AMHARA NATIONAL REGIONAL STATE

BUREAU OF AGRICULTURE

AGRICULTURAL RESEARCH MASTER PLAN

VOLUME I

(MAIN REPORT)

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July 1999

Cover Page

Research Centers, Sub-Centers and Trial Sites of the Amhara Regional State by the End of 2020

AGRICULTURAL RESEARCH MASTER PLAN

(LIST OF REPORTS)

VOLUME I MAIN REPORT

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Part 1 Natural Resources Management and Environmental Protection

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Part 5 Animal Production Improvement

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Part 7 Agricultural Mechanisation

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RARMP	Regional Agricultural Research Master Plan
RCS	Regional Conservation Strategy
RELC	Research Extension Liaison Committee
RTC	Rural Technology Center
SC	Sub-Center
SIDA	Swedes International Development Agency
SWC	Soil and Water Conservation
TGE	Transitional Government of Ethiopia
TS	Trial Site
UNDP	United Nation Development Programme
WADU	Wollamo Agricultural Development Unit

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EXECUTIVE SUMMARY

I. Introduction

1.1. The Amhara National Regional State (ANRS) is predominantly an agricultural Region. Agriculture dominates the economy heavily by employing over 90% of the labour force and contributing about 70% to the Regional Gross Domestic Product. Despite the hard working nature and discipline of the farming population, productivity is far too low due to, among others, lack of technology, deteriorating natural resource base, inadequate institutions and linkages. Population continues to increase while the carrying capacity of the land has been on the decline.

1.2. Although attempts have been made in the Region to change the situations through research and related development activities, their impacts on transforming the peasant agriculture to higher level of productivity have been minimal.

1.3. Cognizant of the significant problems and constraints associated with the development of the peasant agriculture, the Bureau of Agriculture of the Amhara National Regional State took a commendable step to get the Regional Agricultural Research Master Plan (RARMP) and a 20 year action plan formulated. The document is believed to be instrumental to make an impact on the traditional rain-fed agriculture through reorganization of the research system to be agro-ecology based, integrated, multi-disciplinary and demand oriented.

1.4. The overall goal of the Regional Agricultural Research Master Plan (RARMP) is to contribute to the transformation of the low input smallholder-rainfed-traditional agriculture into technology based agricultural production and promote agriculture-led industrialization. The Master Plan will play a central role in achieving this through promoting researches, providing baseline data and prioritizing actions.

1.5. The Master Plan was prepared in a consultative and participatory manner. The Client and stakeholders have been enabled to participate in the major steps of planning and implementation processes of the preparation that included, (i) strategic planning meeting with heads and senior researchers of the Research Centers, (ii) introduction, workplan presentation and discussion workshop under the auspices of BOA, (iii) meeting with the Master Plan Review Committee and (iv) review meetings with the Research Centers staff on locations.

II. Regional Agro-Ecological Distribution

2.1. The ANRS is divided into 10 major and 18 sub-agro-ecologies each with distinct natural resource base (soil, water, climate, etc.,), farming systems and economic and social settings. There is a need to organize the regional Research system to (a) promote integrated research programs (b) ensure rational utilization of resources, (c) address production problems typical to on AEZ and (d) avoid unnecessary

the services for which it was established. RELC's operation was largely affected by frequent changes in staff and organizational set up of MoA that resulted in frequent deployement and reshuffling of committee members. RELC was considered as part time activity. Decision making power was not clear and legal.

4.8. The present skilled manpower of the research centres are not adequate in number, qualification, experiences and critical skills required for the respective discipline. There are only 19 MSc, 44 BSc and 68 diploma holders in all the three research centres.

4.9. The present infrastructure, facilities and equipment are not adequate in number and quality to undertake researches as may be required by the different disciplines. Inadequate supply of inputs for laboratories and fields, poor maintenance of equipment and shortage of transport facilities are identified among the major limitations for research activities.

V. Gap Analysis

5.1. The major constraints identified in the agricultural research system of the Region are (i) limited agro-ecological and program coverage, (ii) inadequate technology development, (iii) poor system of technology transfer and adoption, (iv) inadequate research organization, structure and management and (v) lack of agricultural research policy.

5.2. The current strategy is to increase food production, hence its focus on field crops, (cereals, pulses and oilseeds). Research on animal husbandry (breed improvement, health and feed resources) farmer research-extension linkages, agricultural economics, institutional and policy studies have remained an adjunct to the field crops research. This commodity approach has resulted in the non-commodity research areas to be ignored or to remain small or in some cases not being considered at all. Such areas include natural resource management and environmental protection research, biodiversity and habitat conservation, farm mechanization, irrigation and drainage, farm forestry and range land resource management.

5.3. Judging by the content of the agricultural research in the ANRS, it appears that programes are not fully based on farmers' felt needs and priorities nor are based on policies being pursued. The policy on food sufficiency/security calls for diversification to minimize risks and for research to give priority on natural resource management and environmental protection. Nevertheless, research continues to focus on field crops improvement albeit with some success. Perhaps, the most important problem of the research approach is that it is not sufficiently problem and goal oriented and farmers are not full partners of the research enterprise. To weaken the approach even further is the inadequate research-extension-farmer linkage. Research results are more directed to BOA as annual research reports instead of going to the farmers through Zonal and Woreda agricultural offices.

VI. Proposed Strategies, Research Focus and Priority Setting

6.1. The regional agricultural research strategy is developed to meet the overall objectives of (i) generating appropriate production technologies addressing priority constraints, (ii) facilitating their transfer to clients (farmers, etc), (iii) maintaining the sustainability of the resource base.

