Ethiopia, despite the fact that millions of people rely on the forest and forest products for their livelihood. For instance, from 1989 to 1993, wood products (timber, poles, construction poles, fuelwood and charcoal) produced and used in the country amounted to ca. 291,217,780 million Eth. Birr. Similarly, in 1989/90 natural gum products produced and sold for domestic and export markets amounted to 17,417,138 million Eth. Birr, of which 60 % of products were exported. This is an addition to medicine extract from the forest. Forest resources contribute a significant wealth of products that can be used for food, medicine, construction materials, energy sources, etc. Ethiopia's forest resources have a direct impact on food security. This means that people are still very dependent on the natural environment for their survival. The country depends on a rain-fed agriculture to produce most of its food. If the rain fails to come at any one season, the country has to look for food aid or relief assistance. In many parts of the country, forest and forest related products make essential contribution to the household food security, especially during serious drought periods. A linkage which is often not made is the connection between deforestation, lack of fuel wood, food security and health. As deforestation reduces the available food security, there are a number of possible consequences. This may threaten economic life of a community, which can intensify poverty- the major cause of food insecurity. For people to have adequate food, it is

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necessary that a balance between agriculture and natural resources management should be maintained. This calls for policies that can adequately ensure the sustainable management of natural resources. These measures should include forest management and rehabilitation of degraded environments.

Introduction

Forest ecosystems have multiple functions and services and therefore are of great importance for the well-being of people. It is widely acknowledged that forests and trees simultaneously provide a wide range of socio-economic and environmental benefits and values to humankind. They need to be conserved and wisely used if they are to provide benefit to human beings in general and the rural people in particular who are dependent on these forests.

Historical sources indicate that a large portion of Ethiopia was once covered by high forests and woodlands [1,2,3,4]. In fact, the numerous remnant natural forest patches seen at present and the climatic conditions prevailing in the highlands suggest that a larger portion of the highland area was once covered by forests than at present. However, deforestation has already destroyed many of the forest regions in the country and has accelerated serious environmental degradation such as forest biomass reduction, decline in the productivity of the land, soil erosion, loss of biodiversity and frequent socioeconomic problems in Ethiopia [1,2,5,6,7,8,9,10,11,12]. The extent and the level of land degradation owing to severe deforestation is increasing sporadically and challenging the livelihoods of rural communities. Analysis of the underlying problems indicated that political instability and war, excessive growth of human and livestock populations, weak (forestry) institutional capacity, poverty in the rural area, lack of land use or forest policy and lack of commitment from policy makers are the major actors deriving the forest resources degradation [7,8,9,10,11,12].

Despite, the continuous destruction of forest resources, the contribution of forests and forest related products to the economic wellbeing of the country is relatively high. Forest based activities provide a substantial economic importance to many rural and urban households in Ethiopia [13,14,15,16]. The collection and processing of wood and non-wood forest products provide a major source of income to millions of farmers and contribute significantly to their household food security. Trees have been an integral part of the food security strategies of rural people in many parts of Ethiopia for a long time. Food from forests and other tree systems constitute an important component of household supply. Millions of people across Ethiopia spend regular time in harvesting wood and non-wood forest products. Forests contain many resources of economic value, such as seeds, fruits, medicine, food or wood. Certainly, there are many people who are dependent on forestlands for their livelihoods. Forestry has a large and indispensable role to play in improving present and future food security in Ethiopia. The promotion of these valuable forest products can make an important contribution to the alleviation of poverty by improving food security and economic welfare of rural population. As tropical forest environments are fragile, sustainable use and management of the ecosystem is key to the continuing supply of these forest products, while achieving sustained development and growth in these regions. In fact, food security is very much dependent on environmentally responsible and sustainable use of the forest resources. Unfortunately, this link is rarely reflected in national development programs, especially, the contributions of forests to the livelihood of the rural poor.

Unfortunately, the use of forests has been undertaken with little care about their potential to fulfill many functions and also about their future. With regard to forest conservation, although crucial in order to maintain entire ecosystems with all their services and functions, the effort so far made is inadequate. Deforestation has both direct and tangible economic effects as well as environmental impacts whose economic costs are less immediately visible.

This paper reviews the problems of forest conservation and the role of forests in household food security in Ethiopia.

Forest Resources of Ethiopia

Currently, the high forests of Ethiopia cover around 2% of the total land surface and woodlands cover around 15%. The major forest vegetation types are: 1) Man-made forest, 2) Dry evergreen montane vegetation (*Juniperus* forest, *Podocarpus* forest), 3) Moist montane forest, 4) Broad-leaved deciduous woodland, 5) Small-leaved deciduous woodland, and 6) Lowland dry forest. Generally, significant portion of all forest vegetations are affected by human activities and some of the vegetations are seriously threatened already. For instance, a large proportion of remnant patches of montane rainforests in south and southwestern parts of the country are disappearing as a result of so called "development projects." There are about 7 tea and/or coffee plantation projects that are operating in the regions and changing the forest into other type of land uses. These effects are not considered often and consequently result in deforestation and leave the land surface barren and open to serious land degradation thereby leading the farmers to socio-economic crisis. Environmental degradation associated with deforestation, has already affected production capacity and subsistence systems within rural areas. For example, soil erosion, depletion of nutrient capital and declining of productivity of the land and loss of biodiversity are perhaps some of the outcomes. If the present trend continues, it will bring serious environmental crisis, and will affect rural development.

Value of Forest Resources

Forest resources provide the basis for life on earth, including that of humans. The fundamental social, ethical, cultural, and economic values of these resources have been well recognized throughout human history. However, forests are seen by most people, particularly politicians, planners and decision makers, as a source of one product: wood. Yet they are the source of a host of non-wood products of immense value to the communities within and around them. These products include foods, fibers, wildlife, water, building and handicraft materials, gums, spices, dyes, animal fodder and medicines. FAO (1994) [23] estimates that, the active ingredients in 25% of all prescription drugs come directly from medicinal plants, although not all of these grow in forest habitat, and that the global value of plant based drugs is about US $43 billion a year. The implication is, therefore, that non-timber forest resources multiply opportunities for entrepreneurship. In addition, forests constitute a vital part of the environment. They conserve watersheds, soil and water. They protect land from wind and water erosion, modulate climate and sequester carbon thereby buffering the global warming attributed to increasing levels of Carbon dioxide. Many rivers provide breeding grounds for migratory and permanent fish communities. The value of the forest can be generally grouped into three components. These are:

1. Domestic values of forest products, such as firewood, fodder, and others that are consumed directly,
2. Commercial value's of forest products, such as timber, medicinal plants ("productive use value"); and
3. Ecosystem functions, such as watershed protection, photosynthesis, regulation of climate, and production of soil ("non-consumptive use value"), along with the

4. immense values of keeping options open for the future ("option value") and simply knowing that certain species exist ("existence value").

Although forests are precious natural resources that provide various services and functions, deforestation is advancing at an alarming rate in Ethiopia.

Relative Importance of Forest in the National Economy

Indigenous forest and woodland resources are generally undervalued in Ethiopia, despite the fact that millions of people depend on the forest and forest products for their livelihood [10]. This is because the focus given is on the management of timber resources, with little attention to non-timber products. Non-timber products are very important, particularly, in the montane rainforest regions. And yet, planners and policy-makers do not seemingly recognize the contribution to the local and national economy. EFAP [4] estimates that the harvest of forest and woodland products contribute over 90% to rural community household income and over 10% to GDP of the country. The amounts of wood products produced and used in Ethiopia from 1989 to 1993 are indicated in Table 1. This is not to imply, however, that wood is not used much. The low amount of industrial wood is only a reflection of the fact that the bulk of both the cutting and the use of wood in Ethiopia are largely done illegally and not formally harvested through authorized organization.

Table 1: The Patterns of Wood Products Produced from 1989 to 1993 in Ethiopia

Production	Unit	1989/90	1990/91	1991/92	1992/93	Total	Birr
Timber	m^3	62 733	66 150	64 544	43 405	236832	236832000
Poles	m^3	No	15 303	60 819	82 838	158960	15896000
Construction Pole	m^3	52 084	50 012	36 650	24 739	163485	16348500
Fuelwood	m^3	109 301	127 678	114 788	70 976	422743	8454860
Charcoal	Quin.	59 082	107 620	257 130	32 382	456214	13686420
Total							**291,217,780.00**

Source: [4]

Non-wood forest products like incense and myrrh have been important items of export for long period. The amount of natural gums consumed within the country and exported in 1989/90 is given in Table 2.

Table 2: Natural Gum Products and Marketing in 1989/90 in Ethiopia

Description	Items	Amount (quintal)	Amount (Birr)
Domestic use	Incense	10 955	5 642 888
	Gum (Arabic)	52	4 827
	Myrrh	102	420
	Others	2 304	3 943
	Total consumption	13 413	5 652 078
Exported	Incense	5 730	2 001 753
	Gum (Arabic)	1479	1024598
	Myrrh	50	30 140
	Total export	7 259	3 056 491
Total			17,417,138.00

Source: [42]

Even though Ethiopia has small portion of productive forest, they are still contributing significant amount of revenue to the national economy. The contribution of wood and non-wood products to national economy of Ethiopia should be further quantified.

Causes of Forest Resources Depletion

Throughout the world, relatively undisturbed ecosystems have shrunk dramatically in area over past decades due to an increase of both the human population and resource consumption. Forest conversions are becoming legitimate in tropical countries because of poverty and undergrowth. The majority of the rural communities in many developing countries are dependent on forests and forest products for their daily existence. However, deforestation and conversion of forest ecosystems into other types of land use has already significantly affected the world biological resources. Deforestation is largely man-made, and hence its pace is governed primarily by the speed at which population pressure mounts.

The situation is more acute in Ethiopia as this is supplemented with recurrent drought in the country. Originally about 34% of the total area of Ethiopia was covered by dense natural forest [24]), and a further 20% by woodland/savanna, but the figure declined to about 4.4% by 1960 [25]), to 3% in the 1980s [5] and to ca. 2.7% by 1989 [6]). It is generally recognized that both high forest and woodland vegetations have been subjected to degradation in various ways for a number of years, due to agricultural expansion, overexploitation for fuel wood and timber, seasonal fire, overgrazing and mining [1,2,6,4,7,9,11,26,27,10,12]. It has been estimated that with the present rate of deforestation 150,000-200,000 ha per year, the remaining high forest will disappear within then next few decades, [4,28]). This had and continues to have serious consequences on the people and environment.

The major threats to forest resources of Ethiopia can be broadly categorized into two: 1) Individual elements of the forest are removed without alteration to the overall vegetation structure (e.g. selective logging, fuel wood and construction materials collection and others). Ultimately, this will lead to the change in forestland use through time. 2) Overall impoverishment and degradation of the ecology of the forest ecosystem through (e.g. Agriculture and grazing, human settlements, mining extractions, fire, and conflict or war). The act of degradation or destruction will further lead to the decline of the diversity and abundance of forest dependent plant and animal species and deterioration of forest productivity and degradation of the whole environment lastly.

Loss or alteration of forest habitat through grazing, agricultural pressure, logging and fire results not only in local decline in biodiversity but also affects the biodiversity of other areas [29,30,31,32,33,34], which in turn affect food security of the area. In many rural areas of the tropics, rural communities depend heavily upon forests for many reasons. The utilization and extraction of these resources could have negative impact both on flora and fauna. The consequences of forest destruction for forest and associated biodiversity are beyond expected.

Forest Conservation Status

Forest Conservation

Policies of forest resource conservation in Ethiopia had started a long time ago, although the effect of these efforts were and still are, not satisfactory. For instance, during Socialism Era between 1974-1991, a number of important forest areas have been designated as National Forest Priority Areas (NFPA) for conservation in many parts of the country [4]. However, conservation efforts were not well valued owing to spontaneous settlements, population growth and other related anthropogenic pressures. Currently, the situation is much worse than ever in the past.

Official policies have consistently defined local misuse of resources as the main cause for the destruction and the premises of these policies have been used to urge for the need to establish conservation areas without consulting local communities. Such practices more often dissociate people from development and conservation activities [35,36]. As a result, forests have been subjected to great land-use pressures. Reusing, [9] indicated that in several areas of the NFPA, the forests either do not exist or are highly degraded. As a result, the forests have been fragmented into patches and distributed mainly over the southwestern and southern parts of the country.

There are a number challenges related to the conservation of forests. Many of the Forest Priority Areas are by defacto administered by Regional Agricultural Bureaus and the forests are managed through selective cutting for timber. There are about 50 or more of what are called National (Regional) Forestry Priority Areas for conservation. Nevertheless, none of these forests are considered to be under "good conservation status." Many of these are subjected to varying levels of illegal exploitation and destruction. Overexploitation of the forest is considered illegal, although certain activities such as the collection of fuel wood and certain building materials are not prohibited by law. However, to overexploitation, some forest tree species have already been identified as threatened and are legally prohibited from use. These include *Cordia africana,*and *Hagenia abyssinica*. It should be noted that the number of threatened species due to the overexploitation could be much higher.

Ethiopia's Development Policies

Either a lack of concern or the improper setting up of environmental policies contribute to the devastation of natural resource bases in Ethiopia. There have been a number of instances, when policy issues fail to encourage improved land resource management or actively encourage deforestation due to lack of comprehensive forest policy or land use policy or strategic issues, across-the-board for rural development. When individual or corporate actions severely affect the environment, more government involvement in land management is required.

In evaluating the relationship between economy and environment it is important to separate, where possible, the effects of economic policies from those attributable to worldly processes of growth and economic change. This is especially important in the Ethiopian context, because development strategies and the institutions that support them have significantly impacted on the pace and nature of economic development. A case can be made that inappropriate land use, involving large scale deforestation and land degradation affecting fragile uplands and watersheds as well as lowland ecosystems, and the associated migration patterns observed in the country. The migrations are not merely the inevitable consequences of rapid population growth and the resulting pressures on the land, but at least partly attributable to ineffective environmental policy.

The current Agricultural Development Lead Industrialization (ADLI) strategy pursued by the government in my view has ignored the forest ecosystems and the whole environmental issues. This strategy, together with other related administration problems, resulted in a boom-bust economic growth pattern that had both direct and indirect effects on resource use patterns.

Ignorance about the environment, particularly the forest resources in the country, has already exposed the land to severe biological resources degradation. Many lands are already out of productive system owing to severe soil degradation and soil erosion, and forest biomass reduction. Currently, there is no plan or effort to rehabilitate the degraded lands in the country. Any attempt to boost economic growth, without giving due consideration to the environmental problems may not bring the needed effect to the country like Ethiopia that is suffering from exploding population growth.

The Importance of Forests to Food Security in Ethiopia

Through human history forests have played essential roles to the well being of human society. Forest resources contribute a significant wealth of products that can be used for food, medicine, construction material, energy sources and etc. The contribution of forest products to the households' food security have been acknowledged by many authors [17,37,18,38,39,15]). Forests also contribute in maintaining and moderating world climate, conserve soil, and retain and prolong moisture availability below and above soil surfaces.

Ethiopia's forest resources have a direct impact on food security. This means that people are still very dependent on the natural environment for their survival. For this reason, the demarcation between having enough food and not having enough is very thin. The country depends on a rain-fed agriculture to produce most of its food. If the rain fails in a given season, the country has to look for international food assistance. In many parts of the country, during hard years, forest and forest related products make essential contributions to food security at household level. The importance of forests to food security are described below;

Agriculture

Forests help maintain favorable and stable conditions needed for sustained agricultural productivity. Trees prevent soil erosion, enhance soil fertility and maintain soil moisture. Trees are used to stabilize sand dunes and arrest desertification. Deep-reaching tree roots can help mobilize nutrients from far below the ground level for use by food crops. Windbreaks and shelterbelts protect crops from drying, damaging winds. Trees also provide farmers with material for fence posts, poles and farm implements.

Many pastoralists depend mainly on tree fodder to feed their animals. Trees provide shade for livestock, important to their health and productivity in hot, dry areas. Growing importance is, of course, the role forests play as storehouses of biodiversity, potentially very important in future crop breeding programs and pest and disease management programs.

Forests also have significant links with inland and marine fisheries. Rivers and streams are rich fishing grounds for local populations. Forests regulate the volume and fluctuations of stream flows and provide a shaded riparian environment favorable for the development of smaller life forms which fish feed on. The fish catch enriches protein-deficient diets and generates household income.

For People to have adequate food, it is necessary that a balance between agriculture and forest resources should be maintained. This calls for policies that can adequately ensure the sustainable management of forest resources.

Forest Foods

Forests provide edible fruits, seeds and nuts, leaves, tubers and roots, fungi, gum and sap. These foods add diversity, flavoring and essential nutrition to diets. During seasonal or emergency periods of food shortages, forests provide "hunger foods" which bridge the gap between sufficiency and famine. In the recent drought in Ethiopia, the forests have and are still, providing survival foods for thousands of people. Forests are also the habitat for wildlife which is hunted for food and other uses.

For instance, in southern Ethiopia, the consumption of wild-food plants seems to be one of the important survival strategies [13,40] wild edible plants of Ethiopia are estimated to about 8% of the higher plant species in the country. It is further analyzed that about 25% of these are cultivated as food crops and the remaining (75%) could be categorized as wild, semi wild, or naturalized and used by people at different scale many people are still depend on forest food especially during drought and seasons with food shortage.

Economic Opportunities

Forests provide a wide range of economic prospect for tens of thousands of communities in Ethiopia. Cash income from forest product sales provide the buying power to purchase food when agriculture is not practiced or when crops fail. Forests provide a wide range of economic and employment opportunities. Harvesting timber is an important source of employment. Non-wood forest products are important too. Forests are also a source of a number of non-timber forest products. Non-timber forest products such as spices, honey production, gum and incense, medicinal plants and others serve as important sources for the livelihood in many rural communities in Ethiopia. The economic values of non-timber products in some circumstances can over-weigh the other land use alternatives [14]. Among a number of non-timber forest products used in Ethiopia, honey, coffee and spices provide the major livelihood system in the south and southwest montane rainforest areas.

Forests shelter a number of medicinal plant species which serve as a source of medicine for many rural communities in Ethiopia. Large numbers of rural households in Ethiopia depend on wild medicinal plants to treat themselves from various diseases. Hundreds of plant species are being used by rural communities. These species contribute to the food security of the household either through income generated by selling the products or by keeping/saving the money that could have been spent on buying modern drugs,

Environmental Issues

Forests are harboring a number of wild animals that people are hunting and using as food sources. Without the presence of forest resources it is not possible to get these animals either for food or for aesthetic value. Forests can also play important roles in preventing catchment deteriorations. When a given forest is degraded it may lead to flash floods that has a direct impact on soil erosion and affect the water resources of the area.

Energy Sources

In Ethiopia, the rural poor have no alternative sources of energy for cooking but wood from the forest. The same is true for the majority of urban dwellers. More than 90% of Ethiopians are totally dependent on biomass energy, with fuel wood being the highest component.

Unfortunately, the demand for fuelwood often provokes non-renewing, destructive tree harvesting which causes even further environmental degradation. Many researchers speculated that with the current rural energy crisis, fuelwood and charcoal may become a major cause of forest resource depletion in many parts of the country.

The Challenges of Food Security

Food security requires interdisciplinary, intersectoral thinking and action. Development actions have been too often addressed by isolated interventions which do not address the complexities of the root causes which underlie food security. Policy decisions within one sector can have serious repercussions in others. For example, policy decisions like the privatization of land, can directly affect a community's access to forests. In turn, limiting access can threaten food security and diminish economic opportunities. This may threaten the nutritional and economic life of a community, which can intensify poverty - the major cause of food insecurity.

Rural economies often rely heavily on a few economic activities, making them vulnerable to downward shifts in economic fortunes. Alternative activities and employment opportunities are needed to give rural communities additional security in times of crop failure or during the lean seasons between harvests. There are many under-exploited opportunities to be explored in forest-based, small-scale industries. Little institutional support is given to these endeavors even though a significant percentage of rural employment is related to these enterprises. In addition, supportive infrastructure is lacking in processing, transportation and accessing appropriate markets. Economic necessity frequently impacts negatively on the environment. Forests are cut down to provide land for shifting agriculture, pasture or for other uses. The removal of productive forest lands is not conducive to sustainable development - neither for agricultural practices nor for natural resource conservation. Much biodiversity is lost and the world's genetic storehouse becomes impoverished. With the forests gone, foods that normally supplement diets or add valuable nutrients, during times of need, vanish. Local knowledge of traditional foods and medicinal plants is lost too because the forest has disappeared or because the people have acquired a dependence on purchased foods. A linkage which is often not made is the connection between deforestation, lack of fuel wood, food security and health. As deforestation reduces the available fuel wood, there are a number of possible consequences. Less time is spent on cooking and more time is allocated to foraging for fuel wood. Fewer meals are cooked and smaller ranges of foods, usually those that can be eaten raw, are served. More often, less nutritious foods are prepared. Less fuel wood also means less water is boiled which reduces the amount of clean water to drink or to wash produce. This, in turn, can increase the incidence of water-borne parasitic diseases.