6.2. The formulation of this strategy is based on the principles of (i) use of natural resource base as the foundation for the Region's development; (ii) conservation oriented and sustainable production; (iii) client oriented and participatory; (iv) traditional agricultural production system and indigenous knowledge as building blocks; (v) consideration of the socio-economic setting and (vi) integrated development approach.

6.3. Past research activities were not conducted on agro-ecological context. Existing research centers cover only 2 of the ten major agro-ecologies in the Region. This indicates that agricultural problems significant in most of the important agro-ecologies are either inadequately served or not addressed at all.

6.4. Reorganizing research establishments and designing research programs to address production and resource management problems typical to an AEZ is necessary. Thus, the strategy is to make the research work agro-ecology based which ensures the reproduction of technology generated at one place to a similar zone(s) elsewhere minimizing duplication of efforts and cost.

6.5. Research should be conservation-based and in turn conservation also need to be watershed-based. The strategy is to make research interventions through integration of technologies and local practices within the natural boundaries of a drainage area. This promotes optimum development of land, water, biomass resources and the ecosystem in a sustained manner.

6.6. To date, the regional research program was not participatory in that it did not allow stakeholders (i.e. farmers, development workers, extension experts etc.) to genuinely participate in the planning and evaluation of research. Small farmers who are end users of research technologies never came to the picture when research problems are identified and programmes designed.

6.7. Most research outputs were developed with insufficient on-farm research and ignorance of farmers conditions. As a result, farmers' perception, ambition, problems and priorities as well as economic and social problems were largely neglected. The proposed strategy, therefore, encourages farmers' participation which improves researchers understanding of the socio-cultural, socio-economic and ecological conditions by which the decisions of the farming community are influenced. Through time, farmers in the Region have developed very complex production systems. There is a general failure to appreciate and make use of

accumulated knowledge of farmers on agricultural researches. A better understanding of events on the field and the place of the farm in the overall economy would improve scientists' awareness of the farmer's needs and requirements.

6.8. Technology testing on farmer's field has been part of agricultural research. However, since the physical reach of the research centers is limited, the extension service, which is geographically wide spread, is increasingly enlisted to perform the technology testing function. There is a need to supplement the interface activity with joint regular functions including technology verification, on farm trials, demonstration and field days, technology packaging, approval and design and development of information material.

6.9. Single commodity or activity approach was governing the research system. This setup did not rely upon or encouraged system approaches in which linkages among various components is important. The tendency of researches to concentrate on single commodity has been one of the major reasons for limited impact of research results on small farmers production. The proposed strategy is to make the research multidisciplinary having problem-solving orientation against the backdrop of complexity in farming patterns.

6.10. Partnership in research with parastatals, private sector, NGOs, etc is considered vital which advantages pooling resources, avoiding duplication of efforts and reduce costs.

6.11. The ANRS development objectives involve a broad spectrum of concerns in the natural resources management, field crops improvements, horticulture crops promotion, animal production improvement, agricultural mechanization, socio-economics and research extension, dryland agriculture and plant protection. These areas of concerns are all equally important for the research to promote and support development objectives of the Region. However, there is a need to set priorities in the process of research programs and sub-program formulation within each program category.

6.12. The major prioritization criteria were based on evaluation of program/sub-program's contribution(s) to (i) natural resource conservation; (ii) food-self sufficiency/security; (iii) researchability technical aspect; (iv) relevance to producer and consumer group, foreign exchange earning/saving; (v) general importance of the program/sub-program and (vi) socio-cultural issues.

VII. Proposed Research Programmes

7.1. This Master Plan has considered, identified and prioritized (within a program category) over fifty research programs under the following categories.

1. Natural Resources Management and Environmental Protection;
2. Field Crops Improvement;
3. Horticulture Development;
4. Animal Production and Feeds and Nutrition Improvement;
5. Agricultural Mechanization/Engineering;
6. Dry Land Agriculture;
7. Plant Protection;
8. Socio-Economic and Research Extension; and
9. Research Support Services.

7.2. Each identified research program is summarized in terms of (a) rationale for proposing it, (b) envisaged approach to conduct it, (c) expected output and (d) requirements for its successful implementation. The major programs within a category are further divided into sub-programs, prioritized and their implementation framed in short, medium-and long-term.

7.3. The need for NRM/EP research in the Region is more pronounced than elsewhere in the country. The Region leads the country in having the highest rate of land (soil and water) degradation (57%) due to unsustainable agricultural practices including high rate of deforestation and overgrazing. NRM/EP research is thus urgently needed and accorded highest priority in the Master Plan to find out ways and methods to optimally use and maintain the resource base (soil, water, forests, plant and animal germplasm, etc.,) for production and environmental protection.

7.4. The major research programmes identified under this category are (i) soil and water conservation, (ii) soil fertility and plant nutrition, (iii) soil micro-biology, (iv) forestry research, (v) farm/agro-forestry research, (vi) irrigation and drainage and management of vertisols, (vii) bodiversity and habitat conservation, (viii) ecosystem rehabilitation and wasteland management, (ix) watershed management research, (x) agricultural and natural resources policy and institutional research and (xi) NRM/EP research support activities.

7.5. The cereal crops are dominant occupying 73% of the cropped land followed by food legumes and oil seeds. The major cereal crops produced in the Region are teff, sorghum, barley, wheat and maize. The recurring problems are low productivity due to unavailability of appropriate technologies. Field crops improvement research on prioritized programs will be on applied and adaptive in the short-term. Basic research will be initiated on selected programs in the medium- to long-term.

7.6. Horticultural crops which include roots and tubers, vegetables, fruits, spices, stimulant, industrial and other crops are important source of food and nutrients, export market, and major source of raw material for the agro- and other industries. They increase incomes of the resource-poor farmers by optimizing the use of farm holdings and family labour while protecting the environment. Future prospects for increased production and development of horticultural crops in the Region are not only

dependent on research alone but also closely linked with the current and future polices of the regional government and the nation at large.

7.7. Animal production is a major component of the agricultural economy of the ANRS and goes beyond direct food production (meat, milk and milk by products). Livestock serves as living bank for many farmers and have a critical role in agricultural intensification process through the provision of draught power and manure for fertilizer and fuel. The regional animal production improvement research programme consists of large and, small ruminants, poultry, equines, fishery and apiculture.

7.8. Feed shortage in quantity and quality particularly in dry and wet season are limiting factor hindering animal growth, reproduction and production. Over use of feed resources have lowered productivity, increased soil erosion and land degradation. There is an urgent need for technological innovation that will raise and sustain productivity of forages and livestock by introducing high yielding quality forages to increase meat and milk production and animal power.

7.9. The agricultural research, be it on national or regional level, so far has been focusing mainly on the development of crop and animal husbandry techniques. The research system has to integrate agricultural engineering (mechanization, soil and water engineering) as well. Currently, the Region does not even have the center to handle such a responsibility let alone a strong mechanization research program. There is a need to establish a center and conduct researches to develop on pre-harvest and post-harvest technologies appropriate for the different agro-ecologies.

7.10. The research program in Agricultural Economics has the objectives of developing data base on the farmers needs and priorities, production and marketing constraints and other variables. It could also assist to enhance institutional capacity for impact assessment and make research more demand driven and relevant.

7.11. About half of the arable land in the Region falls within the dryland category, which include the arid, semi-arid, sub-moist and parts of the moist area. Most rural people (95%) living in these areas depend on small-scale dryland agriculture. In these soil erosion and environmental deterioration are sever. There is an urgent need to harness resources degradation in an agro-ecological balance sense for sustained and increased agricultural production.

7.12. The dryland agricultural research program aims at the developing agro-ecologically based technologies to improve productivity and profitability in a sustainable manner through generation, assessment, refinement, transfer and effective adoption of appropriate innovations. Major research activities include agro-climatology modeling, agronomy and crop physiology, cropping system study, soil fertility, Agronomic SWC and management, forage and pasture development.

7.13. Insect pests, diseases and other biotic and abiotic constraints are responsible for the low level of productivity of these in the Region. Under the master plan research shall be conducted in the major crop growing areas to develop resistant varieties with acceptable qualities, increased use of improved technologies, reduced pest damage and increased yield. This will be done with the involvement of crop protection staff, agronomists, economists and extension staff of the BOA.

7.14. The application of biotechnology is rapidly growing. Its potential to (i) increase productivity (of crops, trees, livestock, fishery), (ii) improve plant resistance (to pests, diseases, salinity, acidity and drought), (iii) decrease dependence on non-renewable commercial fertilizers etc is increasing. Its application (genetic engineering) to produce varieties with high protein content would alleviate problem of malnutrition among small farmers. Improves the nutrition and breeds through development of improved forage and transfer of semen and embryos. Germplasm conservation and utilization such as tissue culture, in-vitro culture and storage are all important for increased food production.

7.15. Eventhough there are some traditional processing methods for cereals, pulses and oil crops they all need improvement. Research activities in food science include (i) conducting surveys on utilization of crops and animal products; (ii) assisting researchers in developing varieties; (iii) assessing post-harvest losses of crops and animal products; (iv) developing proper handling practices and (v) developing appropriate processing technologies for household and cottage industries.

VIII. Institutional Development and Capacity Building

8.1. The foundations to guide and manage the agricultural research system within the Region are laid down through institutional development. Adequate emphasis is given in identifying institutional/organizational gaps in the Region's research organizations. At present, the regional agricultural research system consists of a Board, a Coordinating Unit, and three Research Centers and a sub-center.

8.2. The Board has a membership of 14 including the managers of the research centers, cattle ranches and rural technology centers and representatives of relevant government bureaux.

8.3. The Co-ordinating Unit has only been a temporary arrangement. Though it was supposed to coordinate the research activities of all research centers in the Region, the task is too much for it as it is understaffed and does not have the capacity and orientation to provide direction and effective technical leadership.

8.4. The research centers are few, understaffed and not well equipped. More importantly, they acutely lack experienced professional staff and competent technical leadership. As they have no sub-centers, (except Kobo for Sirinka MRC), they have been forced to concentrate in the vicinities of the centers. There is limited

co-ordination among programs/divisions within a center and among centers in the Region. The separation of these centers from the federal system has left them with no backstopping in technical leadership.

8.5. It is proposed to make the Board independent, lean and very effective in strategic planning of the regional agricultural research system. Major duties of the board are to overview and direct the formulation of agricultural research policies and strategies; determine the research priorities of the Region and follows up their implementation

8.6. The Regional Agricultural Research Institute (RARI) which is an autonomous regional apex body for the regional agricultural research system will be established. It's major duties are to co-ordinate agricultural research activities of the research centers, higher learning institutions and other establishments within the Region; liaise with national and international research bodies to support the research activities and facilitate the publication and dissemination of research findings.