Even more serious, diminishing supplies of fuel wood can cause animal and crop wastes to be burned rather than returned to the land as fertilizer. In Latin America, in particular, this signals the beginning of irreversible soil degradation. Scarcity of fuel wood can also constrain meat and fish drying and smoking - often the only means of food preservation available for many rural communities. Unfortunately, the demand for fuel wood often provokes non-renewing, destructive tree harvesting which causes even further environmental degradation.

Conclusions and Recommendations

Currently, agriculture is the mainstay of the Ethiopian economy and will remain so for some time to come. As a result, many rural development options have been focusing toward improvement of the current agricultural production. The key issue for a food security development option is a long-term vision, which integrates natural resource management and rural development by encouraging the participation of local communities. Many of the economic and environmental problems of Ethiopia have common roots. However, they are still poorly recognized, or ignored. It is difficult to seek fast and comprehensive rural development options in Ethiopia in such a frustrating situation of environmental crises in the country. In a poor country like Ethiopia, where a complex socioeconomic and political condition prevail the improvement of agricultural production alone can't bring the desired changes (in terms of securing food security, poverty reduction etc.). When there are good policies ground forests play extremely important roles by providing support in food security. They can support sustainable agricultural systems and assist overall food production. Forests can help reduce the risk of annual crop failure; compensate for seasonal scarcities; and providing an emergency supply in times of long-term drought or other stress conditions. These roles will continue to be the base to ensure physical access to food. Forestry can support economic access to food, especially for the landless and rural poor. The income provided through small-scale enterprises involving the collection and processing of wood and non-wood products, is very important to millions of people in rural areas.

Some points are forwarded as recommendation, which may be worthwhile to consider:

1. Forest resources have multiple economic and ecological uses for the community and their conservation/management ensures this reality. Therefore, forest resources should be conserved and sustainably used.
2. Widespread ignorance is perhaps the single most important factor that enhances forest degradation in Ethiopia. Therefore, the value and the benefits known to the local community in terms of socioeconomic conditions should be quantified and communicated for effective conservation.
3. The country should develop land use policies that may help in promoting forest resources conservation strategy and for better food security supply.
4. Any rural development strategy should gear toward multifaceted approaches; which considers rural development via the carrying capacity of the resource base.

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Contribution of Agro forestry in Food, Feed and Wood Self-Sufficiency and Sustainability in Rural Livelihood

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Abstract

Food self sufficiency and sustainability is insured in any country in general and in Ethiopia in particular where trees exist abundantly as a land cover biological resource. A scattered tree of multipurpose role in crop and pasture insures food and feed self-sufficiency better than any sole production of crop or pasture. Supply of wood for energy, construction or other services are obtained from the same piece of land without depressing the primary and secondary product, in this specific case food and feed. In the system inputs are totally organic under traditional practice. Other direct and indirect benefit that trees as a mix contribute compared to mono farming system is discussed in several respective agroecology. Recurrent drought and scale of the problem will be correlated with the system. Major agroforestry in the rift valley, northwestern and southern and Eastern Ethiopia will be discussed by backing with researched statistics as example. The paper reviews traditional farming system and uses information generated from farmers' traditional practices and quantifies the contribution from sustainability, production increase, storability and quality product perspective. This paper deviates from the conventional approach, which is subject matter or field specific and focused. As any thing in any field is related to every other thing and the vise versa, the paper is comprehensive. Trees that have a complementary production role are identified. Crops in the combination are also considered in each specific site agroecology and farming system. Agroforestry role in soil and water conservation, honey bee forage, temperature stabilization, other indirect roles are presented with practical examples, and research results. Recommendation is made in each specific example. In the introduction and discussion part, conventional confusion between constraints and opportunities will be presented and discussed and evoke. This section will hopefully play an important role in providing a new conceptual framework attitudinal changes of the major actors in rural agricultural development professionals. Contribution of Perennial agroforestry intervention for short and medium term as well as perennial solution in food, feed and wood self-sufficiency will be assessed.

Introduction

Ethiopia's potential productivity such as, the grain basket, the water tower, highest livestock population in Africa and 9th in the world and largest bee colony and the fourth wax producing country in the world and one of the world's four top biodiversity centers in plant and animal are words that one is always hearing/reading. The above-mentioned potential resource when seen in terms of contemporary actual production, conservation and sustainability is indeed frustrating and horrifying. Severe decline in production of the resource and failure in sustainability is directly related to devegetation of the forest resources that would have conserved the soil the surface water; insured, sustained flow and balance of under ground water. Conservation of the vegetation will sustain production of animal feed and bee forage particularly during off-season; control of salinization and entire temperature balance that that

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would keep people, wild and domestic animals and plants under shade in their comfort temperature range in their respective habitat. It also reveals the potential of agroforestry tree inter-crop practices as an important development and conservation short-term strategy in the faces of lack of acceptance and subsequent failures in forest development endeavor. Agroforestry is an entry tactic to the long-term forest development at this juncture.

Conventional stage in agricultural development are described as a ladder in ascending order: hunting/gathering, hoe culture, ox culture and mechanization. However, the reverse seems to reflect the reality in our country.

Major constraints that are conventionally accepted as a problem such as population increase, slope, and several rivers running in a hilly country are opportunities. Thus, the major constraint in the so-called potential highlands are mainly ox-culture farming and free grazing. These two systems are more of a destructive system under current practices. Deeper interpretation reveals that they are not a root or primary problem. It is the man, who is a sole programmer of the wrong print out and deserves to take an absolute blame of absolute poverty in our country. This paper is primarily intended to create a dialogue and awareness among concerned technical and managerial actors in agricultural development system.

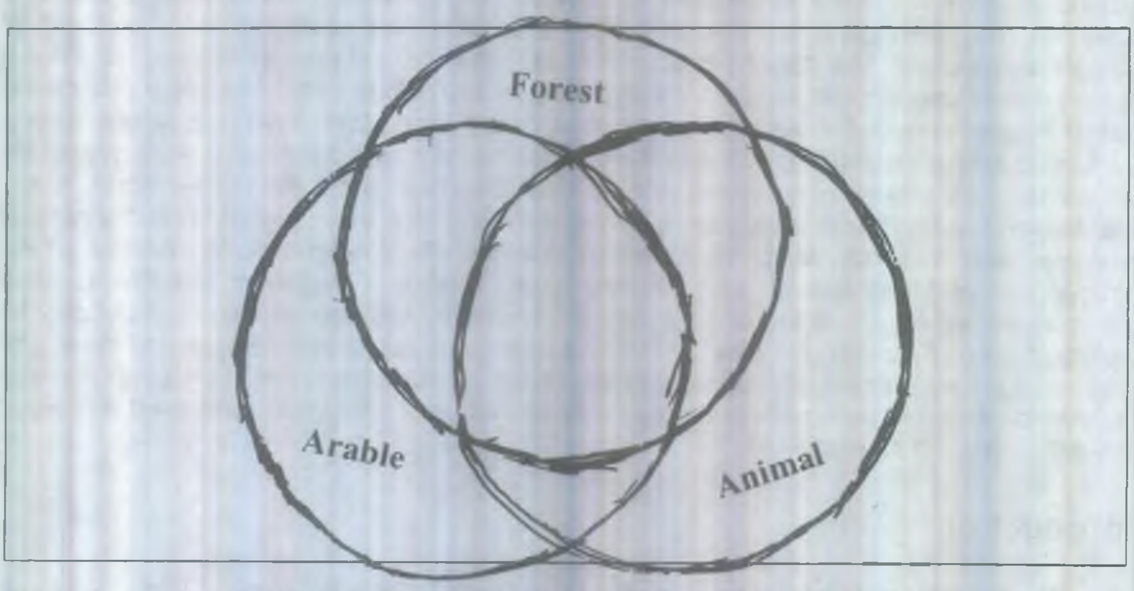


Figure 1: Combination and Mono Cropping

We couldn't strike the balance we are mostly in a crisis hemi-sphere

Mixing of different plants create different root level spread and depth. Such variation will optimize the mining and absorption of underground resource compared to mono plant growing that explores the same depth level. The above ground growth assumes similar orientation in the air, deeper and wider spread of the roots compared with shallow and taller plant. Such a relatively wide dimensional orientation of perennial plant will enable to mine most of the required nutrients and other resource such as sunlight and Co_2 better than the annual plants. This is believed to reflect positively on the nutrient content of the plant. Goats, which are browsers of perennial plant, have the best quality milk and its cholesterol is the best source of immunity than any other grazers of annual grasses. The former ones utilize the resource better; they grow and yield basic need better in general. The prolonged lifetime span in perennial plants is another parameter, which puts it in a superior position. Some plants harbor nitrogen fixing bacteria thus can increase N input. Mixing annual crops with perennial trees is the highest form of mixing.

Another important dimension is to create impression on food and feed quality of the common resources that are produced on farm. Food security/sustainability is both yield and quality. Quality of the food and feed is also determined by the nutrient content of the product. The following table indicates a relative nutrient content of the major annual and perennial farm plants.

Table 1: Relative Crude Nutrient Content Indicator of Major Food and Feed Plants

	Species	Protein	Carbohidrate	Yield Kg/ha/yr
1	*On farm tree*			
1.1	*Acacia albida* Leaf	high	low	1000
1.2	,, ,, Pod	high	low	1500
1.3	,, ,, Wood			8.52m^3/ha/yr
2	Crops			
2.1	Small cereals			
2.1.1	Wheat straw	low	high	high
2.1.2	,, seed	low	high	low
2.2	Smallest cereal			
2.2.1	Teff straw	low	high	medium
2.2.2	,, seed	low	high	very low

Table 2: Nutrient Content of Animal Feed in Semi-arid Rift Valley

Species	%	Dm	EE	Ash	CP	NDF	ADF	Lignin
Acacia species (pod and seed)		92.3	3.4	5.1	18.8	46.1	34.1	8.6
Acacia leaves		93.0	1.4	6.7	6.2*	62.8	50.7	9.8
Natural pasture (hay standing)		93.1	1.3	8.2	3.0	79.0	51.5	8.6
Teff straw		91.8	1.1	6.1	4.0	73.2	35.7	7.7

Source: Siyum and Zinash 1989

Food security is food sustainability. Sustainability can be defined as production and storage. The presenter of this paper believes that production in agriculture failed to include the storage aspect in the production system. Food security that focuses in crop production seems narrowly scoping its domain, the paper reveals that the major subset should include security in food, feed, wood, water, soil and other useful resources that are directly linked and responsible for sustainability of food production. Food security can be secured by producing any one of the products such as crop, livestock or trees etc. This is only possible if we have good infrastructure such as roads, markets and other facilities that would enable the sale of produces and purchase of goods and services. In the face of current Ethiopian reality where infrastructure is extremely poor and the economy is crippling, food, feed and wood need to be produced on nearly every farm as it is illustrated in the figure below. We are an old nation, an old man who is weak and crippling needs a wooden steak to support him to go on in life. Similar logic can apply to our food security in short and medium term in combining the three major agricultural components. In the faces of steep terrain of the Ethiopian highlands, the need for forestry, soil, water, flora and fauna conservation is entirely a question of survival of every life.

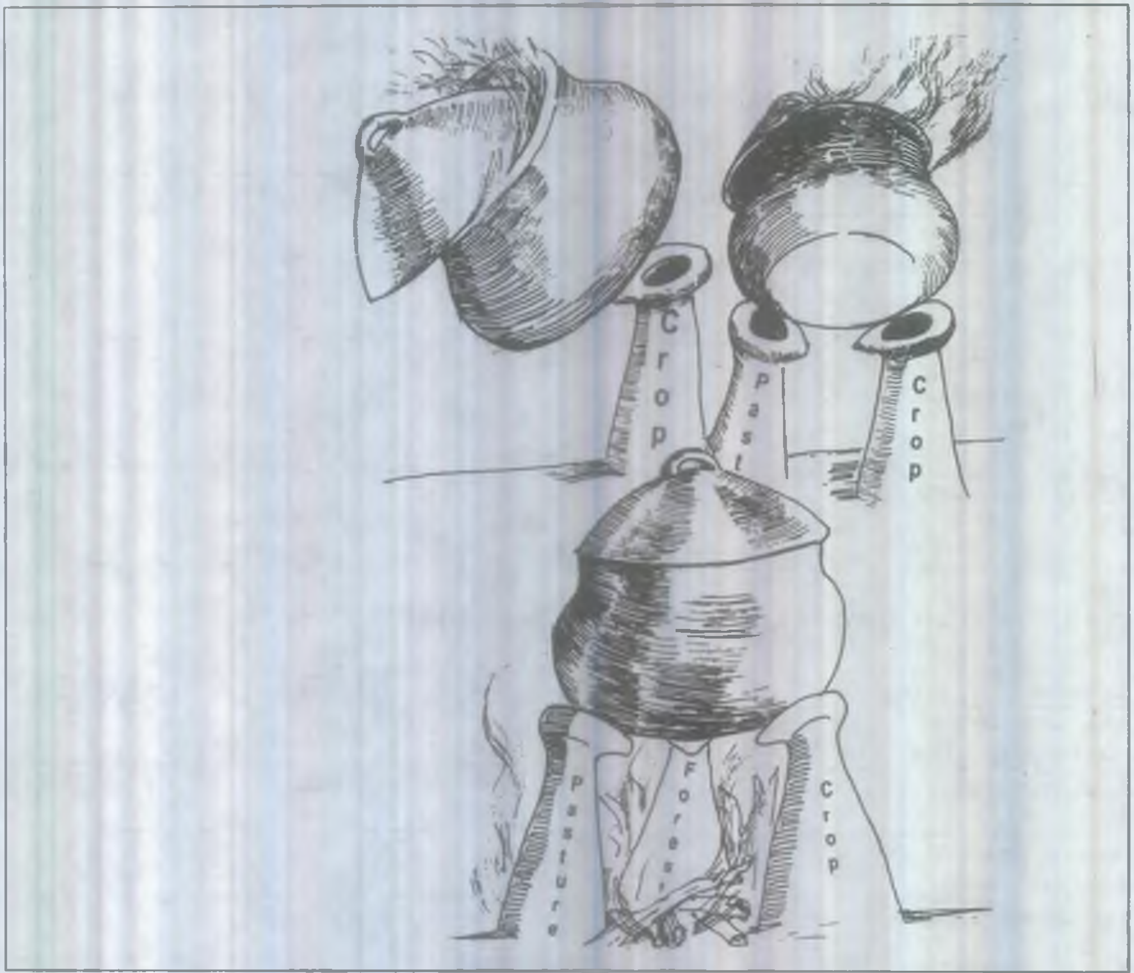


Figure 2: Food Security A Function Of Food,Feed And Wood Sustainability.

Mixing of the Same Species of Different Variety

There are mixing of the same species of annual crops. For example finger millet of different varieties like black, red and white varieties that are suitable for dry, medium and wet respectively. They are mixed in equal proportion and sawn in a farm. Farmer will not loss a crop however dry, medium or rainy a given season is, since the practice is a diversification at very basic primordial level.

Mixing of Different Genera

Mixing of different genera of annual crops are also common example of such combination wheat and barley combination in Tigrai, though they are both annual crops, perform optimally under different environmental conditions. Barley being a highland crop performs better in cooler conditions and higher rainfall or moisture level. In relative terms wheat grows better on dried and hotter conditions. Maize and sorghum in Wollo are diversification of risk. Tef and Nug, Tef and sunflower, tef and mustard, lupin and finger millet are mix of some annual crops in traditional practices. Those are aimed towards granting of yield from the different crops that have long shelf life. The above practice, in general secures sustainability of food and land productivity.Due to fluctuation in rainfall and temperature, any one season is more favourable for any one of the above crop.

Mixing Annual with Perennial Crops

Acacia albida tree intercrop, its uses in crop yield increase,fuelwood and fodder in the Rift Valley and adjacent, *Croton macrostachyus influence on crop yield* in Gojam and multi-purpose uses of *Moringa stenopetala* in Konso, Acacia tortilis in an annual pasture (tree inter-pasture) are an example of major annual and perennial combination in an on farm production system.

Mixing Perennial with Perennial

Cordia Inset Inter Cropping

Cordia african in the past is a straight tree timber tree. Currently we are unable to produce single stemmed straight tree. The problem is due to the fact that apical shoot of Cordia africana cannot withstand direct sun light; as a result, the shoot is killed. Later on the coppice are initiated forming forked multiple stem. Those secondary branches in the next dry season experience the same rhythm and again re-branched to tertiary. To solve this problem different nurse tree trial has been carried out; yet, the result was not promising.

Under traditional management in the southern Ethiopia, the farmers developed a technology in which they plant the tree in inset plantation. Inset is a crop with wide leaves that provides sufficient and uniform shade and grows as high as 6 or more meters. *Cordia africana* is planted as tree intercrop at later stage. Thus, the tree can grow up to 6 meters without losing its apical shoot or without branching below the stated height. Thus using this technique one can grow a strait ball for timber (*Cordia* is a best quality timber). Still some experiment has to be carried out to optimize the required quality output.

Moringa Stenopetala Cabbage and Camel Agroforestry Tree in Dry Farming

The family *Moringa* and species *stenopetala* is a native tree in arid and semi arid regions in the southern rift valley of Ethiopia .The local farmers use the species as one of the major arable tree inter crop specially as one of the tree crop in multi-storey system by the Konso people in Gamu Gofa. The tree is used mainly as food, feed and rarely as wood. As it is native and fast growing species the potential productivity in the short term is one of its positive prospects. The konso people live in arid environment of annual rainfall of less than 500mm/year. This spot is one of the highly populated areas with nearly 500 people /Km^2. It is the highest carrying capacity in relation to its agoecological potential. Surprisingly more than 50% of their daily diet source is moringa's leave that is pruned and used throughout the year. As the plant is perennial, there is no yield loss risk. However, intensive and frequent pruning of the branches as it is traditionally practiced, has a negative influence on seed production. Consideration of alternatives in agro forestry practice will be highlighted in the discussion. It is equally useful for the animal feed including bee forage

Coffee Shade Tree Intercrop

This is a combination where umbrella shaped shade trees are intercropped with organic coffee production. It is a traditional market oriented high value crop production. Information generated from participatory farmers interview has been summarized in the table in the background and research section.

Overall Influence of Shade in Coffee Production

Table 3 summarizes a qualitative role of shade on coffee environment and production under traditional farming system. Under the coffee, shade over bearing of coffee berry is limited to the optimum capacity and thus keep the crop healthy and sustainable in production compared to open field farming. It is a summary from farmers group and key informants around Jimma (30Km West near Agaro and southeast at Seka). Information in each cell is the average value from five farmers group interview.

Perennial Tree Role in Salinity Control

In dry irrigated farming scattered trees on river banks and adjusted arable and range lands tree intercrop or tree inter-pasture keep underground salty water not to appear on surface and caused secondary salinity as in the case of Awash irrigation farm.

The objective of the paper is: -

- To contribute in creating awareness on the importance of perennial plant role in food security among different agricultural sectors and initiate better linkage
- To assist in providing feed back for the future proper land use planning and implementation in the long term

Background and Justification of the Research Results

This main chapter focuses on farming system that is under severe threat not in the system itself but is continuously displaying its destructive irreversible loss to hoe culture cultivation and controlled grazing farming system. It has also an influence on the intermediate system

Misunderstood Causes for Poverty

(The following section is adopted from World Vision Research and development magazine from a section of writer's contribution)

Development Stage under Conventional Classification is Confusing

This point is raised to create a dialogue among researchers, development actors and relevant stakeholders and policy makers to re-look, re-search or re-find the underlying causes for poverty and the related problems of famine. Most agree that the major causes are population increase, physiography and backwardness in agricultural development. In this paper the conventional stages in agricultural development are described as a ladder in ascending order: hunting/gathering, hoe culture, ox culture and mechanization. However, the reverse seems to reflect the reality in the country, as we shall discuss. All of the stages exist in Ethiopia. Diversity is a potential, it is an opportunity, it provides us with a wide variety of options for advancement. In theology people have a longing nostalgia about Biblical antiquity when our first ancestors Adam and Eve (or 'Adem and Hawa', 'Adam and Hewan', 'Ademi and Haweani', etc, expressed in other languages) lived free from worry representing all humanity on Mother Earth.

The author is an agroforester who shares the confusion or the dim vision regarding the distinction between religion and science. What his heart always grieves about is the issue of the absence of integration, combination by way of complementariness that ought to have released the unique synergy of love for nature, which God has created for us to take good care of. Today we can still find Adam and Eve, so to speak, in the south and southwestern

Ethiopia in the gardens of the dense natural forest and woodlands where the water is clean people walk partly naked and free but have healthy and well-built bodies. In this region, the land is still a land of 'milk and honey' abounding in life sustaining provisions in the face of current critical drought in the rest of the country.

Within a distance of 800 kilometers from the Ethiopia capital, one can seed a range of culture from early times to the present, from the most primitive to the most modern. Any one is free to censor this understanding and interpretation of mine. However, in this variation and mosaic of culture I do not see a challenge but an opportunity-we are a museum of diverse cultures and this enhances our potential for tourism, the smokeless industry. For the well being and peace of our region, the nation, the continent and mother earth at large, I believe that we ought to think, write and re-write and work to build up one another. We have to make behavioral changes for the better and do away with wrong notions and tendencies, a task that can be called a paradigm shift. By way of an exercise consider the following constraint/ problems. Some of them can turn out to be opportunities if we understand and solve our differences synergically.