8.7. There are currently three main research centers in the Region; viz, Adet, Sheno and Sirinka. Already decision has been made to set up another main center at Sekota with emphasis on natural resource conservation and development. Effort will be made to gradually (i) establish additional main centers and sub-centers on agro-ecology basis (ii) provide adequate staff and facilities and (iii) create enhanced working and living conditions.

8.8. The general responsibilities of a main center are: survey and identify production problems and technology needs of farmers in the mandate area; enhance farmers' participation in technology development through on-farm trials and pre-extension demonstrations in collaboration with extension staff in its mandated area; execute the approved research programs effectively; propose to the Institute the establishment of sub-centers and testing sites in representative agro-ecological zones as needed.

8.9. At present there is only one sub-center, 'kobo' under Sirinka Main Center and 23 trial sites distributed in most administrative zones of the Region. At trial sites there is no technical and/or administrative staff deployment nor is permanent infrastructure but the fence.

8.10. At the end of the plan period (ie. 2020), there will be a total of 12 (9 new) Main Research Centers, 15 (14 new) Sub-centers and 17 trial sites functioning in the Region. The existing research centers will be strengthened in manpower, infrastructure and facilities to bring them to a full-fledged Main Center status. These research establishments represent 10 different agro-ecologies which are agriculturally important and/or need natural resource rehabilitation. These agro-ecologies, distributed in all administrative zones, cover 81.44% of the Region's landmass.

8.11. Capacity building, in terms of facility and manpower development, creates the ground for effective and efficient operation of the research establishments. It is a long-term process especially when it involves human resource development. Physical facility development and manpower training constitute the major components of capacity building in the coming twenty years.

8.12. Physical facilities are (i) buildings, (ii) equipment (iii) furniture and (iv) supplies and expendable items. Their corresponding total costs over the 20 years period amounts 275.0 million birr, 121.6 million birr, 20.1 million birr and 26.8 million birr respectively. The total cost for the physical facility development equals 443.5 million birr.

8.13. Currently the Region's agricultural research system is critically constrained by inadequate number of trained and experienced technical staff to undertake researches more competently. Manpower is perhaps single most important factor determining the proper and efficient functioning of the Research System.

8.14. Human resource development and management are thus critical for achieving the Region's desired research goal which centers around "increased productivity" of the resources (land, labour and capital) employed in the agriculture business.

8.15. There is an urgent need to embark aggressively on human resource development through long and short-term trainings and other skill upgrading schemes. Trained manpower requirement both for the existing and the new research establishments over the twenty years are 129, 267, 10, 449 and 510 at PhD, MSc, DVM, BSc and Dipl. Level respectively. Over the twenty year period a total of 1,365 technical staff will be trained and/or recruited from the market. The proportions of research staff required with tertiary, secondary and primary degrees are 9%, 20% and 33% of the total technical staff requirement. Nearly half of the envisaged implementation costs of the RARMP (i.e. 441.2 million birr) goes to human resource development.

IX. Action Plan and Resource Requirement

9.1. Institutional development, capacity building and carrying out of research programmes have been planed for the short, medium and long-term. The schedule of activities in each period is planned to facilitate the program implementation in the next phase.

9.2. Major activities during the short-term include identification, land acquisition and establishment of 3 main research centers and 6 sub-centers; strengthening the three existing Main Research Centers and one sub-center; human resource development through 342 man year (long-term) and 317 man month (short-term), initiation of research projects based on the strategy and identified and prioritized program for the mandate area.

9.3. Strengthening established centers (through manpower development, infrastructure building, equipment procurement) technology development and release and developing long-term research programs will be the main activities of the medium-term while the long-term programmes are continuing the strengthening of centers and sub-centers on-farm research activities, status review/evaluation are the major activities of the last phase.

9.4. While deployment of trained manpower is crucial, basic changes in polices and principles governing recruitment conditions of services and performance are essential. Not only the market supply of such scientists is short but also recruitment conditions may not be good to attract scientists from major cities.

9.5. Total manpower requirement for strengthening the existing research centers and new establishments is estimate at 1,362 technical and 509 administrative support staff. The composition of the technical staff by level of education is PhD (9%), MSc (+DVM) (20%), BSc (33%) and Diploma holders (37%). The required administrative staff by level of education is 2%, 4%, 24%, 28% and 43% Masters, First Degree, Diploma, Certificate and below in that order.

9.6. The preliminary cost estimate of implementing programmes envisaged in the Master Plan is Birr 1,164 million over the plan period (2005-2020). The total capital and operational expenditures are estimated at 701mill. birr (60%) and 463 mill. birr (40%) respectively. The anticipated sources of finance for realizing the master plan are regional (domestic) and foreign (external). The Domestic sources include mainly federal and regional contributions. Foreign sources are bilateral, multilateral or NGO assistance in terms of grant or loan. About 635 million birr (55%) of the total cost is expected to be covered from the domestic sources while 529 mill Birr (45%) from foreign sources.

X. Conclusion and Recommendations

10.1. The research centers are few (only three), understaffed and not well equipped. More importantly, they acutely lack experienced professional staff and competent technical leadership. The poor employment conditions and inadequate incentive have deterred experienced and competent researchers from joining the research systems. As there is only one sub-centers, the research centers have been forced to concentrate in the vicinities of the centers.

10.2. There is limited co-ordination among programs/divisions within a Center and among centers in the region. The separation of these centers from the federal system has left them with no backstopping in technical leadership. As a result, they have not managed to generate adequate technological innovations that significantly address production constraints of farmers in the Region.