Population Increase

Population increase has been condemned as a root cause for natural resource degradation like soil nutrient depletion, deforestation, drought and ultimate poverty and hunger in Ethiopia, but this is a crude generalization. The scale of the problem will not positively correlate with the above factor. If we consider similar agro ecology and compare population density or simply degraded site/drought affected areas and population density, we have reasons for confusion. The Gedeo region, for instance, has a population density of nearly 1000 people/ km^2; on the other hand, any open arable land of similar slope and size near Mizan under ox farming and free grazing can only support only some 150 people/km^2 Konso is a dry agro-ecology receiving less than 500mm of annual rainfall, yet it supports over 500 people per square kilometer. Several examples can be sited within or outside Ethiopia. At

Mesonon, Kenya, located near Lake Victoria and along the Equator, the land is dry and yet it has a population density of 1500 people per square kilometer. The same is true of the chagga home gardens of Tanzania at the foothills of Kilimanjaro supporting similar density of population.

It can, therefore, be argued that the problem lies in our free grazing and ox culture farming system where the natural resourse management and utilization has gone terribly wrong exposing us to many dangers. However evaluated, the system remains destructive. On the contrary hoe culture which appears primitive and one step behind the ox culture, one can observe a conservation oriented traditional system with manageable animal population and farmers practicing controlled grazing for their livestock. Here, farmers keep more perennial plants/trees on farms. Natural resources are conserved in the system and this allows for economically viable and sustained production. A mixed system like that of Gurage and Woilaita exhibits an intermediate status. Taking such observation into account, one can conclude that population density alone cannot be blamed as causing land degradation and subsequent poverty/famine. Such points of view have to be reconsidered, analyzed and discussed to avoid rash conclusions.

Physiography (Slopes)

Ethiopia has more than 46% of the total African highlands making her unique among the 53 African states. In fact, it is called 'the roof of Africa'. This physiography is one of the major factors that gave rise to the rich animal and plant biodiversity making Ethiopia one of the top 10 countries in the world in this regard. The rugged mountain and depressions offering such a biodiversity can thus be taken as opportunities. For the conventional understanding, however, this opportunity can be termed a constraint exposing the terrain to soil erosion and land degradation with steep slopes aggravating the situation all the more. Hence, the mistaken idea of regarding physiography as a constraint when actually wrong land use system induced by man is to blame for the difficulties related to slope. Man is responsible for converting and subsequent human threat. Thus the problem pivots around the social system and how to deal with it.

Water Resource Misuse

It can be called water resource misuse or abuse that hinders water conservation development and its proper harvest in Ethiopia. Ethiopia has one of the highest water resources especially in terms the potential of its rivers next only to the Congo. The country has been referred to as the water tower of Africa. Water is indeed life, a useful resource and a blessing. However, under our terrible utilization and management system, water has posed dangers: it removes our fertile soil, it fills our dams and lakes with silt and sand, it floods the lower catchments displacing pastoralists, damaging irrigation physical structures and causing secondary (man made) salinity that subsequently leads to absolute abandonment of good land that cannot be easily reclaimed by a poor economy like ours. All the above man made problems increase proverty and the likelihood of famine. So, it is worth pondering over several questions: is our system of management and utilization of water a cause for life or death? Is it useful or harmful? is it a blessing or curse? Is it more of a constraint than an opportunity? This is again an important issue which as to be reconsidered before it is too late.

Backward Farming System/Agricultural Implement

Backward farming practices and farm implements have led to less productivity in agriculture. Farmers are not exposed to better technologies or refuse to adopt them.

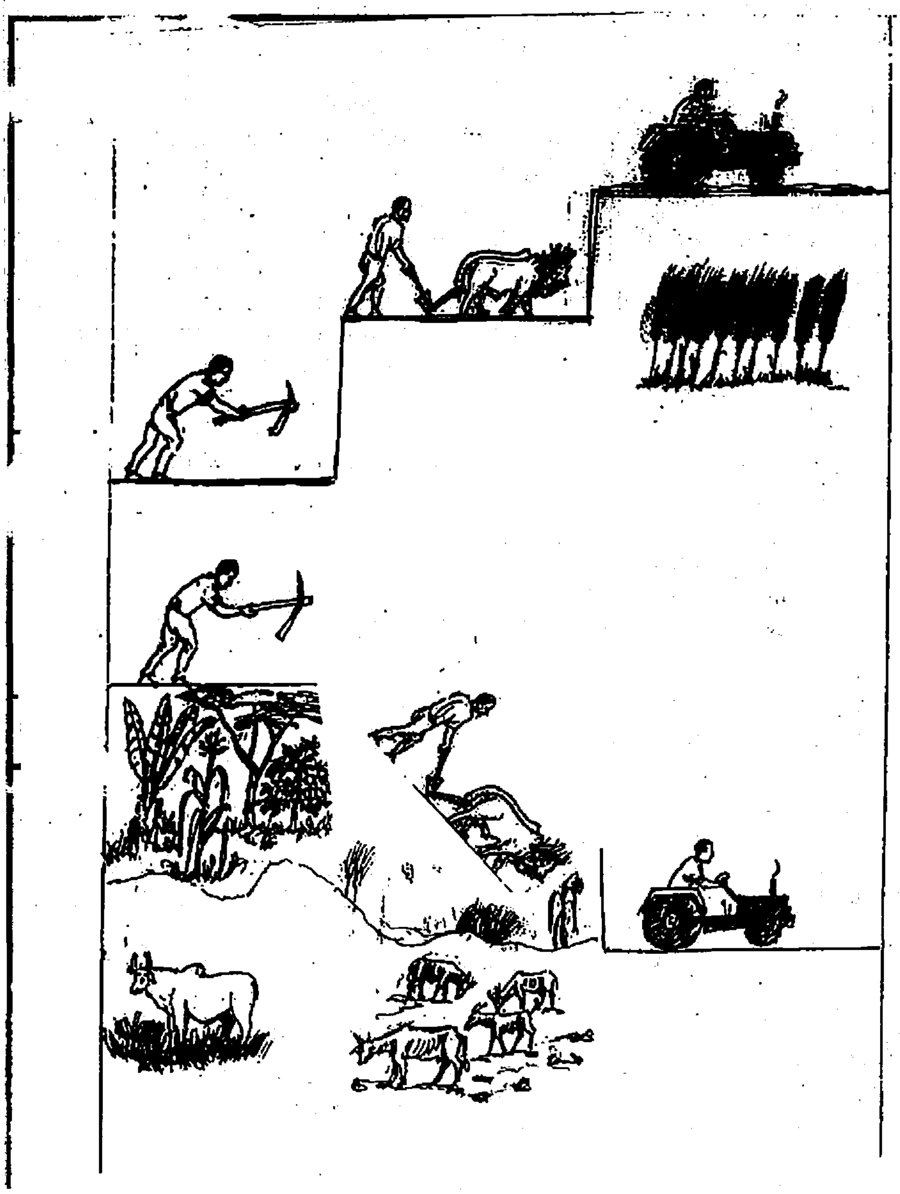


Figure 3: Comparative Farming System Development Stages

Intensive training has to be carried out to bring about behavior changes. Improving farm implement such as plow in ox culture are vitally important and urgent. This implement lasted over 4000 years without any change. This is a tragedy of traditional resistance to a dynamic world. Free grazing system is another form of resistance. In the dynamic world, we have to change but if we fail to do so two things can happen to us: the change will change us if we are lucky and we move on with life, or the change will bypass us and that could eliminate us.

Coffee Shade Tree Intercrop

In western Ethiopia where coffee has originated. farmers group interview was carried out in two places. One of these areas is located at 30km. in the south east of Jimma around Seka village. The second is also at 30 km West of Jimma. The latter is the site where coffee is suppose to have originated. In the faces of current coffee price decline, some farmers still insist and kept on growing coffee. They do diversify and use mixed cropping to minimize risk. This survey focuses on tree intercropping that the farmers focus on. The parameters were five, namely potential of the trees in providing shade, supply organic nutrient, conservation of soil, improvement of quality and overall environmental protection role. Five trees which were selected or ranked by the majority informant farmers were ranked with the highest score of 5 and the least 1. On the basis of ranking Albizia and Acacia were found the best followed by Mellitia, Croton and Cordia. Croton is the worst of all in terms of improving quality of coffee because of the odder, thus it has been given 0 value. Cordia is the second bad in this regard. But Cordia is commonly found in the farm, which is compromised for its best quality timber. These trees are allowed to grow freely and can flower to supply honeybees with honey bee forage. The foraging intensity of each species is shown in honeybee flowering calendar.

Table 3: Relative Appropriateness as a Function Quality and Quantity of Coffee Product, Around Jimma

Function	Shade trees				
	Acacia species	*Albezia gummiferra*	*Croton macrostachyus*	*Cordia africana*	*Meltia ferruginea*
Shade	5	5	3.8	3.8	3.8
Nutrient input	4	5	3.8	3.4	3.6
Soil conservation	4.8	5	4	2.8	3.8
Impact on test (quality)	5	4.6	0	1.6	3.6
Impact on Sustainability & environmental impact	4.8	4.6	3.2	3.2	3.8
Grand Total	93	121	74	74	92
Grand Mean	3.72	4.84	2.96	2.96	3.68

Note: - 5=Excellent,4=Very Good 3=Good, 2=Satisfactory 1=no effect, 0= Bad

Influence of *Acacia albida* on Food, Feed and Wood

i) Effect on Different Cereals Yield

Three sites with maize, sorghum and wheat /teff based farms were selected at Welinchiti, Buta Jira and Mojo respectively. Each farming system has a major agroforestry intervention. The major tree inter-crop is *Faiderbia albida* with a density varying from about 10-100 trees per ha. The branches are pollarded to reduce shading effect on main crop. Yield assessment in the vicinity of a single tree in two directions (shaded and non shaded) was made at two-meter intervals on the area of 4 meters square from the center of the tree to up 15 meters distance. In all observations yield increases as the distance from the tree decreases. The response was higher for bigger stalk crops like sorghum and maize, while it was small for small crops like teff and wheat. Yield being a function of major factors like root depth and spread, leaf area, actual length of growing period and above ground height these factors were relatively considered and compared qualitatively. The yield increase under the tree compared to 15 meters away was 101, 67, 40 and 12 percent for sorghum, maize, wheat and teff respectively. Thus, the yield increase has direct correlation with crop size. Yield increase was assumed to be because of the trees capacity to fix nitrogen and in nutrient recycling as it shades its leaves at the on set of rainy season.

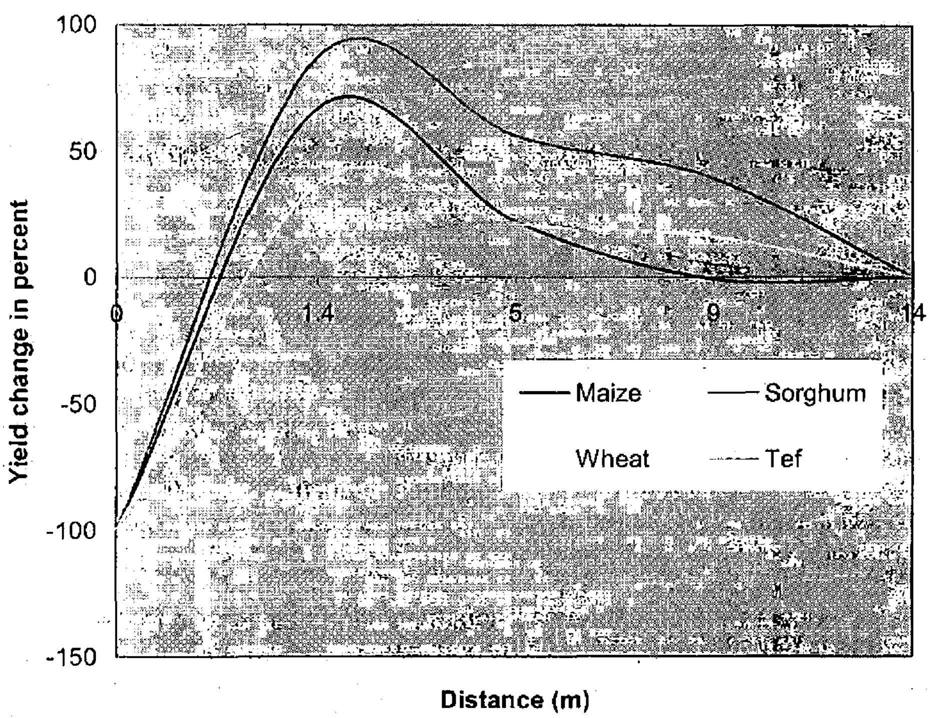


Figure 4: Yield Response Percentage of Different Cereals in the Vicinity of *Acacia Albida*

ii) Influence in Feed Supplement

For 46-60cm diameter tree spacing of 14X14m distance is opted as an optimum spacing which adds up to 49 trees /ha. In general, 50trees/ha is used for convenience throughout this report. The subsequent result and discussion on fodder and wood production is based on the same number of trees per hectare.

Green feed supplement of fresh-pollarded branch were fed to goats and sheep by spreading evenly so that all animals will get good access to fodder. The following table summarizes the average number of animals and time taken to browse a given amount of fresh fodder. The average fresh feed obtained per tree for all sites namely Buta Jira, Wolinchiti Mojo and Debrezeit is 53 Kg.

Study in Sudan by (Le Gouerou 1980) on *Acacia albida* nutritive value analysis showed 37.3 % dry matter, 17.1 % crude protein and 12.4 % crude fiber, which shows high protein and low fiber content (high quality protein and low quality fiber content indicator) has been obtained from the same finding.

Under Ethiopian dry land conditions in the Rift Valley and adjacent areas 53 Kg fresh leaves and some twigs/tree/year has been obtained. The corresponding dry matter and crude protein will be 20 and 3.4 Kg dry matter respectively. Thus the total annual dry matter production/ha is 1000Kg (170Kg crude protein). At the rate of 5% feed supplement rate and consumption of 5000-6000 Kg (5-6tons) total dry matter for one Tropical Livestock Unit (TLU)[1] is enough to supplement a pair of oxen for one year on sustainable basis under farmers management condition. The feed supplement has been obtained with neither any additional land demand nor any crop yield loss. Presence of the tree has even increased the yield of the crop compared to mono cropping.

iii) Influence in Wood Production

Fuel wood is the major problem responsible for land degradation in Ethiopia. Over 80 % forest clearance is due to fuel wood. In energy preference ladder, he preference of energy Is as follows, crop residue, cow dung, wood, kerosene and electricity. The more the farmers are poor and the more they are at the bottom of the preference scale, crop residue and cow dung are more often used compared to wood which also threaten human health by simply being smoky. They are directly or indirectly mined from the upper say 30cm soil depth compared to deep rooted perennial trees. Thus, they mine the soil severely and aggravate soil degradation.

Acacia albida goes much deeper than most researchers think, and has access to deep water table (over 150m author's unpublished Research report based on soil samples from bore hole and extrapolation of root projection of sample trees). The trees use moisture and nutrient without causing competition to crops, grasses and other shallow rooted plants. In addition to being nitrogen fixing, it has complementary production relations with agricultural crops in multi-storey vertical intensification traditional farming.

Samples from pollarded branches were weighed fresh prior and post browsing. The difference in weight was calculated. It was immersed into water; the volume of water displaced by wood was measured by a graduated container. 150 liters of volume per tree on average were obtained. This is equivalent to $0.15m^3$ solid wood production /tree/year as shown in table 4. Thus 50 trees produce $50x0.15=7.7m^3$/ha/year

General conversion factor for solid wood volume to stacked wood is (1/0.7). Thus $7.5m^3$ of solid volume of *Acacia albida* $=10.7m^3$/ha /year of stacked wood. A reduction in volume of 20 % is assumed due to shrinkage when the wood dries to an ideal combustible moisture level. The corresponding stacked volume of dry wood is 8.52 m3/ha /year.

[1] *Jahke, 1982 Conversion factor to (TLU) is 1.0,0.7,0.1,0.1,0.8,0.7 and 0.5 for camel, cattle, sheep, goat, horse, mule and asses respectively*

Total fuel wood requirement per capita/year is 1m3. For an average family size of 5 people the wood obtained from one ha is enough for 8 1/2 persons. Thus, one and a half family can meet the annual fuel wood demand including farm tools, light construction such as fence or barn for their cattle.

Had there not been wood 7 tons of cow dung or 6 tons of crop residues would have been used. Due to the availability of fuel, wood the above amount of cow dung can be used as a soil nutrient input in the form of farmyard or alternatively 6 tons of crop residues can be used as animal feed.

Influence of Croton on Cereal Yield

i) Influence on Finger Millet

Trees on farmer's field under similar growth performance and management were selected at Meshenti near Bahirdar, Northwest Ethiopia. The objective of the study is to assess the influence of the tree on the finger millet grain, height and straw yield and determine the optimum number of trees per hectare at which the straw and grain yield are on average optimum. The trees were 40 to 50 cm diameters at breast height. Since farmers are pollarding frequently at two meters there is a buttressing effect near the pollarded spots, thus trees with normal tapering at breast height were selected. The age of the pollarded branches was from two to three years. Crop and straw samples were harvested from 2m*2m(4m^2) plots at the distance of 0-2.8, 5-7, 9-11 and 13-15 meters respectively and the data was analyzed using the SAS statistical software. The orientation of the first plot (0-2.8m) is tilted to keep consistency with the previous studies. The site is gentle slope with red and friable loam soils. The rainfall is over 100mm/year with the main rain starting in late May or early June and extends up to the end of September or even early October. The poles from pollarding are used for fuel and construction, some leaves will shed, and most are left on the farm as an organic fertilizer right after pollarding. It will be incorporated with soil since pollarding coincides with the time of frequent plowing and the leaves are fresh which is heavy not to be carried out by wind. The species is believed to be among the ones that increase the phosphorus level. This nutrient is the most limiting major element that was not addressed by biological nutrients input and recycling by agroforestry technologies. Phosphorus and other nutrient level and availability are not determined. The response of yield straw and grain is determined. This is an indirect indicator of the nutrient status. Straw yield is 355, 674, 467, and 419 grams of dry weight, while that of the dry grain weight is 253, 622, 426 and 432 grams at 0-2.8, 5-7, 9-11and 13-15 meters distance from the tree respectively. Yield of straw and grain reduced in the immediate vicinity of the tree. Both have significantly increased at the second (5-7m) plots, which clearly indicates the influence of *Croton macrostachyus*. The height growth attained by finger millet at 0-2.8 m is another indicator that justifies the fertility status of the soil, nevertheless it has not reflected on straw and grain yield due to shade effect, leaf mulch and improper cultivation due to physical obstruction created by the presence of roots.

ii) Influence on Sorghum Yield

In dry land soil under tree have better soil moisture and organic matter as compared to open field. Farm trees have positive influence on nutrient input and recycling. Such trees can also be left on a farm where the branches are pollarded before they depress growth and the subsequent yield. *Acacia albida, Moringa stenopetal* and *Croton macrostachyus* are some of the major common tree inter-crops in the traditional farming system. Leguminous trees, which harbors bacteria, that fixes nitrogen an element, which is one of the major lucking nutrients in a farm .In agroforestry several technologies have been generated in this regard. Major lacking nutrients under farm soil conditions are N, P. and K. But K was not a major reported deficiency compared to the other two .The major limiting nutrient P input remains a challenge to be addressed by biological soil nutrient replenishment in agroforestry. This important piece of information attempts to assess the increasing P influence to some degree at a general level, as croton is one of the few species that increase P level in relative terms. This paper will not address the nutrient increase level, but it indirectly reflects the nutrient increase from the yield response. P^{ava}, is reviewed from others work for general information. Determination of nutrient status will be done in the next phase of the project. Very sensitive crops to nutrient input were selected from farmers field. Sorghum, which is selected for this crop yield study, is the first best nutrient response indicator as shown in comparative yield influences of different cereals in the vicinity of Acacia albida tree intercrop. In the current study, Sorghum response is the highest followed by finger millet in *Croton macrostachyus* traditional tree inter-crop. Tree with 50 to 60cm diameter at breast height were selected. Yield is assessed at 2.8,5,9 and 13m(mid point) from a tree of eight replications. Size of each plot was 0.5meter square. The average yield is 1.94,1.62,1.44 and 1.04tons/ha .The rate of increase is 86.5,55.8,38.5 and 0%respectively assuming the last yield is 100%. The crop farm is selected in areas where both inorganic and organic fertilizers were not used to avoid external yield influence. Influence of the tree on sorghum yield in its immediate vicinity is significant even upon consideration of yield depression at the base of the trees.

iii) Influence on Maize Yield

Farm trees have positive influence on nutrient input and recycling. Some trees have detrimental influence on the main crop; such impact can be evidenced from yield depression. Under such conditions, farmers remove trees from their farm. Some trees with intermediate characters usually have a negative influence on yield at later stages of branch development. Such trees can also be left on a farm where the branches are pollarded before they depress growth and the subsequent yield. *Acacia albida*, *Moringa stenopetala* and *Croton macrostachyus* are common tree- inter-crops in the traditional farming system. Leguminous trees fix nitrogen, one of the major lacking nutrients in a farm. In agroforestry, several technologies have been generated in this regard. Major lacking nutrients under farm soils conditions are N, P and K. But, K was not a major reported deficiency compared to the other two. The major limiting nutrient p input remains a challenge to be addressed by biological soil nutrient replenishment in agroforestry. This important piece of information attempts to assess the increasing p influence to some degree at a general level, as croton is one of the few species that increase P level. This paper will also address the nutrient increase level, but it indirectly reflects the nutrient increase from the yield response. P_{ava} is reviewed from other works. Determination of nutrient status would be done in the next phase of the project. Crops very sensitive to nutrient input were selected from farmers' fields. Maize which is selected for this crop yield study is the second best nutrient response indicator after sorghum, as shown in comparative yield influence of different cereals in the vicinity of *Acacia albida* tree inter-crop(3/). In the current study, sorghum response is the highest, followed by Finger millet in *croton macrostachyus* traditional tree inter-crop. Trees with 50 to 60 cm diameter at breast height were selected. Yield is assessed at 2.8, 5, 9 and 13m (mid point) from a tree from 8 replications. Size of each plot was 50 cm wide X 100cm long. The yield is 15, 16, 14 and 12 tons/ha. The rate of increase is 24, 35, 13 and 0% respectively. The crop farm is selected in areas where neither inorganic nor organic fertilizers were used to avoid external yield influence. Influence of the tree on maize yield in its immediate vicinity is significant even upon consideration of yield depression at the base of the trees.

Influence Of *Acacia Tortilis* On Livestock Production

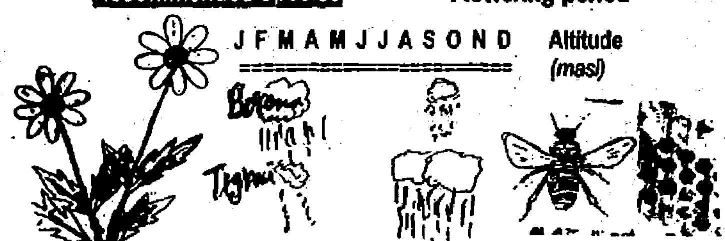
In Arid And Semi-Arid Areasshade Trees Reduce Extreme Temperature And Give Comfort To animals. Shade trees have significant influence on animal physiology in production, reproduction and maintenance

i) Honey Bee Forage (Flower)

Ethiopia has three to five million bee colonies, which makes the country first in bee density in Africa. It is also the fourth largest wax producing country after China, Mexico and Turkey.

The total estimate is about two thousand one hundred tonnes per year; it is one of the largest honey producing countries in Africa. World wide it stands in tenth place in honey production. In areas where cattle production is limited apiculture plays a significant role. Information on honeybee forage calendar give a clear vision for project planners, honeybee forage developers on species choice for the right quality and quantity of forage at a required time.

Table Flowering calendar of honeybee forage



	Recommended species	Flowering period J F M A M J J A S O N D	Altitude (masl)
1	*Acacia albida*		500 - 2600
2	*Acacia tortilis*		600 - 1900
3	*Acacia seyal*		500 - 2300
[redacted]	[redacted]		1300 – 2700
[redacted]	[redacted]		2000-3300
7	*Dovyalis caffra*		1500 - 2600
[redacted]	[redacted]	ΩΩΩΩ	1250 -2800
[redacted]	[redacted]		900 - 2400
10	*Euphorbia candelibrum*		1200 -1900
11	Acacia melifera		
[redacted]	[redacted]		In arid—2400
13	Annualgrases/Weeds		Wide range
14	*Guizotia scabra*		
15	*Acacia ethbaica*		
[redacted]	[redacted]		500 – 2800
16	*Phonex reclinata*		100 -2500

Source Dechasa 1995 mainly based on honeybee flora of Ethiopia

Note:- ==================== Pollen and nectar are collected frequently

\=\=\=\=\=\=\=\= Pollen and nectar collected less frequently

_____________ Either pollen or nectar

ΩΩΩ Juice of ripe fruit in critical dry period

Source;- Dechasa 2002 Agroforestry Training Manual at National level

ii) Animal Feed

Pod

Acacia tortilis pod drops for a period of 2-3 months. In the rift valley at Hadami Tullu it starts dropping in February to April. Some individual trees drop at different times depending on age, site or variation at sub species level, etc. The variation and longer duration is important to sustain supply in areas of free grazing. The pod is a high value feed supplement, which is comparable to oil seed cake and alfalfa Mieso (1998). Prior to pod production flower is the moist important honey bee forage as shown in honey bee flowering calendar.

Leaves and Twigs

Acacia tortilis is one of the four economically important species in Africa and in Ethiopia as well. The leaves are important feed supplement and pods are equally important. Those plants are so important in that, they access the deeper profile of the soil reaching most types of major and minor nutrient. Thus, browser animals have better chance of getting a complete diet, which can be reflected on their respective milk or meat products. Currently goat milk is if a high quality milk at national or international standard. Goats have also a particular character that enables them to access rather un-accessible spots which help them to widen the variation of choices of their feed. According to local information they feed on snakes and several medicinal plants, thus their cholesterol is known for development of immunity against several diseases. Camel milk has similar advantages. In terms of spatial arrangement, perennial plant occupies deeper and wider space in underground spread for mining and absorbing a variety of nutrient and have similar orientation in its above ground reach to optimize trapping of sunshine energy and other above ground resource essential for plant development. Perennial plants as the name indicates are permanent. Thus, the active lifetime of the plant is much longer. Thus, they have longer time of absorbing and mining resources essential for growth and development of the plant.

iii) Shade for Livestock and Fodder/crops

Under extreme cold and high temperature animals of almost all classes need to be sheltered to keep them in their optimum comfort temperature range for optimum production; so do need plants. High temperatures reduce birth rate and production of milk and meat. On the other hand, cold temperatures result in loss of new born animals. For the optimum comfort range of some animal species see the following diagram. In all cases the temperature requirement by newly born animals is elevated with a very narrow range. As a result their housing or shelter requirement need to be designed in such a way that it can keep them in the required temperature ranges. Thus the right species selection for shade or manipulation of a canopy to obtain the right density of porosity level to control both direct sun light and controlling wind speed to avoid chilling are the most important pieces of information.
In a mixed farming, scattered trees have multiple uses both in pasture and arable land. Acacia species are the most popular shade trees in Ethiopia. The form of their canopy is predominantly umberella-shaped.

Crops in dry and arid areas benefited from shade in two ways. The fist one is reduction of high temperature during the day and increase in temperature during the night. Thus, presence of the tree has a temperature-stabilizing role. The second advantage is that moisture under the shade is higher compared to open. Soil moisture content at ILCA where the sunshine hour intensity is 200 hour/year (5/) was 1.5 to 2 times higher compared to open (1/).

Under Ground Vegetation, Cover in Naturally Regenerated Woodland

In a pasture due to shade effect and probably soil enrichment role due to leaf shading weed herds grow under the tree evicting grasses. Of course there are some high quality grasses like Muga, Marga hilet and herbs like Dergu which are the best animal fodder. Thus a balance has to be reached in determining spacing for integrated benefit maximization on the bases of food, feed and wood need in a more sustainable way as well as quality production. The following graph and table shows the detail of underground cover in naturally regenerated acacia woodland of area enclosed for 25 years at Melkasa.

Under ground vegetation cover in terms of density and composition is sampled, from four replications. Each sample was taken from an area of 16m^2 at random within 154m^2 circular plot where wood yield is assessed. Practical observation reveals that under growth from proximity of the tree, dense canopy and bigger trees showed strong correlation with high-density herb cover and on the contrary open spaces are covered with grasses. A detail observation in each replication will be discussed below.

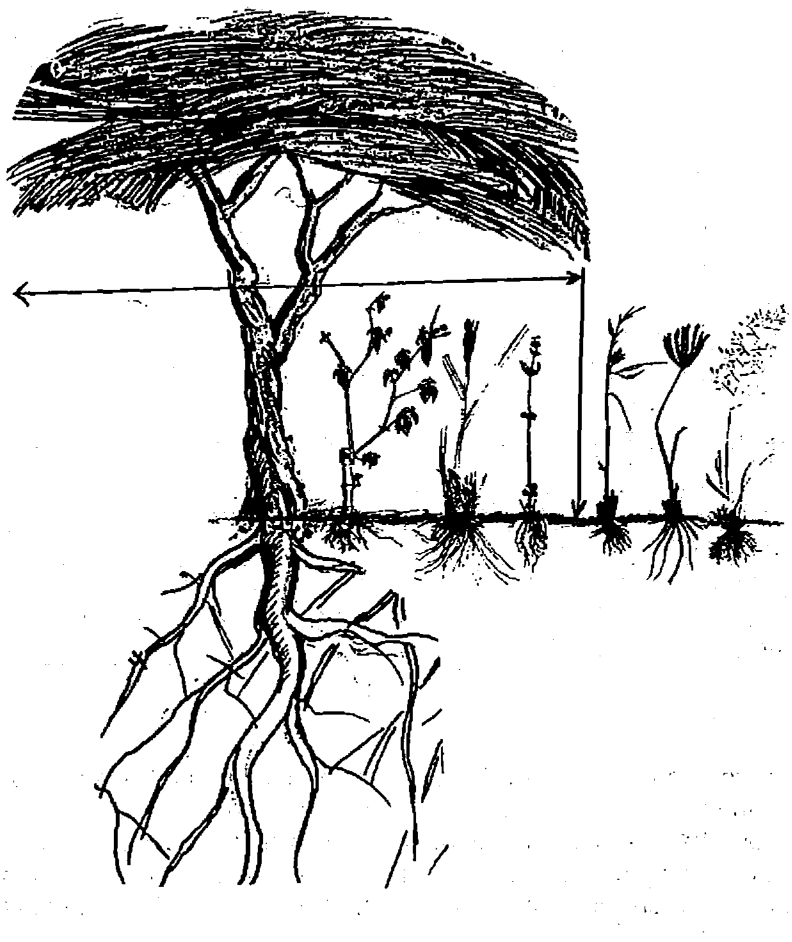


Figure 5: Illustration of the Major Hers and Grasses Under the Canopy and Vicinity of *Acacia Tortilis* in their Relative Location

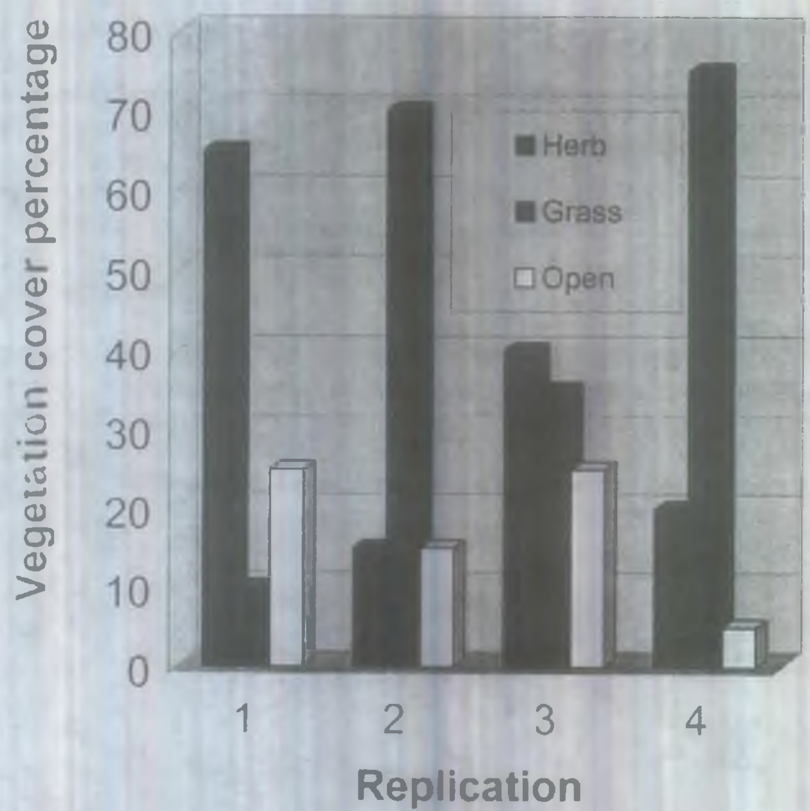


Figure 6: Vegetation Cover Under and Near *Acacia Tortilis*

Table 5: Number and Average Diameter of Trees in Each Replication

Description	Quantity			
Replication	1	2	3	4
Number of trees	8	5	4	4
Average diameter (cm)	24.56	10.32	15.89	17.38

Replication 1: -

The tree where the sample is taken is relatively the biggest both in canopy and diameter in general. A randomly selected plot is within 7m radius plot's spot. A 4x4 meter sample fell near the base of a tree. Another tree is also nearby which increases the influence of the tree on underground vegetation cover. Thus, there is distinct domination of herbs population recorded from the sample plot. Herbs in general contributed 65 % of the total under growth cover and can be detailed, to 40 % leafy herbs of different species and 25 % of locally known as Dergu (the dominat single species in the plot). It is the best fodder herb especially for dairy animal/milk production (personal communication with local farmer). The local grass is the smallest of all the replication and is dominated by a grass locally known as merga Hileti (Rabbits' grass), which is another indicator of site's fertility. This can be explained by the fact that *Acacia tortilis* at the plot is a deciduous tree and shades every leaf every year and recycles nutrient in the vicinity of the tree. Open area contributesto about 25 % of the total area. It is difficult to explain confidently. Its most probable reason can be drips from the branches during rain that have an erosive power on soils and competition that can be created by some species. For this specific answer other research concerning this problem need to be conducted after preliminary survey. Similar open area coverage is obtained in replication 3. Replication 3 plot is generally has relatively low productivity from the underground species type and performance. Thus the open space can be explained by conventional generalization.

Replication 2: -

The density of the tree is very low the trees are relatively smaller. Thus the shade casted and the leaf that shades to enrich soil is low. As a result grass cover is high with more proportion of low quality grass which is 35 % (Mergaa serie 20% and other grasses 15%) compared to 25 % high quality grass (Kikuyu grass) and there is highest site quality indicator grass called locally Muggaa. All in all grass contributes to 70 % of the total land cover. Compared to herb and weeds grass sites are indicator of low quality site. Open space is 15 % of the total coverage, which seems very low in relation of concluded low fertility. Probably there is less sheet erosion or there might be original site variation in terms of fertility. Thus, soil nutrient status study is required for a reliable result.

Replication 3: -

It has lower number of trees than replication 2. Since the sizes of trees on average is bigger and sampling is taken near the tree, coverage is relatively high. The site is similar with that of replication 2 from visual observation. Grass cover is 35 % with the constituent of (Kikuyu grass 15 %, Marga sinbira 10 % and other grasses 10 %). The open space, 25 % which is another indicator of low fertility.

Replication 4: -

Site 4 (rep.4) has 75 % grass. Since the type of grass is Kikuyu grass it is a sign of high potential site within a grass covered area. Another indicator of fertility is that bare surface (Open area) is the lowest in coverage which contributes to only 5 %. The number of trees are the lowest but it has the second highest average diameter. From the above information grass cover must reduce and herb coverage should increase (if the above interpretation is correct). Based on the writers observation, the sample plot is at the edge of naturally regenerated woodland. Trees being umberella shaped and single stemed will allow enough morning and afternoon light that allowed better development of the grasses. Since the site is at a flat lower area, there is an accumulation of soil by erosion, which may improve the productivity. This can be evidenced from 75 % of Kikuyu grasses share cover. Generally, this study has to be supported by soil nutrient analysis for more information that is reliable.

Influence of windbreak in cool exposed highlands of Ethiopia

I) Wind break for crops

Wind causes yield loss by desiccation and removal of fertile soil. Thus planting of wind break will improve soil physical conservation, reduce evaporation and evapotranspiration.

II) Windbreak for Animals

In cooler areas of the highlands of Ethiopia and frost pockets trees need to be planted as shelter to keep animals in their comfort temperature range. Presence of trees in general avoid temperature extremes.

Agroforestry Intervention in Salinity (secondary) Control in Dry Irrigation

The case of the rift valleys

Cause: **Increase in ground water recharge**

Deforestation (removal of deep rooted perennial)
Replacement with (shallow rooted eg. Annuals)
Flooding (faulty irrigation deforestation climate change)
Others

Scale of the problem varies with

Geology
Climate (more rain, high temperature etc.)
Land management
Land form (river that dies inland) are very difficult to reclaim the land for further usage ones for it is salt prone lan

- *Segen & woito*
- *Awash*
- *Omo*
- *Tikur wuha*
- *Others*

Optimum spacing recommendation in integrated tree inter-cropping

Yield increase optimization is the focus of the package. In this paper, one model will be presented. Tree intercrop in this regard is *Acacia alibida*. Yield increase in percentage near the tree at about 2.8 m from the center of the tree is 100, 67,40 and 12 % for sorghum, maize, wheat and tef respectively. The distance at which yield increase influence terminates varies based on type of crop site and sizes of the tree. An average for all crops at the diameter of a tree ranging from 40-60 cm diameter is considered in this condition. Thus 50 trees /ha is optimum for crop optimization (to be specific it is 49 trees/ha).

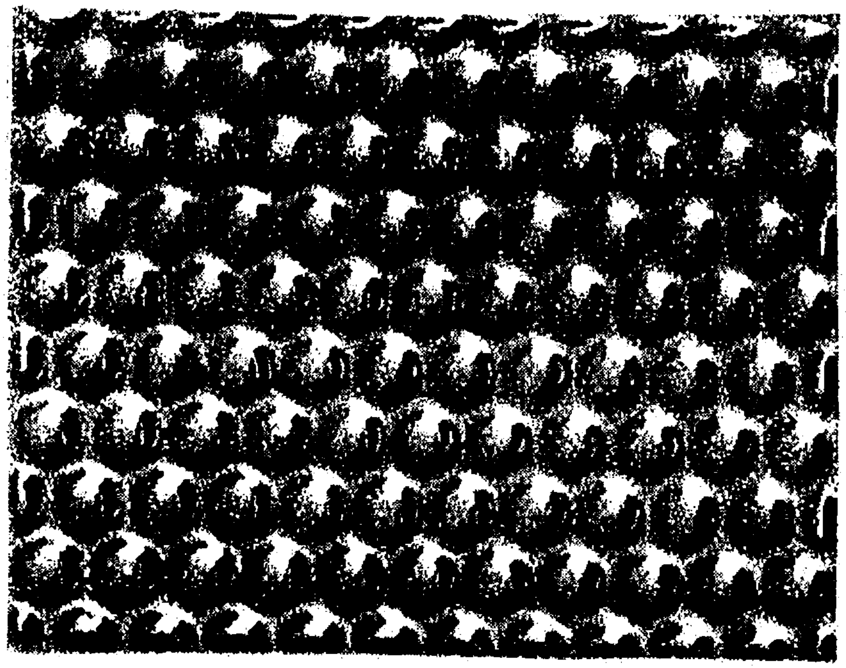


Figure 7: Staggered Design Adopted from Honey Comb for Efficient Space Utilization in Tree Intercrop Planting

A staggered design from honeybee comb is adopted in planting. Thus, 14m by 14 m spacing is adopted. Such growth stage is reached at the age of 30 to 50 years. Since pollarding retards growth it will even take more time. At the initial year planting density will be 7by 7 which will total to 196 trees per hectare. Over the years they will be thinned accordingly. Fodder yield and wood yield obtained /ha has been discussed already.

The next tree influence there is a double yield increase effect shown by the double crossing. The same area is used to fill the above depression shown by the dotted sign. Theoretically, optimum yield is optimum area under curve in yield increase percentage as shown below.