10.3. The regional research centres, as organized now, are incapable to handle all research needs due to lack of skilled and experienced staff and inadequate infrastructure and facilities. The technologies developed in the past have not been adequate and in some cases inappropriate to contribute to the production and productivity of the regional agriculture. In most cases, the technologies developed are not within the reach of the resource-poor farmers and socio-economic level.

10.4. The commodity approach dominated the research system. This approach has resulted in the non-commodity research areas to be ignored or to remain small or in some cases not being considered at all. Those ignored research areas include natural resource management and environmental protection research, biodiversity and habitat conservation, farm mechanization irrigation and drainage, farm forestry and range land resource management and animal (apiculture, fishery, poultry) researches.

10.5. The regional research program was not participatory in that it did not allow stakeholders (i.e. farmers, development workers, extension experts etc.) to genuinely participate in the planning and evaluation of research. Particularly, small farmers who are end users of research technologies never came to the picture when research problems are identified and programmes designed.

10.6. The research approach is that it is not sufficiently problem and goal oriented and farmers are not full partners of the research enterprise. To weaken the approach even further is the inadequate research-extension-farmer linkage. The lack of critical skill needed and shortage or unavailability of required facilities and infrastructure and limited agro-ecological distribution of the research establishments are important problems in the Regions agricultural research system.

10.7. The overwhelming view is that the situation calls for a formalized institutional structure to co-ordinate and lead the regional agricultural research system to support the objective of the region for technology-based agricultural development. To achieve this the reestablishment of a Board, a Regional Agricultural Research Institute, Research main Centers, Sub-centers and Testing sites is recommended.

10.8. Main Research Center and sub- center establishment should be Agro-ecology based and the center should have carefully selected and prioritized research programs that will reflect its researchable problems of the mandate area and general areas of excellence.

10.9. To ensure the proper implementation of proposed research programes and the generation of required technologies, there should be a total of 12 (9 new) Main Research Centers, 15 (14 new) Sub-centers and 17 trial sites established in the Region.

10.10. The current technical manpower at research centers is inadequate both in number and qualifications. They need to be strengthened with qualified and experienced researchers to meet the regional research needs adequately. For this, in addition to human resource development effort, basic changes in policies and principles governing recruitment conditions of services and performances should be made.

10.11. Researches should be conducted in multidisciplinary manner having problem-solving orientation against the backdrop of complexity in farming patterns. This necessitates conducting researches by taking into consideration the socio-economic settings of the farming community, understanding the resource endowments, production systems and management practices.

10.12. Because the farming system is predominantly smallhoder based which constitute about 95 % of the farming community. Research strategy should give a special focus to address the major problems constraining agricultural production of the smalholder.

10.13. To create the ground for effective and efficient operation of the research institutions established, capacity building in terms of facility and manpower development should be given emphasis. Manpower is perhaps single most important factor determining the proper and efficient functioning of the Research System. Human resource development and management are thus critical and be given priority for achieving the Region's desired research goal which centers around "increase in productivity" of the resources (land, labour and capital) employed in the agriculture business.

1. INTRODUCTION

1.1. The Need for Agricultural Research Master Plan

The Amhara National Regional State (ANRS) is predominantly an agricultural Region. Agriculture dominates the economy heavily by employing over 90% of the labour force and contributing about 70% to the Regional Gross Domestic Product.

The production system is *small-peasant-rainfed* agriculture practised by nearly all the farmers. Agriculture is traditional characterized by subsistence mixed farming with crop and livestock husbandry typically put under the same management unit. Despite the hard working nature and discipline of the farming population, productivity is far too low due to, among others, lack of technology, deteriorating natural resource base, inadequate institutions and linkages. The farm power is exclusively underfed draught animals mainly oxen although horses in some highlands of Gojam are used. Irrigation and uses of modern inputs such as fertilizers and improved seeds with accompanying technologies are extremely limited.

The potentials for development of the sector are severely threatened by complex factors, which may be categorized as '*natural*' and '*man made*'. Extensive deforestation, which causes land degradation and loss of soil fertility (due to erosion and improper farming practices) has aggravated the problem and left 30-35% of the once agricultural productive land unusable. Institutional issues such as "land tenure policy", which ideally promotes efficient and productive utilization of the land resource, agriculture and related policies and structural problems of the peasant farmers have also deterred growth the sector's performance. Population continues to increase while the carrying capacity of the land has been on the decline. Economic returns to land, labour and capital are low and thus revenue to the State and the Country as a whole from the sector is low.

Although attempts have been made in the Region to change the situations through researche and related development activities, their impacts on transforming the peasant agriculture to higher level of productivity have been minimal. Indeed, the Five Year Development Programme of the Region (1996) identified insufficient research activities/results and inadequate research institutions as factors contributing to the poor performance of agriculture. Lack of attention to the limited research results and poor linkages among research institutions, benefiting community and service giving agencies have been major shortcomings of the efforts.

Cognizant of the significant problems and constraints associated with the development of the peasant agriculture, the Bureau of Agriculture of the Amhara National Regional State took a commendable step to get the Regional Agricultural Research Master Plan (RARMP) and a 20 year action plan formulated. The preparation of the Master Plan will undoubtedly make an impact on the traditional rain-fed agriculture through reorganization of the research system to be agro-ecology based multi disciplinary demand oriented.