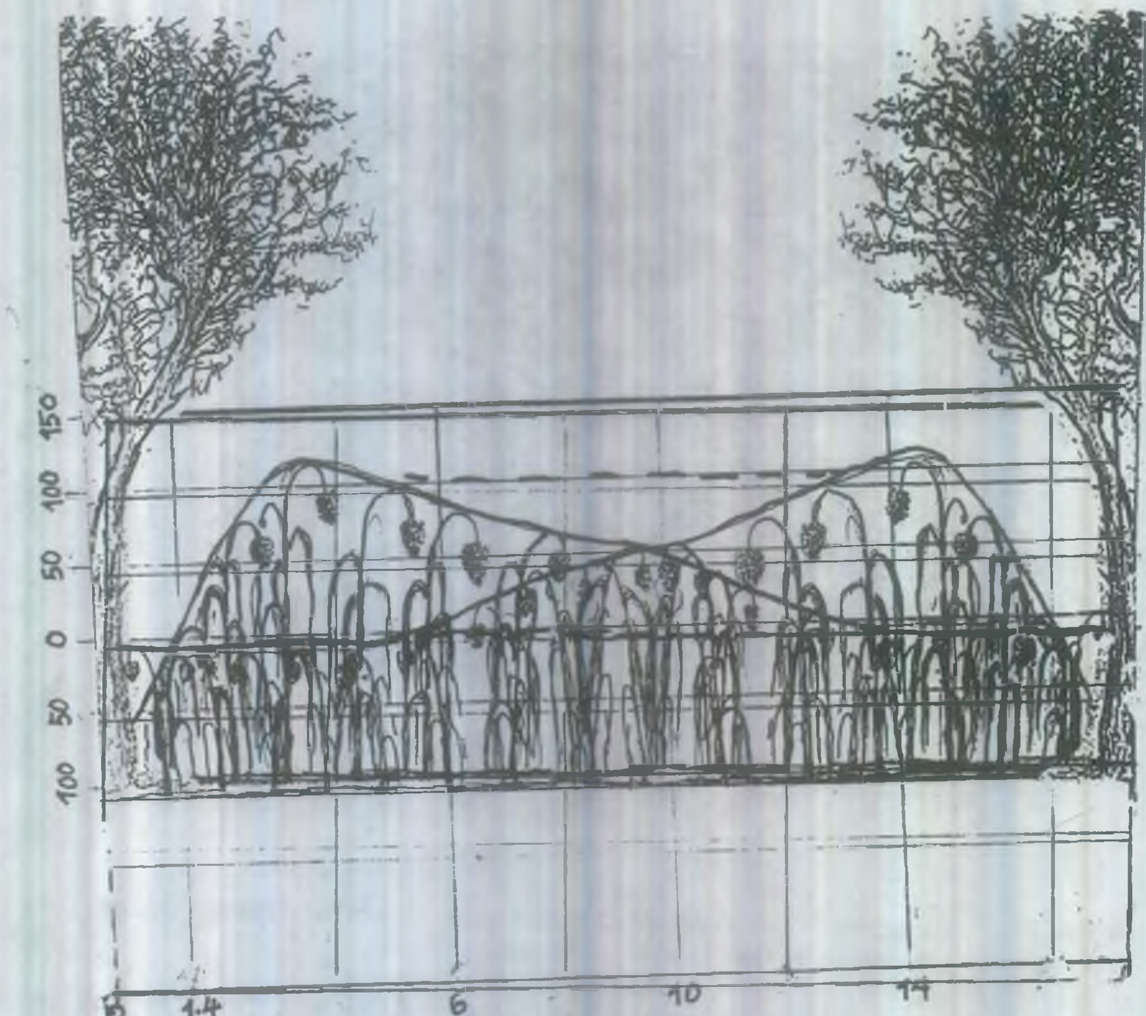


Figure 8: **Superimposing and Finding of Area Under Curve to Find Optimum Tree Intercrop Spacing**

Recommendations

For a short or long term change in attitude particularly in the farming system, innovations in agricultural implement, changes in food habit and policy in favor of integrated rural development can have great contributions. Common understanding, transparent persuasive discussions can help alter traditional societies especially in their farming practices.

Change in social attitude of capitalizing on opportunities and awareness on farming system that favors biological conservation in the entire catchment of a given area particularly in places of steep slope is recommended.

Same options mentioned in physiography can apply to water resource management. Natural regeneration with better vegetation cover such as grass will improve infiltration, reduce erosion/siltation that ultimately balance underground and surface water existence and flow respectively thereby avoiding occurrence of secondary (man made) salinity.
Acacia albida tree inter-cropping has several multiple advantages specially in increasing soil productivity. There is long gestation period say 10 to 15 years depending on the site conditions till tree reaches harvesting stage. This gap in production can be bridged by increasing plant density and thinning every two or tree years. This management practice will reduce the loss of benefit at early stage.

Soil nutrient input has to be studied, nutrient input and output (in nutrient flow model study) need to be assessed which intends to show the role of *Acacia albida* in the system by comparing with mono cropping and use of inorganic fertilizers.

Other direct and indirect benefits have to be evaluated to understand the over all benefit of the tree to a farmer.

Uses and values of cow dung crop residue compared to wood as an alternative from *Acacia albida* has to be studied from environmental conservation over long term perspective.

Root spread, development, taproot elongation rate response to moisture and underground water table need to studied in detail. Since phonology of shedding leaf is ideal and is a potential species, more attention has to be given.

Wide scale studies on different ages at different sites need to be carried out for different crops under controlled experiment for complete tree inter-crop farming system package generation.

Optimum spacing for optimum production for each major site, crops and age of the tree can be generated

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The Energy Dimension in Food Security

Bekele Bayissa[*]

Abstract

In a country such as Ethiopia, where peasant farm and pastoral agriculture are the predominant ones, the energy dimension in agriculture, and, thus, in food security is not vivid and may even be ignored in designing and implementing development policies, programmes and projects. The main reasons for this are: firstly, no commercial energy source requiring technologies are employed for almost all food production activities. Secondly, energy is usually wrongly understood to be only in-animate energy, the energy supplied by fuels, electricity and other energy sources. Animate energy, the energy provided by the muscular power of animals and humans, is not taken as energy in most cases. Thirdly, animate energy is only noticed as a problem for peasant farm and pastoral agriculture when there are long dry seasons and famine that weaken farm animals, peasants and pastoralists. However, any agricultural activity, be it crop or animal production, is done either by muscular power of animals and humans or by the machines powered by combustion engines, electric motors or other prime movers, and, therefore, requires energy. Irrigation, one of agricultural activities that was not given due attention in Ethiopia for decades, but, currently, gaining popularity, cannot be done without the application of energy, especially in hilly landscapes and where there is lack or shortage of surface water sources. Activities such as grain milling, baking and cooking, which consume a lot of energy, may not be considered as direct food production activities. However, muscular power, which is needed for food production, cannot be obtained unless the farm labour and draught animals are fed well. Energy is also needed for rural workshops/industries and social services such as education and health that support food production and related activities. Therefore, be it animate or in-animate, energy is needed for food production, food distribution, preparation of palatable food for humans and feed for animals, for rural workshops/industries, and for social services that support food production. In fact, it is a very essential input for all major activities undertaken to secure food. The history of world agricultural development shows that farming was started with the application of human direct labour. Then it went to employment of draught animals and then to engagement of engines/motors, which are very powerful. These developments increased the energy input in many folds and were all coupled with jumps in food production, which overall shows that the more energy input the more agricultural output, of course, without disregarding the great contribution of other agricultural inputs and the decreasing trend of energy intensity due to technological developments. Therefore, in view of the present state of affairs where the energy input into the Ethiopian agriculture is mainly limited to animate energy, the sector needs more and more energy input together with wide application of energy efficient and resource conserving farming techniques such as conservation tillage in order to give much more output and achieve sustainable food security. Those who work for the achievement of food security, should, therefore, seriously take the energy dimension into consideration. Moreover, there are a lot of simple energy technologies (for water supply, cultivating, harvesting, threshing, transport, grain milling etc.) that could be adapted to the needs of the Ethiopian peasants and pastoralists provided the energy dimension in agriculture and food security is understood and due consideration is given to the application of those energy technologies.

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1. Background and Introduction

The agricultural sector of Ethiopia is predominantly peasant farm and pastoral agriculture. Almost all farm works are done by employing animals and human labour. No commercial energy source requiring technologies are employed for almost all food production activities. Until very recently, wide-scale introduction of modern agricultural technologies has been almost grossly limited to the application of fertilizers, selected seeds, pesticides and other agricultural practices, which do not demand considerable energy supply. The fact that irrigated land is only 3% of the total land area of Ethiopia [1] and the ridiculously low utilization of 3.6% of the total petroleum fuel energy consumption[1], simply shows that the agriculture is rain-fed, employs primitive technology and there is little modernization.

Moreover, energy is usually wrongly understood to be only in-animate energy, i.e., the energy supplied by fuels, electricity and other commercial energy sources. Animate energy, the energy provided by the muscular power of animals and humans, is not taken as energy in most cases. Energy is only noticed as a problem for peasant farm and pastoral agriculture when there is long dry season and famine that weaken farm animals, peasants and pastoralists.

Consequently, the energy dimension in agriculture, and, thus, in food security is not clearly understood and even usually ignored in designing and implementing development policies, programmes and projects. Even when the need for energy in some agricultural schemes such as irrigation projects is recognized, only conventional energy sources and technologies such as diesel pumps are employed without undertaking studies for alternative energy supplies suitable to the area and the project.

The objective of the present paper is, therefore, to show the need and importance of energy for various agricultural activities and for the development of the sector and related fields as a whole. Accordingly, the first section of the body of the paper discusses the role of energy in agriculture and food security. The section treats the relation between energy and the level of agricultural development, irrigation and the need for energy, energy and food preparation, energy and food transportation, energy and social services, and energy and rural workshops/industries.

Following this, the status of energy in Ethiopian agriculture is presented with some elaborations on the supply status, demand status and supply/demand gap. Finally, before presenting the conclusions and recommendations of the paper, measures for improving the energy supply option are discussed. Here, some review of renewable energy technologies is given before making proposals on the energy technologies to be applied and/or developed for food production and related activities. Then, measures to be taken to improve the energy situation to bring about sustainable agricultural development that could ensure continued food security are presented.

The author would not like to give the impression that the present paper covers all the issues that need to be raised in relation to energy and food security. However, he hopes that the paper will initiate more discussions and further in-depth studies in the area. Moreover, he believes that the issues raised in the paper are of major concern and demand due consideration by the concerned policy makers and those who undertake development activities related to agriculture in general and food security in particular.

2. The Role of Energy in Agriculture and Food Security

Energy, be it animate or in-animate, is needed for food production, food distribution, preparation of palatable food for humans and feed for animals, and for social services that support food production. In fact, it is a very essential input for all major activities undertaken to secure food. The following sub-sections provide some elaborations.

2.1. Energy and Levels of Agricultural Development

Any agricultural activity may be seen as either crop (edible or non-edible) or animal production and one may consider three levels of agricultural development: simplest, intermediate and high levels. At the simplest level of agriculture, only human labour and animals are used. At the next stage, intermediate level, small power machines are used in addition to human labour and animals. The machines are usually used for stationary applications such as irrigation/pumping and crop threshing. At the high level of agricultural development, power machines do most of the activities. The common feature of this stage is that land preparation becomes mechanised with tractors and power tillers. It is quite obvious that with the increase in the development, the energy consumption increases tremendously. Generally, although the types of energy, animate or in-animate, and its intensity, high or low, are different depending on the level of the agricultural development, a considerable amount of energy is required for direct agricultural production. This relationship could be more easily shown using the ideal model given in Figure 1 below.

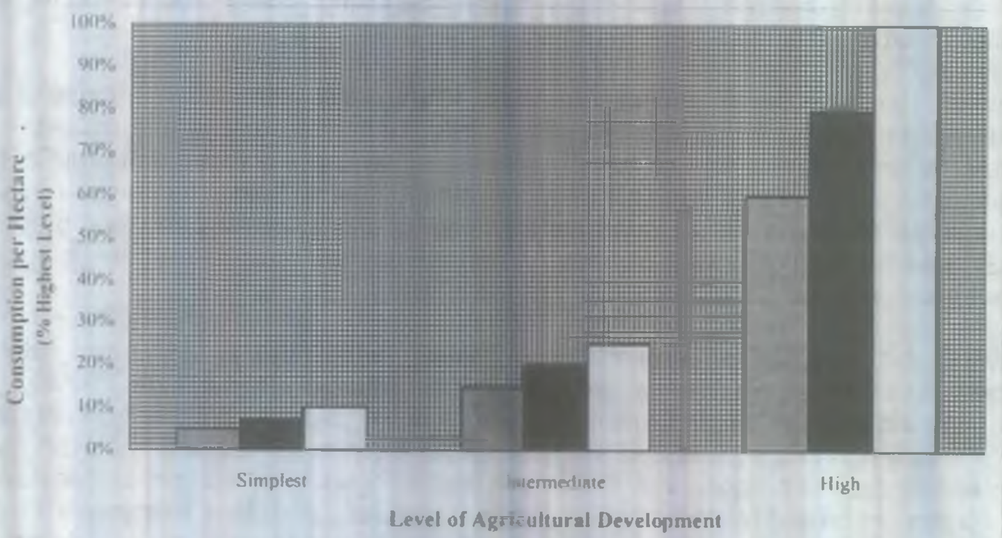

Figure 1: Relationship Between Level of Agricultural Development and Energy Consumption

The ideal model given in Figure 1 could also be substantiated by a statistical analysis. A cross-sectional data analysis of 108 countries from the six continents of the world (i.e. excluding Antarctica, which is inhabitable by humans) shows that there is a strong correlation between per capita energy consumption and cereal crop yield per hectare [2], [3]. In fact the best-fit curve indicates that the relationship is exponential. Figure 2 shows the graphical representation of the cross-sectional data together with the best-fit curve or the trend line.

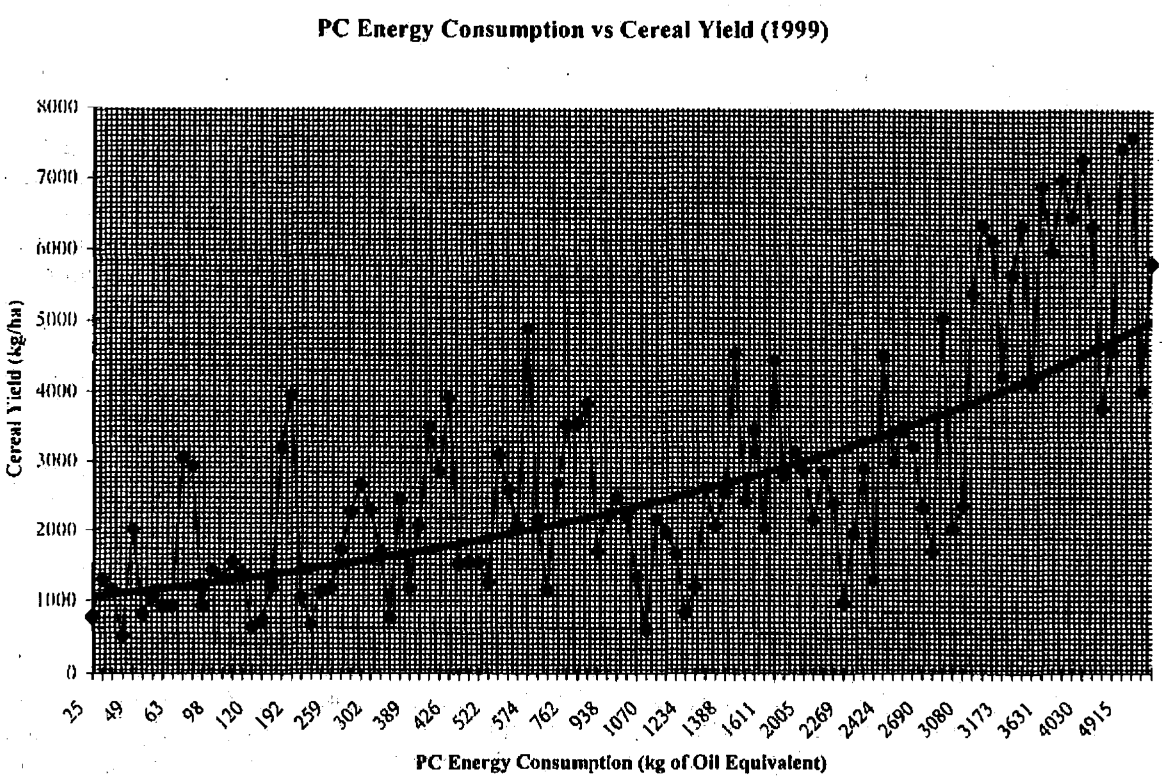

Figure 2: Per Capita Energy Consumption Versus Cereal Crop Yield of 108 Countries for the Year 1999.

As could be observed from the graph, the cereal crop yields are generally very high for countries with high per capita energy consumptions. However, this doesn't mean that energy is the only contributing factor for the high level of crop yield. It should never be forgotten that countries with high per capita energy consumption do also have high consumption rates of other agricultural inputs such as fertilizers and selected seeds, which highly increase the crop yield. It may be important to note here that better results could be obtained if per hectare energy consumption were used instead of per capita energy consumption. However, this data was not found on international energy statistics publications [2] and thus was not available to the author.

2.2. Irrigation and the Need for Energy

Irrigation is one of the oldest agricultural technologies. However, it was not given due attention in Ethiopia for decades. Currently, it is gaining popularity because of the recurring drought and improved animate-powered (manual) devices that are being introduced in many areas where irrigation is applied. Nevertheless, as the size of irrigable land increases beyond garden-scales, these devices may not be able to provide sufficient water to allow the farmer to change the cropping pattern from that used under rain-fed conditions. Thus, there comes a need for application of pump irrigation, which brings with it transition to consumption of modern energy.

2.3. Energy and Food Preparation

The need for energy in food security is not only limited to direct production activities. Activities such as grain milling, baking and cooking, which are not direct food production activities, are required to feed farm labour and draught animals that produce muscular power. Obviously these activities demand a lot of energy. Decades ago, grain milling used to be done manually in many households of rural Ethiopia. However, this has long been replaced by diesel engine and electric motor driven grain mills located in urban and semi-urban areas, and market places of the countryside. The engines consume a considerable volume of diesel fuel and the electric motors demand a significant electric power input, both of which are commercial energy sources.

The major household food preparation activities, baking and cooking, require a lot of energy. In fact they are considered as the main causes for deforestation next to forestland clearing for agriculture and cutting of trees for construction purposes.

2.4. Energy and Food Transportation

Food security demands good food distribution system and hence reliable transportation. Thus, even though transportation of food is another area that may not be put under the category of direct food production, it also requires energy in the form of animate, if humans or pack animals were employed, or in the form of in-animate, or commercial energy if power vehicles were used. The level of energy requirement and consumption here also generally varies with the type of the transportation system employed. Obviously, power vehicles, which correspondingly carry huge amount of load, require much more energy than humans, pack animals and carts pulled by animals.

2.5. Energy and Social Services

Energy is also needed for social services such as education, communication, health and supply of clean drinking water that support food production and related activities. Nowadays, most elementary and high schools in the country use radios and some even also use televisions to receive teaching programmes broadcasted/re-broadcasted by a dozen of stations distributed all over the country. Currently, there are programmes that even elevate these efforts to a much higher technological level by employing Vsats for the transmission of teaching programmes and exchange of information [4]. Although very limited, some schools in the rural areas also provide evening classes using solar or some other type of lighting systems.

Rural health services, clinics and health centres, also require energy, specifically electric energy, in order to operate some medical equipment including lab equipment and refrigerators for storage of perishable drugs such as vaccines.

a. Energy and Rural Workshops/Industries

Rural workshops such as metal workshops/blacksmith support food production and related activities by way of producing and maintaining agricultural implements and household items.

Grain mills could also be considered as the rural industries that provide milling services to the farm households. Even though the traditional blacksmith and artisans mainly depend on human labour and traditional fuels, workshops and small industries in the rural areas require commercial source of energy such as diesel fuel and electricity.

3. The Status of Energy in Ethiopian Agriculture

The Ethiopian agriculture mainly uses human labour and animals. The sizes of irrigated land and mechanised agriculture are very small. According to the Annual Report 2000/2001 of the National Bank of Ethiopia, of the total land area of Ethiopia, which is 1.14 million square kilometres; the size of arable land is 45% and that of irrigated land is only 3% [1] or 13.5% of the arable land. This shows that the level of the agricultural development is very low and is mainly categorised in the simplest level, which uses smaller amount of energy for food production and related activities.

3.1 Supply Status

As mentioned above, the Ethiopian agriculture mainly uses animate energy, which is supplied by draught animals and farmers (peasants and pastoralists). According to the survey made by the Central Statistical Authority, the number of peasant families (households) and the cattle (the main draught animals) population in the country by the year 1999/2000 were estimated at 10.7 million and 33.1 million, respectively. The average number of members per family was 5.0 during the same year. The land under cultivation during the same year was estimated at 9.1 million hectares [5]. Assuming 50% of members of each household are active and 40% of the cattle population are deployed on agricultural activities, the human and draught animal per hectare of land under cultivation was 2.9 persons and 1.5 animals. An average person can do about 46 foot-pounds of work per second, which is 0.084 horsepower (hp) or 0.062 kW [6]. An ox is estimated to have about 0.33 hp. Thus, the power input into the Ethiopian agriculture may be estimated to be 0.66 kW per hectare, which is less than one horsepower.

On the other hand, the commercial energy (petroleum fuels and electricity) consumption of the agricultural sector of the country is very small. According to the energy balance made by the Ethiopian Rural Energy Development and Promotion Centre, the annual consumption for the year 1998/99 was 41,240 tonnes of diesel fuel (=1,497 Tera Joules), which, in terms of share, is only 0.2% of the total energy consumption of the country during the year. In terms of the total energy consumption from petroleum fuels, the share of agriculture is only 3.6%. This is ridiculously very small and, thus, modern energy consumption in agriculture may be considered nil for practical purposes.

There is no data on the supply of energy from other sources such as wind, small hydro and solar systems. However, based on the available qualitative information, it is not significant and may be ignored for analytical purposes.

3.2. Demand Status

The demand for energy in the agricultural sector arises from direct agricultural activities such as cultivation and irrigation, and indirect activities such as food preparation, food transportation and social services in the rural areas. With the current state of the Ethiopian agriculture, the demand for energy is mainly for animate power. However, with the increasing size of irrigation schemes; expansion of rural roads, education and health services; and spread of modern life style in the country. the demand for commercial energy would also increase significantly. Although quite small, the increase in the agricultural mechanization services and mechanized private farms would also increase the demand for commercial energy.

However, based on the past trend, the future demand for commercial energy in the agricultural sector cannot be much higher than what it was. This indicates that a significant shift in agricultural and related policies, which could bring about a major change in technology application, is required.

3.3. Supply/Demand Gap

The growth of population obviously increases the demand for food, which, in turn, normally increases the demand for energy for agriculture. Currently, the population of Ethiopia is estimated to grow at a high rate of about 3% per annum and has already created pressure on various resources. According to the available statistics, the average crop area per agricultural household has significantly decreased over the past years, showing a population pressure. Table 3.3.1 below presents the average crop area per agricultural household during the past six years.

Table 1: Average Crop Area per Agricultural Household

Year	Households (In '000s)	Crop Area (In '000Ha)	Crop Area per Household	Change
1994/95	7,949.18	7,691.83	0.97	
1995/96	8,516.47	8,687.15	1.02	5.4%
1996/97	8,682.13	8,825.06	1.02	-0.4%
1997/98	9,292.87	7,566.95	0.81	-19.9%
1998/99	9,311.57	8,924.26	0.96	17.7%
1999/00	10,738.20	9,133.51	0.85	-11.3%
Average				-1.7%

Source: [5], [7] and [8].

As shown in the table, although both the number of households and the size of crop area are increasing, the crop area per household is decreasing at an average rate of 1.7% per year. This shows that there is a great need to increase the agricultural output per unit crop area in order to sustainably feed the growing population, which, as mentioned earlier, requires more energy input together with other agricultural inputs.

Generally, the following major energy supply/demand gaps are being observed in the agricultural sector.

1. Need to increase the agricultural output per unit crop area because of population pressure, which has resulted in continuous decrease of crop area per agricultural household;

2. Increasing shortage of oxen supply because of increase in cultivated land, demand for more beef with population growth, and shortage of pastureland;

3. Shortage of supply or scarcity of commercial fuels in the rural areas because of little supply network, road infrastructure and high mark-up; and

4. Very limited use of renewable energy technologies because of little knowledge and high initial costs.

4. Measures for Improving the Energy Supply Option

As shown above, agricultural development, and, thus, food security requires good supply of energy. Fortunately, there are various ways of improving the energy supply options for the agricultural sector. With the current level of the Ethiopian agricultural development and the need for changing this status to the next higher level, the measures given below may be suggested. However, before providing some suggestions on the measures to be taken, it would be important to present brief discussion on renewable energy technologies, which are becoming more and more competitive alternatives.

4.1. Renewable Energy Technologies

a) Solar (PV) Systems

Solar (PV) systems convert the radiant energy of the sun into electricity. The electric energy so produced is used to run electric motors to drive irrigation pumps, light lamps and provide power to other facilities. The sun, being a free source of energy, the operational costs of these systems are so minimal. Moreover, solar energy is pollution free and renewable. The initial costs of solar (PV) systems are also decreasing and these systems are becoming more and more competitive. In fact they are the best alternatives in remote areas where grid extension is very unlikely, petroleum fuels are scarce and expensive. Rural agricultural areas in Ethiopia are usually far away from urban centres and do not have the necessary road infrastructure for the transportation of petroleum fuels. Moreover, petroleum fuels are imported from abroad and their importation creates a huge drain on the hard earned meagre foreign currency of the country.

b) Wind Mills/Turbines

Wind mills/turbines capture the energy in the wind and convert it to mechanical/shaft power that is usually used for driving pumps in the case of windmills and for generating electricity in the case of wind turbines. Like the sunlight, wind is also a free source of energy. Thus, wind mills/turbines have very low operational costs. Moreover, their power generating capacity (per wind mill/turbine) is increasing tremendously and now there are wind turbines that can generate electric power in mega watts (MWs), not in kWs. Low operational costs coupled with possibility or availability of local manufacturing makes wind mills/turbines very appropriate for windy places such as those close to the costal areas and some low lands.

c) Small to Pico Hydro Power Plants

It is a well-known fact that hydro power plants are the largest source of electric power in Ethiopia. Almost all of them are big power plants the construction of which requires a huge investment, highly skilled personnel and long years of gestation period. Large hydro power plants, although renewable, are not environment friendly for they disturb the eco-system of the area in which they are established.

Unlike large hydro power plants, small to Pico hydro power plants require small investment, much less skilled personnel, and short period of construction and start-up. They are environment friendly for they do not require construction of big dams that disturb the eco-system. Most or all mechanical parts of these hydro power plants can be constructed in an ordinary mechanical workshop with good metal casting and other facilities. Most of the electrical parts could also be constructed in local electric workshops with the necessary equipment. The power generated by these power plants could be used for irrigation, potable water supply, rural industries, home lighting and other services. All these aspects make small to Pico hydro power plants very appropriate for developing countries, especially rural areas.

Noting this, some countries such as China have highly developed their capacities and established tens of thousands of units in hundreds of their river basins and streams. According to Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power, China had about 80,000 small/mini hydro power plants with 8,500 MW of generating capacity in 1985 [9]. Ethiopia should learn from such abundant experience and be able to develop its huge hydropower potential, which is not yet utilised even to the extent of 2%.

d) Biogas

Biogas is a gas produced by a natural degradation of organic substances such as plant and animal wastes. Cow dung, human faeces and municipal wastes are excellent raw materials for the production of biogas. Ethiopia, being the home of the largest livestock population in Africa, the potential for producing biogas from this source is very large. However, little is done so far because of various reasons including lack of large programmes and high cost of equipment (biogas digester) for individual households of the rural community. Experience of some countries such as China and India, which have constructed millions of biogas digesters all over their countries, must be thoroughly studied and adapted.

There are three major advantages of using biogas. These are:

1. Satisfaction of the household energy needs;
2. The waste from bio-digesters is an excellent fertilizer. Thus, use of biogas enhances production of organic fertilizer, which could be used for agricultural production to achieve food security; and
3. Environmental benefits due to reduction of generation of greenhouse gases, decrease of deforestation, and lessening of pollution.

Considering these advantages, the wide-scale implementation of biogas technology in rural areas could modernize rural homes and enhance agricultural production, and thus, of course, improve food security.

e) Bio-ethanol and Bio-diesel

Bio-ethanol and bio-diesel are fuels that are produced from plant sources. Bio-ethanol could be mixed with or totally replace gasoline used in light engines. Similarly, bio-diesel could be used for diesel engine driven vehicles such as buses, trucks and tractors. Bio-diesel could also be used for diesel irrigation pumps and other agricultural equipment. The production of these bio-fuels demands industrial set-ups, which may require considerable investment. However, as the source materials of these fuels is the agricultural sector, and as they could be used for supplying modern energy sources for the agriculture sector itself, the production of these fuels could be seen as a good strategy for creating sustainable agriculture, which is essential for food security. Moreover, it creates a strong linkage between agriculture, industry and transport sectors, which are vital for sustainable development.

4.2 Food Production

a) Irrigation

Irrigation is one of the major agricultural activities that demand considerable energy input and usually modernized first. The common ways of supplying energy for irrigation are through commercial fuel and animate power. The usual commercial fuel employed for irrigation pump engines is diesel fuel. Because of its convenience for use, high-energy content, cheaper price, and relatively lower initial costs of pump engine sets, diesel fuel is widely applied for such purposes. However, with the increasing environmental concerns, rises in fuel prices, and technological developments, alternatives are becoming more and more competitive and applied in many countries all over the world. Renewable energy sources, especially solar (PV) systems, are the most attractive alternatives in this regard. The many advantages described above have made PV systems so attractive and they are being seen as one of the best alternatives for application in irrigation. Consequently, it is much preferable to use solar pumping systems for irrigation in the rural areas.

b) Threshing

Threshing is the other major agricultural activity that demands considerable energy input. Like irrigation, it is also among the activities that are modernized first. Diesel or gasoline engines are again the major prime movers (drives) applied. Considering the need for portability, application of diesel or gasoline engines could be the best options available.

However, the fuels used for these engines should preferably be bio-ethanol in the case of gasoline engines and bio-ethanol modified to suit diesel applications[2] or bio-diesel in the case of diesel engines. As mentioned earlier, the use of agro-based fuel would help to develop sustainable agriculture. Therefore, it is required to give sufficient attention to the development and use of bio-ethanol and bio-diesel.

c) Cultivation

Cultivation is a soil preparation activity that demands a lot of energy input. In fact, the energy demand of conventional modern agriculture is very high mainly because of the high demand of energy for cultivation. However, current developments in agricultural technologies indicate that intensive soil preparation activities are harmful and, thus, what is called *conservation tillage* has developed. *Conservation tillage* advocates for minimum cultivation. This has the advantage of maintaining the soil fertility and reducing the need for cultivation.

The Ethiopian agriculture is heavily oxen power dependent. Thus, *conservation tillage* could have the advantage of reducing the demand for oxen. Small power machines such as *portable power tillers* could also be applied together with *conservation tillage* so as to further reduce the demand for oxen. Moreover, *portable power tillers* could avail motive power to farms during prolonged dry season when farm animals are at their weakest level and unable to pull the plough in dry soil. Unlike hand tractors, which require high traction force and vertical load, *portable power tillers* work on a different principle, which enables them to cut into dry soil like the wheel saw cuts into wood [10]. Figure 3 shows a *portable power tiller*, which could be appropriate for the Ethiopian peasant farms. As the most common and more suitable energy source for *portable power tillers* is petroleum fuels, it may be recommended here to use these fuels. However, due to the unavailability of petroleum fuels in rural areas and the need to save foreign exchange on imported fuels, it is important to consider the use of bio-ethanol and bio-diesel for such applications.

Figure 3: Portable Power Tiller that could be Appropriate for the Ethiopian Peasant Farms

4.3. Food Preparation

Currently, biomass is the only source of energy for food preparation in the rural areas of Ethiopia. There is nothing wrong with the use of biomass as far as it is used in a sustainable manner. However, the prevailing practice is unsustainable for it is based on destroying the existing forests and wood lands without any consideration of replacement. The policy and regulatory regimes of the Federal and Regional Governments do not also encourage tree plantation. Thus, measures have to be taken in order to correct policy and regulatory regimes so as to encourage investment in tree plantation.

There are also very good alternatives to the traditional biomass use. The use of biogas and solar ovens/stoves are the most attractive in this regard. Use of biogas, as discussed above, has the extra advantage of producing organic fertilizer and abating environmental pollution.

4.4. Food Transportation

Utilisation of horse, mule and donkey pulled carts at much more wider scale could enhance food transportation and marketing in rural areas. Moreover, the introduction of low costvehicles, two and three wheelers, which have been very successful in India and Southeast Asia, should also be encouraged. These vehicles are usually gasoline engine driven or in some cases diesel driven. Two and three wheelers have the advantage of being easily assembled/manufactured locally, and, thus, enhance the transport and industrial sectors, and the overall national economy. As pointed out earlier, bio-ethanol and bio-diesel fuels could be easily used for these engines.

4.5. Social Services

The demand for energy by social services such as education, communication, health and supply of clean drinking water could be satisfied in a number of ways. Education, communication and health services usually demand electric energy. Although the common energy supply systems employed for such cases are grid-extension and diesel generators, the later is usually unsuitable for rural settings. Thus, the alternative of using renewable technologies that could be appropriate to the specific situation should be considered. A special emphasis should be given to the development of small to Pico hydro power plants, and application of wind mills or turbines, for these technologies could be suitable for many sites in the country.

4.6. Rural Workshops/Industries

Rural workshops/industries usually have equipment driven by diesel engines. However, in the current Ethiopian context provision of diesel fuel is not easy and expensive. A better alternative power supply system could be mini/micro hydropower plants and wind mills/turbines. The use of bio-ethanol and bio-diesel could also be a good alternative. Thus, it is recommended to assess these alternatives and apply the option that best suits the particular situation.

5. Conclusions and Recommendations

Energy is a key input needed for food production, food distribution, preparation of palatable food for humans and feed for animals, for social services and for rural workshops/industries that support food production. Consumption of energy in agriculture depends upon its level of development. Generally, although the type of energy, animate or in-animate, and its intensity, high or low, are different depending on the level of the agricultural development, a considerable amount of energy is required for direct agricultural production. A cross-sectional data analysis of 108 countries shows that there is a strong correlation between per capita energy consumption and cereal crop yield per hectare. Best-fit curve on the plot of these data indicates that the relationship is exponential. However, this fact is not usually well noted in designing and implementing development policies, programmes and projects. Therefore, there is a need to give due consideration to the energy dimension in the agriculture and, consequently, in food security.

Currently, the Ethiopian agriculture mainly uses animals and human labour, and, thus, consumes only a small amount of energy. However, with the increasing size of irrigation schemes, expansion of rural roads and spread of modern life style in the country, the demand for commercial energy would increase significantly. There are various ways of improving the energy supply options for the agricultural sector. With the current level of the Ethiopian agricultural development and the need for changing this status to the next higher level, the following measures may be suggested.

1. Irrigation and threshing are the major agricultural activities that demand non-traditional energy inputs and are usually modernized first. The uses of improved manual systems coupled with solar (PV) systems, windmills, and small hydro, where appropriate, are the best alternatives recommended for the development of irrigation schemes in the country.

2. Combustion engine driven farm implements are well suited to threshing and tilling. Portable power implements, such as *portable power tillers* that require small power and are more efficient than the conventional ones are recommended for small farms. However, the fuels commonly used for these engines could be replaced by bio-ethanol and bio-diesel, which are agro-based. Therefore, it is required to give sufficient attention to the use of such farm implements, and development and use of bio-ethanol and bio-diesel.

3. Use of biomass on sustainable basis, and widespread use of biogas and solar ovens/stoves are proposed for tackling the energy problem of food preparation. Utilisation of horse, mule and donkey pulled carts at much more wider scale, and the use of bio-ethanol and bio-diesel driven two and three wheelers are recommended for reducing the problem of food transportation and the development of the rural transport sub-sector.

4. The energy need by rural workshops/industries and social services such as education, communication, health and supply of clean drinking water in rural settings where grid-extension is not foreseen could be satisfied by the production of electric energy from various renewable resources. A special emphasis should be given to the development of small to Pico hydro power plants, and application of wind mills/turbines and solar systems, for these technologies could be suitable for many sites in the country.

Footnotes

[1] According to the energy balance data compiled by the Ethiopian Rural Energy Development Centre, in 1998/99, the total energy supplied to all sectors by petroleum fuels was 41,189 Tera Joules of which the agricultural sector consumed only 1,497 Tera Joules.

[2] There are patented ethanol formulating processes that would make it suitable for diesel engine applications.

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Enhancing the Contribution of Forestry to Food Security: Examination of the Legal Environment

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Abstract

Forest is one of the natural resources the conservation, development and utilization of which affects biodiversity, human health and food security in many ways. This resource, which has such profound implications, is now in danger – dwindling from time to time in terms of quality, quantity and diversity. A proper legal environment of sustainable forest management enables to enhance the contribution of forestry to food security, human health and biodiversity. The purpose of this paper is to explore Ethiopia's legal environment for sustainable forest management. In particular it examines the property laws of the country as far as land and trees are concerned and it analyses the impact of such laws on private investment in forestry. What is more, the Forest Conservation, Development and Utilization Proclamation will be discussed. The approaches adopted by this major forest proclamation – permit, state ownership, protection, prohibition, benefit sharing and penalty – and their corresponding problems are also the concern of this paper.

1. Introduction

Forest is one of the natural resources the conservation, development and utilization of which affects biodiversity, human health and food security in many ways. This resource, which has such profound implications, is now in danger in the whole world in general and in Ethiopia in particular. In terms of quality, diversity and quantity, it is said to be dwindling from time to time. It is believed that a proper legal environment of sustainable forest management enables to enhance the contribution of forestry to food security.

The purpose of this paper is to explore Ethiopia's legal environment for sustainable forest management. Problems are identified in this legal environment and recommendations are made. To this effect the paper is divided into eight parts. The first part is the introduction. The second part is a review of the link between forestry and food security. In part three, the challenges surrounding forest resources will be discussed. The fourth is a discussion of the public and private approaches to sustainable forest management. In part five, Ethiopia's legal environment for sustainable management of forests will be explored. Part six is the analysis of the legal environment for the sustainable forest management. In this part problems are identified regarding the legal environment. The conclusion and recommendations are contained in part seven. And finally the references are stated in the last part.

2. The Missing Link between Forestry and Food Security

A certain writer has said, "Among the various natural resources with which our Earth is endowed, water is unique in the diversity and importance of needs it fills"[1]. But considering the importance of forests in enhancing the status of water bodies, purifying water and

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protecting watersheds, one can say that they are more unique than water. Forests have social, economic, environmental, cultural and spiritual benefits. The economic and social benefits of forests include: the use of fuel wood as energy; the use of some trees for food; production of timber; and medicine production. The following are some of the environmental services of forests: carbon storage; clean water; habitat for flora and fauna [2]; erosion protection; soil desalinisation; watershed protection; and biodiversity conservation. All these benefits are vital factors in ensuring food security.

Food security is a broad and complex concept, which is described as follows:

When all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life. Achieving food security requires that the aggregate availability of physical supplies of food is sufficient, that households have adequate access to those food supplies through their own production, through the market or through other sources, and that the utilization of those food supplies is appropriate to meet the specific dietary needs of individuals [3].

As it can be seen above the concept of food security has three main dimensions: food availability, food access and food utilization. And it is the outcome of complex interactions among natural resources management and political, social and economic factors [4]. Forests, as one part of natural resources, affect food security in three main ways [5].

First, the environmental and economic benefits of forestry (prevention of soil erosion, enhancing of soil fertility, mobilisation of nutrients far below ground level for use by food crops; protecting crops from drying, damaging winds; providing farmers with materials for fence posts, poles and farm implements; improving the forage quality of the grass, resulting in greater milk production; providing shade for livestock, important to their health and productivity in hot, dry areas; playing a role as a storehouse of biodiversity, potentially very important in future crop breeding and pest and disease management programs; regulating the volume and fluctuations of stream flows and providing a shaded riparian environment favourable for the development of smaller life forms which fish feed on; and so on) are important elements in sustainable agricultural production. One should note here that food availability, as one dimension of food security, is achieved when sufficient quantities of food are consistently available and such food can be supplied through household production.

Food security does not necessarily mean producing a sufficient and quality food by oneself. There are countries, which are said to be food secure because they have developed the purchasing power to acquire sufficient and quality food. Here also forests play an important role; they provide economic and employment opportunities that produce cash income and hence purchasing power. These opportunities include processing, consumption and marketing of timber, fruits, latexes, rubber, nuts, medicines, spices, as well as the materials to make household, hunting, fishing and agricultural implements.

Finally, apart from helping agriculture and developing purchasing power, which are vital to food security, forests provide food items, adding diversity, flavouring and essential nutrition to diets. The title says 'the missing link' just because the link is rarely reflected in national development programs [6]. For example, in the rural development policy of the FDRE, one of the strategies adopted is proper utilization of land and other natural resources. Though proper utilization of land and natural resources is said to be one of the directions of the Country's rural development policy, the content is an evidence of the fact that the emphasis is given to only land [7]. This is in disregard of the two other contribution of forestry to food security.

3. The Challenges Surrounding Forest Resources

Forests, which play such paramount role in food security, are, however, surrounded with various problems, which can be summarized as challenges of competing uses and competing users, which result in the dwindling of the quality and quantity of forests.

According to FAO estimates, the extent of the world's forest decreased by some 180 million hectares between 1980 and 1985. This represents an annual loss of 12 million hectares. This is due essentially to the growing needs of local inhabitants of food, fuel, industrial and mineral products. The rate of deforestation is indirectly in proportion to the rate of population expansion and the poverty of the country. Of the production of timber from tropical forests, 85% is for fuel; 10% is for local timber needs and 5% for export...Shifting cultivation and forest fires are responsible for 60% of tropical deforestation; 30% is due to conversion to agricultural and/or industrial use as the population expands; while 10% is due to unsustainable forest management practices [8].

Ethiopia's forest resources have been disappearing at an alarming rate. A century ago, forests covered about 40 percent of the total land area. This proportion has been reduced to 16 percent in the early 1950's and to less than 3 percent today [9]. The cause is:

The primary cause of deforestation is cutting trees with the aim of opening up new agriculture land to feed the ever-growing population. Deforestation is estimated to take place at the rate of 200,000 ha/year. The widespread use of fuel wood as energy has also contributed to the deforestation process. About 95 percent of the total energy consumption in Ethiopia is composed of traditional biomass energy sources...The woodland/Savannah region originally covered 371,900 sq. km (30% of the country) in the semi-arid and sub-humid regions surrounding the highlands. Only 7.6 percent of the total area is currently covered by this vegetation type...Another problem related to forest protection is the failure to stop encroachment by land-hungry farmers and unregulated commercial exploitation...Poverty and lack of awareness have adversely affected rural communities' contribution to natural resource conservation [10].

As stated earlier the existence of competition among users and various uses results in the depletion of the country's forest resources. The economic and social uses of forests undermine the invaluable environmental use of forests. This is because forests are used economically, such as for fuel and timber, by cutting them. On the other hand, environmental services of forest resources require that forests be not logged. The problem is worse because of the increasing demand of forests for their economic use.