Among the initial moves to improve production, making required institutional improvement/arrangements, designing research strategies, setting priorities, allocating adequate resources in terms of facilities and trained manpower as well as creating enabling environment for the dissemination and testing of research results are important. A well prepared agricultural research. Master Plan will lay the foundation for the advancement of agriculture and structural transformation of the economic base of the Region. The need to properly organize research activities and streamline efforts for the advancement of agriculture is considered pivotal in the strategic development of the Region's economy. The preparation of the Master Plan The Regional Agricultural Master plan will play a central role in achieving this through promoting researches, providing baseline data and prioritizing actions.

1.2. Goals and Objectives

Goal

The overall goal of the Regional Agricultural Research Master Plan (RARMP) is to contribute to the transformation of the low input smallholder-rainfed-traditional agriculture into technology based agricultural production and promote agriculture-led industrialization.

Objectives

Major objectives of RARMP intend to address the following issues which are important in achieving the above goal.

- To improve research performance through institutional development and capacity building;
- To design well thought and practical research strategies and approaches;
- To identify priority research areas meeting the demands of the end users;
- To widen program as well as geographic coverage of research activities on the basis of regional agro-ecology diversity;
- To help develop effective linkages among research institutions, the extension service and the farmer for successful transfer and dissemination of recommended research outputs; and
- To foster institutional strengthening and networking among relevant agencies within and outside the regional research systems.

1.3. Methodology and Planning Tools Used

1.3.1. Methodology

Participatory and Consultative Planning

Preparation of the Master Plan was consultative and participatory. The Client and stakeholders have been enabled to participate in the major steps of planning and implementation process that included, (i) strategic planning meeting with heads and senior researchers of the Research Centers, (ii) introduction, workplan presentation and discussion workshop under the auspices of BOA, (iii) meeting with the Master Plan Review Committee and (iv) review meetings with the Research Centers staff on locations.

Literature Review

Relevant literature including earlier study reports, strategic documents, periodical reports from the respective research centers and other sources were consulted in the preparation of RARMP. The review was made both before and during the preparation phase of the master plan. The activity has been useful in obtaining required data and information. List of major reports and other documents reviewed are annexed.

Visit to Relevant Institutions and Sites

Field trip was organized to visit all Research Centers, some trial sites, Rural Technology Centers (RTC), ranches, plant and animal health laboratories, nurseries, regional and zonal councils, line bureaus and departments in the Region. Moreover, other relevant international agencies (such as SIDA, CIDA, ILRI and UNDP) and federal offices (such as EARO and AAU) in Addis Ababa were contacted for gathering data and sharing of experience relevant to Agricultural Research Master Plan.

Discussions

Discussions were held with concerned officials and staff of all visited offices. Useful interactions were made with researchers in all the centers on constraints in manpower development, program coverage, research-extension-farmer linkages, institutional and other potentials for the development of sound agricultural research. Farmers in the different AEZs were also contacted. They were asked to air their opinion on benefits they obtained from past research activities, system of technology dissemination and wishes they have in the strengthening/improvement of the agricultural research system in the Region.

Regular Study Team Meetings

Members of Study Team met every week at CEDEP Head Office to synergize opinions on research programs for the Master Plan. The interaction among the scientists allowed

adequate exchange of views to ensure that research programs are (i) integrated, (ii) demand oriented and (iii) reflect the needs and aspirations of small farmers in the different AEZs of the ANRS.

1.3.2. Planning Tools Used

Agro-ecology Maps

The Amhara Region has varied and divers agro-ecologies each with distinct natural resource base (soil, water, climate, etc.,), farming systems and economic and social settings. There is a need to organize the regional Research system to (a) promote integrated research programs (b) ensure rational utilization of resources, (c) address important production problems typical to each AEZ and (d) avoid unnecessary duplication of efforts. Thus, Agro-ecology classification map prepared by the NRMRD of the Ministry of agriculture (1998) and Crop Pasture Production System Zone Classification of the IGAD/FAO (1995) have been used in the preparation of the master plan. These maps were used in proposing locations of research establishments and identifying research programs.

Population Density

Population density in a rural setting has significant implications on resource utilization and production systems. Public expenditures should also confirm equitable and fair distribution of research establishments. Although agro-ecological population distribution of the Region is lacking, data on administrative divisions was used in deciding on the geographic locations of research centers/sub-centers and identification and prioritization of research programs.

Farming Systems

The Region has different AEZs in which farmers have developed diversified and complex farming systems. Crop, livestock and forestry are produced in highly integrated manner in some areas while small peasant rainfed crop/livestock mixed farming are practiced in another. These currently most prevailing farming systems and those envisaged to be significant in the future (such as 'large scale commercial farming' and 'irrigated agriculture') were considered in designing research strategies and formulation of programs.

Production Constraints and Potentials

Agricultural production problems faced by the small farmers such as soil degradation, deforestation, genetic erosion, low input use and institutional constraints were taken into

consideration in the preparation of the Master Plan. Production potentials including availability of water and vast cultivable land in the lowlands, genetic resource diversity,

political willingness to encourage conservation based agricultural development and high work discipline of the farming population were also considered in the identification and prioritization of research programs.

Criteria Development and Priority Setting

Agricultural research programs for the plan period were identified and prioritized on the basis of criteria developed for the Region. Standard system of priority setting was employed and criteria for prioritizing research programs developed. The criteria included relevance of the program to food self sufficiency, researchability and contribution to conservation strategy.

1.3.3. Time Frame

The Master Plan formulation involves the preparation of a 'Twenty Year' action program which extends from 2000 to 2020. The time frame, for implementation purposes, is divided into short (2000-2005), medium (2006-2010) and long-term (2011-2020) planning periods. Research programs and related activities to be carried out over the twenty years are identified and prioritized. Total physical facilities and human resources requirements for the plan period and envisaged achievements in training and facility development in the first five years with their associated costs are summarized.