Sustainable forest management [11] can address the above-discussed problems (challenges) among competing uses and among competing users. Sustainable forest management implies that forest resources should be utilized, developed and conserved to meet the social, economic, ecological, cultural and spiritual human needs of present and future generations [12]. Therefore sustainable forest management should address the following problems: the need to meet the increasing demand for forest products; the need to curtail forest loss and degradation; the need to conserve environmental services; and the need to maintain the livelihood needs of rural people, especially in developing countries.

4. Public and Private Approaches to Sustainable Forest Management

Sustainable forest management requires the involvement of both public (the government through its regulatory, enabling and financing powers) and private sectors. Regulation involves imposing of rules and procedures in a given sector. Regulatory power of the government is justified usually on two grounds: public interest—regulation serves to remedy market failures-- and public choice—regulation serves the economic interest of some private group or groups [13]. Regulation can be carried out by the use of the three constitutional organs of government and by the use of regulatory agencies. In the first case, the lawmaking organ will enact laws and these laws will be enforced and interpreted by the executive and the judiciary respectively. But in the second case, laws will be enacted, applied and interpreted by expert regulatory agencies created for this purpose. In most cases the first possibility will not be sufficient and as a result it should be supplemented by the second method. The creation of regulatory agencies is necessitated because of various practical and compelling reasons: the legislature needs to have the input of professionals, who have expertise not shared by the three traditional branches of government; the need to be flexible so as to accommodate rapid changes so that the development in technology may not be stacked; and the need to conserve the resources of the government.

The point here is that general policies and laws are necessary but not sufficient and hence they should be supplemented by implementing laws and institutions. Some commentators have suggested that following a clear sequence of action involving four steps can develop an effective structure for environmental management (this can also apply to forest management).

First, a national forest policy must be developed in order to provide general direction and guidance. Second, a coherent body of forest law must be drafted to provide a framework for implementing the national forest policy. Third, appropriate institutional structures must be established to implement the new legislation. Finally, the government structures established must develop the capacity (for instance trained staff and appropriate facilities) to implement the law [14].

The issuance of legislation by the lawmaking body can do no good in preventing problems identified in section three above. Regulatory agencies with the power to make laws, adjudicate disputes and implement the laws should be established. And these agencies should be equipped with trained staff and appropriate facilities.

As far as the regulatory approach to sustainable forest management is concerned, the following tools are in particular helpful in solving the challenges surrounding forest resources [15].

Environmental Impact Assessment

Whenever a proposed development action will have a significant effect upon the quality of the human environment, the responsible governmental organ must analyse all feasible alternatives, including the proposed action, and consider the environmental impacts of each. Essentially it cautions as well as compels the government to look before it leaps.

Establishment of Uniform National Cutting Limits

Sometimes having regard to the economic and social importance of forests and the environmental importance of forests it may be necessary to compromise such needs. And this can be achieved by establishing uniform national cutting limits that governments impose on individual users. This control strategy thus acquired its reputation as a "technology-forcing" scheme since its requirements are designed to force industry to develop whatever alternative devices are necessary.

Permit

The requirement to obtain permit and comply with its terms is another regulatory mechanism. By this enforcement will be greatly simplified because the permit scheme imposes numerical limits on all users. This system helps to subsidize poor farmers when their interests are adversely affected by big industries.

Supervising Mechanisms

This involves imposition of substantial monitoring and reporting requirements on the regulated community. The determination of a violation is thus a rather simple affair in many instances, requiring only a comparison of permit conditions with the permittee's actual performance.

Citizen Suit

Any adversely affected individual should be authorized to seek injunctive relief against a source who violates the law or against the regulatory agency should it fail to perform one of its mandatory duties under the law and the imposition of civil penalties.

Use of Administrative Orders

The concerned administrative agency should be given not only the power to set limits and standards but also the power to see to it that these limits and standards are observed by individual polluters by imposing administrative orders such as injunctive relief, civil and criminal sanctions.

Apart from using the above regulatory tools, the government can be involved in the sustainable management of forests by financing, developing and managing plantation projects, researches and technological advances. Moreover the public sector involvement can be supplemented by the private sector particularly in increasing the area covered by trees. Here the government has also a role to play—creating enabling environment for private sector involvement. The point here is that the supplementary role played by the public and private sectors in sustainable management of forests enhances the contribution of forestry to food security.

5. The Legal Environment of Sustainable Forest Management

Under this section, an attempt is made to discuss the laws of Ethiopia that have to do with sustainable forest management. The following points are underscored in particular: definition of property rights in general and property rights on land and forests in particular; uses of procedures and mechanisms to enforce forest laws and regulations; the public participation and consultation; and sanction for violation of forest laws and regulations.

a) Property Rights Over Land and Forests

The natural place to start examination of the legal environment is the FDRE Constitution as it is the supreme law of the land. It is provided in the Constitution that every Ethiopian citizen has the right to the ownership of private property [16]. The right of ownership is the widest right that one can have over a given property and it consists of the following component rights: the right to acquire, to use and, in a manner compatible with the rights of other citizens, to dispose of such property by sale or bequest or to transfer it otherwise [17]. There are other property rights, which are less than ownership such as possessory right and usufructory right. In the case of possessory right, a person has only a right to use and in the case of usufructory right a person has the right to use and transfer it for limited period of time. There is also another right known as bare ownership. In this case, a person has the right to abuse (dispose) the property. Property is said to be a bundle of rights, since it can have multiple rights belonging to several different persons or groups [18]. Stated in other words, with respect to one property, one person may have the right of bare ownership; another person may have the possessory right and still the other may have the usufructory right. And as far as ownership is concerned, it can basically take any one of the following three forms: private, communal or state. Before we move to discuss the land and forest laws of the country, it is of paramount importance to clarify a common misconception about property and property rights. Property right is usually taken to mean private ownership. But the reality is that property right is a generic name, which refers to ownership, possessory, usufructory and bare ownership rights. And ownership is clearly part not the whole of property right. What is more, private ownership is one kind and not all of ownership right. This misconception has a repercussion on so many analyses made by economists as it is going to be explained in connection with secured property rights.

The right of private ownership, mentioned in the Constitution, does not include the right to own land. The right of ownership of rural and urban land, as well as of all natural resources, is exclusively vested in the state and in the public [19]. The point here is that land and all natural resources cannot be privately owned. The owners of land and other natural resources are the Nations, Nationalities and Peoples of Ethiopia as a whole. And when the FDRE Constitution provides that land and other natural resources cannot be privately owned, this is to exclude only the right to dispose land and other natural resources from the power of private individuals. The right to use and enjoy the fruits of land and other natural resources is not limited by the FDRE Constitution. Of course, this is emphasised in other articles of the Constitution.

There are three principal ways by which one can get a land in Ethiopia. First, according to Article 40 (4) and (5) of the Constitution, Ethiopian peasants and pastoralists have the right to obtain land without payment. Second, according to Article 40 (6) of the Constitution, private investors have the right to the use of land on the basis of payment arrangements established by law. And finally, individuals can lease land from peasants. Therefore, the point here is that though the FDRE Constitution reserves the ownership right of land to the State, it also guarantees the right of peasants, pastoralists and investors to use land.

All what is stated in the FDRE Constitution is too general and hence depends on detailed legislation for its application. According to Article 51 (5) of the FDRE Constitution the federal government has the power to enact laws for the utilization and conservation of land and other natural resources. And according to Article 52 (2) (d) regional governments have the power to administer land and other natural resources in accordance with federal laws. And in line with this, the House of Peoples Representatives has enacted a law regarding rural land. This law is known as the Federal Rural Land Administration Proclamation No. 89/1997. According to Article 2(3) of this Proclamation Ethiopian peasants have the holding right, meaning the right to use rural land for agricultural purposes as well as to lease and, while the right remains in effect, bequeath it to his family member; and includes the right to acquire property thereupon, by his labour or capital, and to sell, exchange and bequeath the same. This Proclamation is also general, providing only those principles that should be incorporated in the regional land administration laws. The land administration law of a region, for example, shall:

- Be in conformity with the provisions of laws on environmental protection and shall observe the federal land utilization policies;
- Secure against eviction and displacement from holdings on any grounds other than total or partial distribution of holdings effected pursuant to decision by the Regional Council;
- Allow women, orphans not having attained majority, physically weak and similar others to use hired labour on their holdings or to, otherwise, make agreements thereto;
- Provide that demarcation of land for house-building, grazing, forests, social services and such other communal use shall be carried out in accordance with the particular conditions of the locality and through communal participation;
- Allow, where distribution of holdings is effected, for an opportunity to retain, to the extent the distribution would permit, portions of the land they have been improving upon their labour or capital or ensure payment of due compensation, by the new holder, to a previous and lawful holder; and
- Guarantee, where a holding right changes hands under distribution of holdings or terminate on various grounds, the right to remove permanent work buildings, or tree-crops cultivated, on the land or to claim payment of compensation thereupon or collection of the fruits thereof.

For the purpose of administering land and other natural resources, according to Article 5(2) of Proclamation No. 89/1997 and Article 53 (2) (d) of the FDRE Constitution, regional council has the responsibility to enact a law on land administration.

In Tigray, for example, the relevant legislation is the Rural Land Utilization Proclamation No.23/1989 as amended by Proclamation No. 55/1994. The following are some of the points incorporated in these two Proclamations:

- A peasant can lease his land for another person for a term, which does not exceed 20 years for modern agriculture and 2 years for traditional agriculture;
- The regional government can lease a land for a maximum of 50 years taking into account the economic desirability of the investment;
- A peasant has the following obligations regarding the land he/she is holding:
    - The obligation not to cause any damage to the trees in the farm land;
    - The obligation not to plough within 3 meters from the river coast; and

- The obligation to take soil and water conservation measures.

- Any trees found in the farmland are properties of the land holder;
- It is prohibited to plant cactus and eucalyptus trees on farmlands; and
- Forestlands are not to be used for farming.

One other point regarding property rights is: how about forest resources? Can they be privately owned or not? Does the term 'natural resources' under Article 40(3) include forest resources? If it includes, then the conclusion is obvious: that forest resources cannot be privately owned.

Though Article 40 (3) reserves the right of ownership of all natural resources to the exclusive domain of the Nations, Nationalities, and Peoples of Ethiopia, the reservation is qualified in another sub-article: that every Ethiopian has the full right to the immovable property he builds and to the permanent improvements he brings about on the land by his labour or capital. It is clear from this that forests planted by a citizen on a land are the private properties of that citizen. Thus, it is imperative to divide forests into two: natural forests and plantation forests. And the conclusion is that plantation forests can be privately owned, whereas natural forests are state owned. The same thing is stated in Proclamation No. 94/1994. This proclamation recognizes two kinds of forest ownership: private and state. On the other hand, the Forest Conservation, Development and Utilization Regulation No. 14/ 1994 E.C. of the Tigray Regional Government recognizes three kinds of forest ownership: private, *kebele* and state.

b) Conservation, Development and Utilization of Forests

The FDRE Constitution has some provisions governing sustainable forest management. The following are some of the articles. Article 43 (1) provides that the peoples of Ethiopia as a whole, and each Nations, Nationality, and People in Ethiopia in particular have the right to improved living standards and to sustainable development. Article 44(1) provides that all persons have the right to a clean and healthy environment. Article 51 provides that the federal government has the responsibility to formulate and implement the country's policies, strategies and plans in respect to overall economic, social and development matters. Particularly it should enact laws for the utilization and conservation of natural resources. Article 89 (8) stipulates that government shall endeavour to protect and promote the health, welfare and living standards of the working population of the country. Article 92(2) provides that the design and implementation of programs and projects of development shall not damage or destroy the environment. And Article 92 (4) says government and citizens shall have the duty to protect the environment.

Thus, it can fairly be said that the FDRE Constitution has some provisions that, among other things, are concerned with the conservation, development and utilization of natural resources. And for this all branches of the federal government-the House of People's Representatives, the Council of Ministers and the Judiciary-are responsible. However, those provisions in the FDRE Constitution, and their corresponding obligations, are too general to be applied to particular cases. And hence there is an increasing need for specific and detailed legislation relating to the development, conservation and utilization of natural resources. But so far there is no any comprehensive legislation, which is enacted to implement the general principles of the Constitution. The only legislation in this regard is the Forestry Conservation, Development and Utilization Proclamation No. 94/1994.

The conservation, development and sustainable utilization of forests play a decisive role in combating the grave and alarming situation in soil erosion and in arresting the expansion of desertification and ecological imbalance [20]. And the Forestry Conservation, Development and Utilization Proclamation No. 94/1994 is issued with this objective in view. This proclamation employs several approaches so as to manage the resources in a sustainable manner. These include prohibition, protection, penalty, permit, benefit sharing and state ownership. The following is an examination of the main features of this Proclamation.

The Ministry of Natural Resources Development and Environmental Protection is charged with implementing this proclamation. Particularly, the ministry shall designate, demarcate and register state and protected forests and every region shall designate and demarcate its regional and protected forests. Forests are divided into four by this proclamation: State, regional, private and protected forests. State forest means a forest designated as state forest by a regulation to be issued by the Council of Ministers, upon the recommendation of the Ministry and that are given special considerations as to protect the genetic resources or conserved to keep the echo-system with a program that covers more than one region. Regional forest means a forest designated as regional forest by the official gazette of the region or developed by the said region. Private forest means a private forest developed by any person and includes a forest development by peasant association or by an association organized by private individuals. And protected forest means a forest to be demarcated in order to make it free from the human or animal interference for the purpose of protection of the environment and genetic resources.

Other responsibilities of the Ministry, regarding state and regional forests, include [21]:

- Preparation of forest development program and monitor its implementation;
- Taking appropriate preventive measures to ensure that the forest is free from pests and forest disease;
- Facilitating the construction of access roads and other service facilities within the forest necessary for the development and conservation of the forest;
- Ensuring that the forest is protected from fires and other disasters;
- In a manner that inhabitants within the forest do not obstruct or hinder forest development, facilitate conditions that ensure their well being in such a way that the inhabitants would be beneficiaries from the development;
- For sustainable utilization of forest resources, and to administer the same in accordance with forest management procedures, hence provide appropriate technical and related assistance not only to provide sanctuary to wildlife and protect forest eco-systems from imbalance, but also conserve biodiversity;
- Rehabilitate endangered indigenous species; and
- Collaborate with appropriate bodies towards the strengthening of conservation, development and management of forests.

This major forest legislation of the country recognizes also the role of private investment in alleviating the problems surrounding the forest resources. To this effect it provides that forests can be privately owned. But this does not mean that these private owners can use the resources of the forests, which they own in any way, which they like. Instead, they are obliged to manage it in a sustainable way. To this effect too, the proclamation provides the following duties on private owners of forests [22]:

- Develop forests in a sound manner and replace trees made use of, in different ways;
- Notify the Ministry or the appropriate regional body on forest pests and disease;
- Take the necessary measures to ensure that the forest is free from pests and disease;
- Ensure that the forest is protected from fire and other hazards; and
- Implement the overall directive issued by the Ministry on environmental protection and on those pertaining to catchments, unique habitats as well as endangered tree species and forest communities within a region.

One other point regarding this forest legislation is that it employs protection as a mechanism of managing forests in a sustainable manner. That is why it gives the power to the implementing regulatory agency to demarcate and designate any forest as a protected forest. Forests are to be declared protected in order to [23]:

- Conserve the soil from desiccation, erosion and degradation as well as maintain and improve soil fertility;
- Protect and improve the status of water bodies, sources of rivers and catchments;
- Control floods;
- Protect rare or endangered endemic plant, animal and bird species, and genetic resources in general; and
- Conserve unique and representative habitats or natural resources.

And the consequence is that no person shall cut any tree, utilize the products thereof, or perform other activities in the forest [24].

Permit is also employed to conserve, develop and utilize the forest resources of the country in a sustainable manner. The Forestry Proclamation provides that permit is necessary for the following activities [25]:

- Cut trees;
- Settle temporarily or permanently;
- Graze domestic animals;
- Carry out hunting activity; and
- Keep beehives or extract honey.
- Take any forest product from or carry out any activity that may be harmful to natural resources in state, protected, and regional forest.
- Conduct large-scale farming, mining operation, construction of roads, water drilling, irrigation and dam works and other similar activities, or to give license fro such operation within state or regional forests.

It also provides list of trees that may not be utilized or harvested. That means for the harvest or utilization of these trees the regulatory agency is not empowered to issue permits. The trees include *Hagenia abyssinica, Cordia africana, Podocarpus gracillior and Juniperus procers* from state or regional forests [26].

The following activities are declared punishable by imprisonment not exceeding two years or with fine not exceeding Birr 5,000 or both [27]:

- Cutting trees, taking, processing or in any other manner use forest products, except in accordance with the proclamation and regulations and directive to be issued pursuant to this Proclamation;
- Destroying, damaging or falsifying forest boundary marks;
- Causing damages to forests by setting fire or in any other manner; or
- Carrying out activities that are categorically prohibited or carrying out activities without permit.

c) Public Consultation and Participation

One of the cardinal wisdoms in development-oriented enterprises is ensuring public participation and consultation. Experience worldwide shows that projects fail if adequate participation and consultation of the people is absent. This is a well-recognized principle that it is reflected in various international environmental agreements which increasingly call for citizens to be offered opportunities to influence affairs related to environmental, natural resources or forest management issues [28]. This is because highhanded regulatory decision-making is more than offensive to basic notions of democratic government; a failure to seek at least the acquiescence of the governed eliminates a vital ingredient for effective administration. Charting changes in policy direction with the aid of those who will be affected by the shift in course helps dispel suspicious of agency predisposition, unfairness, arrogance, improper influence, and ulterior motivation.

What is more, there is usually a gap between what the public knows and what an agency can know. This is because the agency is relatively far from the day-to-day observations of a certain activity. Thus, the purpose of pubic participation is to assure that the agency will have before it the facts and information relevant to a particular administrative problem, as well as suggestions for alternative solutions. Many development programs have failed to generate the expected benefit mainly because of the absence of public participation in the design and implementation of these programs.

The Report of the Team of Specialists on Participation in Forestry defines public participation as a voluntary process whereby people, individually or through organized groups, can exchange information, express opinions and articulate interests, and have the potential to influence decisions or the outcome of the matter at hand [29]. Accordingly it is believed to achieve the following purposes:

- Increase awareness of forestry issues and mutual recognition of interests;
- Gather information and enhance knowledge on forests and their users;
- Improve provision of multiple forest goods and services;
- Stimulate involvement in decision making and/or in implementation processes;
- Enhance acceptance of forest policies, plans and operations;
- Increase transparency and accountability of decision making; and
- Identify and manage conflicts and problems together, in a fair and equitable way [30].

The following are some of the provisions in the FDRE Constitution that govern public participation and consultation. Article 92(3) provides that people have the right to full consultation and to expression of views in the planning and implementation of environmental policies and projects that affect them directly. Article 43 (2) provides that nations have the right to development and, in particular, to be consulted with respect to policies and projects affecting their community.

6. Problems Identified

In examining the legal environment of forest management in Ethiopia, several problems have been identified. For the sake of convenience the problems are analysed under the following categories: secured property rights versus private investment, state ownership, protection, prohibition, penalty, benefit sharing, public consultation and participation.

a) Secured Property Rights Versus Private Investment

The first problem is related to the impact of land law and ownership of forests on the development of forest resources. In the case at hand, sustainable forest management is the only mechanism that can avoid the disappearance of forests, which offer invaluable contribution to the noble effort of achieving food security. If the relationship between forest management and food security is established, the next step is to examine efficient mechanisms of developing forests. It has been discussed elsewhere that market-based alternatives can also be used in forest management in addition to political leadership. One of the market-based alternatives is private investment in forestry. Policies and laws that favour private investment could be designed in order to increase the social, economic and environmental benefits from forest ecosystems. But private investment must be carried out under the general objective of sustainable development, conservation and utilization of forest resources. There are a number of problems that are believed to have an impact on private investment as a mechanism for sustainable forest development. These include:

- Lack of an integral vision of the forest sector;
- Limited knowledge of the markets;
- Inefficient industrial processes and use of forest resources;
- Scarce investment in training of human resources and research;
- Limited investment of national capital in forest sector;
- Need for definition in the structure of land ownership;
- Lack of well defined and structured policies;
- Need for more awareness of sustainable use of forest resources;
- Capital availability;
- Limited access to credit;
- Unequal possession of the land; and
- Limited access to technological changes [31].

The concern here is not to analyse all of these problems; instead, it is to examine the relationship between property (for our purpose the analysis is limited to land and forests) rights on the one hand and private investment on the other hand.

One of the variables, which affect investment, is certainty and predictability of legal consequences. Investors do not like surprises. They need security. If there are certainty and security, there will be a growth in investment and hence economic growth. The correlation of rule of law, taken as concern for legal certainty, with economic development seems to be a settled one. So that men may trade and arrange their affairs with confidence, certainly as to the legal consequence of their actions is important. This is best summarized in the following words:

Rule of law provides with the stability and predictability in economic affairs required for agents to engage in entrepreneurial action-both in terms of exploiting existing opportunities for profit through arbitrage and the discovery of new profit opportunities through innovation. Absent the security and predictability provided by a rule of law, economic actors will shorten their time horizon of investment and economic progress will be thwarted...Economic policies not in conformity with a rule of law introduce discretionary and ad hoc decisions that undermine the predictability and stability in the economic environment. A policy environment consistent with the rule of law, on the other hand, leads to an enhanced ability by economic actors to predict the behaviour of others with whom they must coordinate their plans [32].

The point here is that property rights (whatever form they may take) must be secure so that government initiative for development of forests may be supplemented by private sector activities. Otherwise, investors will shorten their time horizon, which is fatal for forestry sector in particular. The question is: do Ethiopian laws afford this stability?

Security of tenure has different meanings in various contexts. It may mean that the state or other individuals cannot interfere with the landholder's use of land. In another context, economists often use the term to include the confidence factor and a second element: long duration. And a third way the term is used adds another element: a requirement of full rights in the land. Therefore the particular meaning that we are using the term for should be explained first. In our case, security of tenure should assume the second meaning—the government should not interfere with the rights of the landholders and they should hold it for relatively long period of time.

As it is stated before private individuals cannot own land. Land is a property of the Nations, Nationalities and peoples of Ethiopia. Private individuals can only have the right to use and enjoy the fruits of land. Ethiopian peasants have the right to obtain the protection against eviction from their possession and private investors have the right to the use of land on the basis of payment arrangements. Moreover, the FDRE Constitution ensures the full rights to the immovable property built and to the permanent improvements brought on the land by labour or capital and this right includes the right to alienate, to bequeath, and where the right of use expires to remove his property, transfer his title or claim compensation for it.

Here one should take note of the kind of certainty required from land laws for investment in forestry. What matters is not the right to dispose the land; instead the right to enjoy the fruits of and the right to use the land. And hence, the certainty is as to whether one can certainly continue to use the land. It is clear from lease laws of the country that from 25 to 99 years of security is granted when one takes possession of land. If the individual is deprived of his possession before this period or if this period lapses, scheme of compensation is provided. And hence this can be said a fair certainty for the purpose of private investment as a mechanism for sustainable development.

The problem is when a person leases land from private individuals (farmers). The maximum lease period provided in this regard is twenty years depending on the particular region that we are concerned with. This will reduce the time horizon for investment made by private individuals.

There is such uncertainty also in forest ownership. The forest Proclamation recognizes basically two kinds of forests: private and state (federal and regional). And there is one other category of forests: protected forest. According to this proclamation the Ministry of Natural

Resources Development and Environmental Protection or the appropriate regional body is empowered to designate any forest (private as well as state) as "protected forest". The legal consequence of this is that, as I have stated somewhere, the owner or any person for that matter, cannot derive any benefit from the forest. This is categorically prohibited. There is no even any compensation scheme in the Proclamation. The problem is worse when one discovers the absence of in-built or external mechanism for controlling how the regulatory agency exercises its power. The ultimate effect of this is that it undermines the legal certainty and security that our system affords to potential investors in the field of forestry thereby aggravating the situation.

b) State Ownership

As it is stated in the previous section, one of the approaches, which the existing forestry Proclamation employs, is state ownership. The ownership of some forests is reserved to the state. This is also stated in the FDRE Constitution—the Nations, Nationalities and Peoples of Ethiopia are owners of land and natural resources. The problem is that sustainable forest development by public sector is likely to suffer from the following problems:

- Limited financial incentives;
- Excessive bureaucracy;
- Limited technical assistance;
- Limited knowledge of the markets;
- Lack of clear policies and rules in the short, medium and long terms;
- Investment in the training of human resources is limited;
- Undefined and unstructured policies;
- Limited capabilities in coordinated sectorial and intersectorial elements;
- Institutional capabilities for ruling, supervising and following up of experiences are limited; and
- Excessive concentration of power in the Government [33].

c) Protection

The other approach of the forest Proclamation is protection. So that the purposes stated therein may be achieved, the Ministry or regional bureaus (to use the language of the law) are empowered to demarcate any forest (including private forests) as protected with the consequence that any person (even with permit) cannot use the resources. This has a repercussion on private sector involvement in the development of forests—because as it is stated previously, it erodes the confidence of private forest owners. By this it does not any way mean that the right of owners over forests should be absolute. In deed, the involvement of the private sector in forestry is beneficial as long as it is carried out with the general principle of sustainable development. Moreover no property right is absolute—the possibility of taking private property for the sake of public purpose is also recognized in the FDRE Constitution. Therefore, the idea of protection is not by itself to be blamed. The problems regarding the protection approach have to do rather with the consequences and procedures of declaring a certain forest protected. It is now a settled human right that individuals may not be deprived of their 'life, liberty and property' without due process of law—which simply means the right of the right holder to be heard in an independent judicial organ. This is essential for the purpose of controlling corrupt or sometimes zealous civil servants as well as for the sake of convincing to ensure procedural, in addition to substantive, justice. Lack of legislative framework for subjecting the regulators to rule of law- a problem not unique to the forestry sector but also common to other sectors. Regulators have been given in many areas to affect the life, liberty and property of citizens. It is said often that the actions of regulators (bureaucrats) is like tax and death; this is to mean that they are inevitable to come. But so far there is no external controlling mechanism that is built in this regard. The widely and frequently announced 'civil service reform' is only an attempt to control the bureaucracy by the bureaucracy itself. But this is not sufficient and hence external controlling mechanisms-control directly by the people, by representatives of the people and by an independent judiciary-have to be put in place. Even if the forest Proclamation grossly delegates the power to declare protected a given forest to the Ministry of Natural Resources (to what ever agency that has succeeded it), it fails to clearly provide the procedures and more importantly the right of the owner to argue otherwise.

The other problem has to do with lack of compensation arrangement in the forest Proclamation. The FDRE Constitution clearly provides that " without prejudice to the right of private property, the government may expropriate private property for public purposes subject to payment in advance of compensation commensurable to the value of the property". It is obvious that compensation at the expense of your property is not the same as maintaining your property. But even this is not recognized by this single and most important forest legislation.

d) Prohibition

The problem in using law, as an instrument to achieve a certain purpose is, because of one or other reason, the law may not achieve its intended result. On the contrary, it may end up in achieving latent effects. The same is true regarding the forest Proclamation as far as the approach of prohibition is concerned. The Proclamation, as it is stated earlier, prohibits certain tree species from being harvested by anybody even with permit. At its face, this is praiseworthy. A close scrutiny of the approach is saddening, though. This Proclamation seems to accept that the current volume of such tree species is more than sufficient and seems to be concerned with protecting them from being logged. The reality is not however in consonance with this. We need more of these tree species. We need to plant, and cultivate them here and there time and again. And for this a positive incentive should be designed instead of prohibition. This is for the simple reason that is in line with human nature—any person (with the exception of altruist individuals, governmental and non governmental environmental clubs) will not plant such trees if he knows for sure that he will not use the fruits of his investment in any way. What is more, I am afraid that prohibition with no organized and effective law enforcing machinery may end up developing the tendency to violate the law.

e) Benefit Sharing, Public Consultation and Participation

Though public participation and consultation is recognized by the Constitution, so far there is no detailed and workable legislative framework for this. The FDRE Constitution is too general to be applied to particular circumstances. Therefore, legislation, which addresses the following issues, is required: when can people participate? How can they participate? What will happen if a certain government agency has acted without consulting the people?

f) Penalty

The forest Proclamation employs penalty as a supplementary approach to sustainable management of forests. The purpose of punishing violators of forest laws and regulations is to deter the violator and other potential violators from being involved in similar acts in the future. Hence, the punishment imposed on offenders should have a deterrent effect. At least three variables are believed to affect the deterrence nature of punishment in general. These include the variables of certitude, severity and celerity. To begin with the variable of certainty, the idea is that people should be certain as to whether punishment will be imposed upon them in case they cut trees. And the punishment should be swiftly imposed on offenders. And thirdly, the punishment should be severe enough to weigh against the benefits of committing the particular crime. The point here is that the punishment imposed in the above Proclamation is not severe enough to deter calculative offenders. The punishment of two years imprisonment is nothing compared to the benefit of cutting tress. The problem is worse when other variables are considered. The variable of certitude and swiftness requires the effectiveness of our law enforcing machinery, which has a number of problems as well. The proclamation relies mainly on forest guards to ensure that forests are protected. In this regard, the use of advanced technology in controlling and investigating violations of forest laws is required.

7. Conclusions and Recommendations

Food security is a broad and complex concept, which is the outcome of complex interactions among natural resources management and political, social and economic factors. Forests, as one part of natural resources, affect food security in three main ways. Forests, which play such paramount role in food security, are, however, surrounded with various problems, which can be summarised as challenges of competing uses and competing users, which result in the dividing of the quality and quantity of forests. These challenges can be dealt with sustainable forest management conservation, development and utilization of forests to meet the social, economic, ecological, cultural and spiritual meets of the present and future generations.

In the preceding sections, an attempt has been made to discuss the laws of Ethiopia that have to do with sustainable forest management. The property rights that one can possibly have over land and trees have been examined. Moreover, the Forestry Conservation, Development and Utilization Proclamation No. 94/1994 and the various approaches adopted by the proclamation towards sustainable management of forests is explored. In addition, the place of public participation, as one important element of sustainable development, has been discussed.

Apart from exploring the legal environment of sustainable management of forests, the paper has identified problems. For the sake of convenience the problems are analysed under several categories: secured property rights versus private investment, state ownership, protection, prohibition, penalty, benefit sharing, public consultation and participation. The following conclusions and recommendations can be made regarding the topics covered under this paper:

* Secured property rights over land and trees are significant factors that have an impact on private investment. Secured property rights means, for our purpose, the state or other individuals cannot interfere with the right holder for long duration. The fact that the

government can limit the right of private forest owners without any compensation is an erosion of the security, which is essential to private investment. Moreover, the fact that one can lease land from peasants for a short period of time is an instance where the security of tenure is frustrated. Therefore, the issue of security of property rights should be given due attention.

* The Forestry Conservation, Development and Utilization Proclamation No. 94/1994 uses a number of approaches with a view of achieving its purpose. The approaches include prohibition, protection, penalty, permit and so on. These approaches as they are incorporated in the Proclamation are surrounded with several flaws:
    - The penalty is not deterrent;
    - Prohibiting individuals from cutting some tree species is a latent disincentive to plant such kinds of trees; and so on.
* Though the Constitution recognizes the significance of public participation at various stages of the decision making process, the principle calls for specific rules and regulations for its implementation.

The FDRE Constitution clearly provides that it is the mandate of the House of Peoples Representatives to enact a law regarding natural resources. And based on such law, regional governments are empowered to enact specific law so as to administer natural resources. This constitutional principle is not implemented although some regional governments have legislated on this matter. The only national forest legislation is enacted before the Constitution. This seems to explain the problems identified above. Some of the problems are not unique to the forestry sector, however. The absence of legislative framework for public participation is a problem, which is common to all sectors.

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Sustaining the Forest Cover as a Mechanism of Offsetting Carbon Gases in the Atmosphere and Controlling Global Warming. See Dr. Don Tayor, "Investment Opportunities in the Framework of Sustainable Development", A Paper Presented in A Conference on *Private Investment As a Mechanism for Sustainable Forest Development in the Americas*, Honduras, 1995; Sustainable Forestry is A Natural Part of the Global Sustainable Development, Which was Defined by the world Commission on Environment and Development as Development that "Meets Our Present Needs Without Compromising the Ability of Future Generations to Meet Theirs" (Http://Www.Adonis.Ee/Links.Htm).

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[20] See the Preamble of the Forestry Conservation, Development and Utilization Proclamation No. 94/1994.

[21] See Article 5 of Proclamation No. 94/1994.

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of Trees By Those Who Plant Them and Stronger Market Information Systems and Forest Laws are Believed to Contribute to Private Investment In Forestry. For Example, The Government of Malaysia has Reviewed the Existing Fiscal Incentives And Had Granted Full Tax Exemption Under The Pioneer Status for Ten Years and 100% Tax Exemption Under the Investment Tax Allowance (ITA) for Five Years (See Http://Www.Adonise.Ee/Links.Htm).

[32] Ibid.

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Part III

ANNEXES

Food Security Conference 2003

Programme

Challenges and Prospects of Food Security in Ethiopia

Organized by
Science & Technology Professional Associations' Joint Secretariat (PAJS)
In Collaboration With
Fifteen Professional Associations:

Venue: **UN Conference Center, Addis Ababa**

Date: **August 13 –15, 2003**

Sponsours:

1. **ActionAid Ethiopia**
2. **The Royal Norwegian Embassy**
3. **SG - 2000**
4. **Ethiopian Science & Technology Commission**
5. **Ethiopian Agricultrual Research Organization**
6. **CRDA**

Conferenc Programme

Day I: August 13, 2003 (Wednesday)

8:30 - 9:00 Registration

Opening Session

9:00 - 9:05 Programme Introduction, *Ato Tesfahun Fenta* Chairman, Conference Organizing Committee

9:05 - 9:15 Welcoming Address, *Dr. Tesfaye Dama* Board Chairman, PAJS

9:15 - 9:30 Opening Address, *H.E. Ato Belay Ejigu* Acting Minister, Ministry of Agriculture

9:30 - 10:00 Coffee Break

Session I: Policy Issues (Morning Session)

Chairperson: Dr. Seme Debela
Rapporteur: Kidanemariam Jemberie

10:00 - 10:20 Agricultural Developmetn in Ethiopia: The Challegnges of Overcoming Famine, *Mulat Demeke (Dr.)*

10:20 - 10:40 The Food Security Challenges in Ethiopia, *Getahun Bikora*

10:40 - 11:00 Land Tenure System & Agricultural Developmetn in Ethiopia, *Berhanu Adenew (Dr.)*

11:00 - 11:20 Gender and Food Security, *Haregewoin Cherinet*

11:20 - 11:40 Land Tenure Links to Resource Degradation: the Case fo Central Ethiopia, *Terefe Degefa (Dr.)*

11:40 – 12:45 Discussion

12:34 – 14:15 Lunch Break

Session II Extension, Credit and Finance (Afternoon Session)

Chairperson: Dr. Solomon Belete
Rapporteur: Terefe Degefa (Dr.)

14:15 - 14:35 Agricultural Extension Programme in Ethiopia: Retrospect and Prospect, *Dejene Habesha*

14:35 - 14:55 Agricultural Input System & Public-Private Partnership in Ethipia, *Belay Simane (Dr.)*

14:55 - 15:15 Models for Private & Public Extension Cooperation as Applicable to Ethiopian System, *Mathewos Belissa & D.M. Chandargi*

15:00 - 15:20 Coffee Break

15:45 - 16:05 The Role of Cooperatives in the Enhancement of Food Security *Zerihun Alemayehu*

16:05 - 17:15 Discussion

Day II: August 14, 2003 (Thursday)

Session III: Crop Production (Morning Session)
Chairperson: Dr. Tekalegn Mamo
Rapporteur: Tesfahun Fenta

09:00 – 09:20 Attaining Food Security with Integrated Approach to Agricultural Development, *P.A. Choadhokas*

09:20 – 09:40 Organic Farming in the Context of Food Security in Ethiopia, Novelty or Necessity? *Emiru Seyoum (Dr.)*

Conferenc Programme

09:40 – 10:00 Policies and Instituions to Enhance the Impact of Irrigation Developmetn in Crop-Livestock Mixed Systems in the Highlands of thiopia, *Birhanu Gebremedhin (Dr.)*

10:00 – 10:20 Comprehensive Community and Household Asset Building Approach (CCHABA) for Improved Food Security in Tigray, *Kiros Tikue*

10:20 – 10:50 Coffee Break

10:50 – 11:10 Land Degradation, Low Soild Fertility and Water Stress: Major issues for Improving Crop Production and Food Security in the Dry Land Areas of Ethiopia, *Kidane Georgis (Dr.)*

11:10 – 11:30 Features of Grain Marketing Networks in Ethiopia: A Synopsis of the Implications for Achieving Regional Food Security Objectives *Abebe Haile Gabriedl (Dr.)*

11:30 – 12:45 Discussion

12:45 – 14:10 Lunch Break

Session IV Animal Production & Health (Afternoon Session)

Chairperson: Dr. Workeneh Ayalew
Rapporteur: Wondimagegnehu Shibru

14:15 – 14:35 Challenges and Prospects of Food Security in Ethiopia: Macro Issues Related to Livestock, *Alemayehu Reda*

14:35 – 14:55 Dairy Developmetn for Food Security and Improved Livelihoods: Experiences from Ada'a-Liben Woreda Dairy & Dairy Marketing Association, Debre Zeit Ethiopia *Azage Tegegne (Dr.)*

14:55 – 15:15 Ethiopian Pastoral Systems and Food Security Issues, *Getachew Gebru (Dr.)& Solomon Desta (Dr.)*

15:15 – 15:45 Coffee Break

15:45 – 16:00 New Approaches for Food Security Through Sustainable Management of Natural Resources, *Eugne Laible*

16:00 17:15 Discussion

Day III August 15, 2003 (Friday)

Session V: Natural Resources and Environment (Morning Session)

Chairperson: Dr. Ensermu Kelbessa
Rapporteur: Birhanu Mengesha

09:00 – 09:20 Rainwater Harvesting Technologies andTheir Contribution to Household Food Security in Dryland Areas of Ethiopia, *Hune Nega*

09:20 – 09:40 Agro Climatic analysis of Ethiopia with Emphasis on Policy perspectives, *Tesfaye Gissila*

09:40 – 10:00 Do Forest & Trees have a Significant Contribution to Food Security? *Tesfai Mebrahtu (Dr.)*

10:00 – 10:30 The Paradox of Forest Conservation and Food Security in Ethiopia, *Feyera Senbeta*

10:30 – 11:00 Coffee Break

11:00 – 11:20 Contribution of Agro Forester in Food & Wood Self-sufficiency & Sustainability in Rural Livelihood, *Dechassa Jiru*

11:20 – 11:40 The Energy Dimension in Food Security, *Bekele Bayissa*

11:40 - 12:00 Enhancing the Contribution of Forestry in Achieving Food Security Examination of Legal Environment, *Mulugeta Mengist*

12:00 – 12:45 Discussion

12:45 – 14:15 Lunch Break

Session VI: Panel Discussion

Chairperson: Ato Addis Anteneh
Rapporteur: Ato Osman Ali

14:15 – 16:00 Discussion, Conference Participants

Panelists

1. Dr. Mulat Demeke
2. Ato Takele Gebre
3. Ato Zerihun Alemayehu

16:00 – 16:15 Closing Remark
H.E. Ato Mulugeta Amha
Commissionr, Ethiopian Science & Technology Commission

Session II (Parallel II): Renewable Energy Technologies

Session Chair: Ato Birhanu Abate (Head, Planning Department, Ministry of Infrastructure)

Session Raporteurs: 1. Ato Melis Teka
2. Ato Daniel Danano

14:00 - 14:20	Dereje Kebede, *Renewable Energy Technologies for Rural Development*
14:20 - 14:40	Getnet Tesfaye, *Institutions and Linkages for Renewable Energy Development in Ethiopia*
14:40 - 15:00	Benjamin Jargstorf (Dipl.-Ing.), *Wind Energy for Electricity Production - Experiences World-Wide and Prospects for Ethiopia*
15:00 - 15:30	Discussion
15:30 - 15:50	***Coffee Break***
15:50 - 16:10	Abiy Awoke Tessema (Dr.), *Literature Survey and Strategy for In-Country Design & Manufacture of Micro-Hydropower Equipment*
16:10 - 16:30	Demiss Alemu (Dr.-Ing), *Low Cost Domestic and Industrial Solar Water Heaters Development and Dissemination*
16:30 - 16:50	Birhanu Gizaw (Dr.), *Implementation of Solar and Biogas Technologies in Ethiopia*
16:50 - 17:30	Discussion

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168	Mr. Yoseph Hussen	Ethiopian Soil Science Society	2311422

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172	Mr. Zerihun Alemayehu	Cooperatives Commission	
173	Mr. Zinabe Mekonnen	PAJS	09227412

Annex 3 *List of Food Security Conference Organizing Committee Members*

NO	Name	Title	Organization
1.	Dr. Tesfaye Dama	Board Chairman	PAJS/Ethiopian Society of Mechanical Engineers
2.	Dr. Bantikasegn Workalemahu	Member	PAJS/ Ethiopian Physical Society
3.	Ato Tesfahun Fenta	Chairman, Organizing Committee	PAJS/Crop Protection Society of Ethiopia
4.	Ato Yohanes Jorge	Member	PAJS/Ethiopian Pharmaceutical Association
5.	Ato Zinabe Mekonen	Member	PAJS/ Ethiopian Library and Information Association
6.	Dr. Ensermu Kelbessa	Member	Ethiopian Society of Chemical Engineers
7.	Dr. Taddesse Gebremedhin	Member	Ethiopian Society of Mechanical Engineers
8.	Ato Wondimagene Shibru	Member	ESTC
9.	Dr. Ensermu Kelbesa	Member	Biological Society of Ethiopia
10.	Ato Berhanu Mengesha	Member	Ethiopian Foresters Association
11.	Dr. Terefe Degefa	Member	Agricultural Economics Society of Ethiopia
12.	Dr. Belay Simane	Member	National Input Authority
13.	Ato Asmamaw Berhanu	Member	Ethiopian Assistant Veterinarian Association
14.	Ato Esubalew Alehegne	Pro. Officer	PAJS
15.	W/t Elizabeth Mulugeta	Secretary	PAJS

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