In the short-term, the thrust of the Master Plan is put on human resources development, strengthening of existing research centers (infrastructure and facility wise), conducting researches which will quickly create impact on food production, conservation and development of natural resources.

In the medium to long-term, the master plan emphasizes on the establishment of main and sub-research centers with required facilities and manpower. Establishment and strengthening of research support services will also be implemented in the medium-term. Research programs and associated activities to be carried out over the plan period are detailed in the respective technical reports.

2. AGRO-ECOLOGY ZONES

The ANRS has a wide range of agricultural environment. This is depicted by the great geographical diversity with high and rugged mountains, flat topped plateaus and deep gorges, incised river valleys and rolling plains. The effects of altitude on temperature and evapo-transpiration and therefore on texture are always compounded with those of relief. This is particularly true in the Northern and Eastern highlands of the Region where sharp changes in climate and soils occur. The Wello highlands are very heterogeneous with variety of land forms, diversified due to differences in elevation, geology, edaphic conditions, steepness and orientation in slope, wind and precipitation. These factors contribute to variations within short distance.

According to the recent agro-ecological classification by the Natural Resource Management and Regulatory Department (NRMRD) of the Ministry of Agriculture (1998), the ANRS is divided into 10 major agro-ecological zones. The zones are further divided into 18 sub-agro-ecologies using the different physiographic units including lowland plains, lakes and rift valleys, valleys and escarpments, gorges, mountain and plateau. The sub-agro-ecologies seem to be more homogenous in terms of moisture available period, thermal conditions and physiographic characteristics. The sub-agro-ecologies are characterized by parameters of climate, soils, elevation, land use and cover, pyhiography, farming systems, available crops, livestock, wild life and forestry, agricultural potential and constraints.

Among the ten major agro-ecologies, the tepid to cool moist (M2), the cold to very cold moist (M3), the hot to warm sub-moist (SM1), the tepid to cool sub-moist (SM2) and the sub-humid (SH) zones covering 84.2% of the Region are given priority based on their agricultural importance, sustained agricultural production, environmental degradation hazard and area coverage. The sub-agro-ecologies which are selected as priority zones for research in the coming twenty years are described below in terms of their area coverage, the existing farming systems, land use and cover, agricultural potential, constraints and the proposed research program.

2.1. Coverage of Agro-Ecologies

2.1.1. Sub-Moist

The sub-moist area consists of several sub-agro-ecologies including sub-moist, hot to warm (SM1); tepid to cool sub-moist (SM2), and cold to very cold sub-moist (SM3) zones. The sub-moist zones cover one third of the Region (about 33.7 %) with area coverage of 39,325 Km^2. The major agricultural production zones under the sub-moist zone are considered as priority zones for research.

Since land degradation, low productivity of soil, water stress, deforestation and animal feed shortage are the outstanding production constraints, the major research agenda should focus on conservation-oriented land management practices. This includes developing appropriate soil and water conservation practices, rainwater harvesting techniques and crop management systems such as inter-cropping and crop rotation. Integrated soil fertility management practices through biological nitrogen fixation and input efficiency, selection of drought resistant/tolerant crop and forage species. Afforestation and agro-forestry which integrate crop and animal production, soil fertility, animal feed and fuel wood should also be given research emphasis.

(i) Sub-Moist Mountain and Plateau (SM2-5)

The sub-moist mountains and plateau (SM2-5) is the most important sub-agro-ecology of the sub-moist areas and covers about 22.1% of the Region (38,881Km^2). It is predominantly present in North Shewa, North Wello, Wag-Hemera, South Wello, South and North Gonder administrative zones covering most of the drought prone areas of the ANRS. Its altitude ranges from 1600 to 2200 m.a.s.l. The mean annual rainfall varies between 700 mm and 1200 mm, its annual Potential Evapo Transpiration (PET) ranging from 1800 mm to 1900 mm indicates that water stress is a major problem in the area. It has a relatively longer growing period of 90-175 days.

The farming system of most areas within the sub-zone is classified as cereal/livestock (IGAD/FAO 1995). The major cereal crops are sorghum, teff, wheat and pulses. Cattle, sheep, goat and donkey are the dominant livestock species. *Ficus sur*, *Ficus vasta*, *Andonsonia digitata*, *Anogeissus leiocarpus* are most prevalent tree species (NRMRD 1998).

(ii) Sub-Moist Hot to Warm Low Land (SM1-1)

The Sub-Moist Hot to Warm Low Land (SM1-1), which is an important agricultural sub-zone mainly located in North Gonder around Metema area (refer to map) covers about 11,130 sq.Km and 6.32% of the Region. The altitude ranges from 400 to 1400 m.a.s.l. The mean annual temperature varies from 21-27.5 °C. It receives an annual rainfall between 200 and 1000 mm. The PET ranges between 1500 and 2200 mm and has a growing period of 80-120 days.

According to IGAD/FAO classification, this agroecology lies within the sorghum/maize-sesame crop production zone. The cropping system is dominantly cereal-based mono-cropping. Livestock production is very important and the major species are cattle, goat and donkey. The existing wildlife includes lion, baboon and leopard.

These areas have relatively better growing conditions with at least one reliable growing season. The sub-zone has potential for both rain fed and irrigated agriculture. The major problems are water stress, deforestation, infrastructure and malaria infestation constraining the availability of labor force.

(iii) Sub-Moist Zone, Hot to Warm Gorges (SM 1-4)

The other important production area within this major zone is the *sub-moist zone, hot to warm gorges* of North Gonder around Beyeda, Belesa and Sanja weredas, and Wag-hemera around Dahana and Wag weredas. The total area is about 3,282 km^2, which is 3.39% of the Region. The altitude ranges from 800 to 1000 m.a.s.l. The mean annual rainfall varies from 700 to 1000 mm with high annual PET ranging from 1800 to 1900 mm. It has LGP of 75-90 days. The dominant soils are vertisols, cambisols and leptosols.

The farming system is cereal-livestock based in the barley/wheat-tef-sorghum crop production zones in Belesa wereda (North Gonder) and Wag and Dahana weredas (Waghamera). In Beyeda wereda (North Gonder); the teff/barley-maize production system other crops such as lentil and chickpeas are also prevalent. Mono cropping with cereal is the usual practice. Most areas have at least one reliable growing period except Wag wereda where one or two short unreliable periods predominate. The relative importance of livestock production is low to medium. Cattle, goat, sheep, camel, donkey and mule are the dominant animal species. Greater kudu, Duiker, and Guinea fowl dominate the wildlife.

Due to land pressure, particularly in the Wag-Hamera, most areas of the sub-zone are intensively cultivated, deforested and overgrazed. This has led to sever land degradation and the productivity of the land is reduced. The rainfall is also limited in amount and highly variable. Low agricultural production and total crop failures have become common occurrence in these areas.

2.1.2. Moist Zone

The moist zone comprises several major agro-ecologies including the moist hot to warm (Ml); moist tepid to cool (M2) and moist cold to very cold (M3) zones. There are several sub-agro-ecologies within each agro-ecology. The moist zone covers about 57.31 % of the Region with an area coverage of 100,879 Km^2. The major agricultural production priority sub-zones under the moist zone are the tepid to cool moist mountain and plateau (M2-5), tepid to cool moist plains (M2-1) and the moist cold to very cold mountains (M3-7).

Major production constraints of the moist zone are problem of soil (vertisol) workability, over cultivation, land shortage, steep slope cultivation, erosion, deforestation low temperature and termite.

The research programs for the zone should focus on natural resource management, soil and water conservation techniques, farm forestry, development of appropriate land preparation technologies (that improve workability of the vertisoil), generation of high yielding varieties, and development of multiple cropping system (such as double, relay and inter-cropping).

(i) Moist Plains, Tepid to Cool (M2-1)

This sub-zone refers to the tepid moist planes around Lake Tana. It covers areas in South and North Gonder (Alefa Takusa, Dabat, Dembia Gonder zuria) and West Gojam. The total area is, about 7,884 sq. Km., which is 4.48% of the Region. The altitude is 1000-2200 m.a.s.l. The annual rainfall, temperature, PET and LGP vary from 500 to 1500mm, 16-21 ^{0}C, 1400-2200-mm and 90-120 days respectively. The dominant soils are nitosols, vertisol, leptosol and cambisol.

The farming system is cereal/livestock based. It is also classified as Maize/Sorghum-Teff Barley crop production system zone. Millet and pulses are also important crops grown in the area. The animal species include cattle, goat, sheep and donkey.

This sub-zone has a high potential for rain fed crop production (double cropping, inter cropping and in general crop diversification), livestock, fishery and forestry. The major constraints are workability of the vertisol and malaria.

(ii) Moist Mountains and Plateau, Tepid to Cool (M2-5)

This zone has a total area of about 58,449 sq.Km and covers about 33% of the Region. It is one of the most important agricultural zones found in parts of North Shewa, North and South Wello, North and South Gonder, West and East Gojam and Oromia. The altitude ranges from 2,000 to 3,600 m.a.s.l. The mean annual temperature varies from 11-16 ^{0}C and receives an annual rainfall between 500 and 1000 mm. This area has both single and double growing season. Areas with single and double growing periods have about 180 and 60-120 days LGP respectively. The annual PET ranges between 1300 and 1850 mm. The dominant soils in the zone are luvisol, vertisol, nitosol, regosol and leptosol.

Both crop production and animal husbandry are important. It has good potential for growing all sorts of crops including cereals, pulses, oil and horticultural crops. The LGP is generally adequate for cultivating crops under rain fed conditions. The area is conducive for animal rearing. The major livestock species in the area include cattle, sheep goats, horses, mules and donkeys.

Although there is no data by agro-ecology, the human and livestock population residing in the area is high. Both are increasing at an accelerated rate. This has lead to decreased arable land in almost all parts of the sub-zone. Arable land per capita has declined significantly and in most parts, farmlands are as small as 0.1 ha and are not larger than 1 ha in most cases. The area has been under cultivation for a long time, the soil is shallow, termites, land shortage and fuel wood are problems.

(iii) Moist Mountains, Cold to Very Cold (M3-7)

This sub-zone covers 4% of the Region and the total area adds up to 7,041 Km^2. It is found at some spots in North Shewa, South Wello, North and South Gonder, West and

East Gojam and Oromia zones. The altitude ranges from 2,800 to 4,200 m.a.s.l. The mean annual temperature varies from 7.5-16 ^{0}C and receives an annual rainfall between 1,000 and 1,800 mm. It has a relatively longer LGP of 150-210 days and the annual PET ranges between 1,300 and 1,800mm. The dominant soils in the zone are haplic phaeozoms and leptosol.

The farming system is cereal/livestock based. The major crops grown are barley, teff and horse bean. The livestock species include cattle, goat, sheep, and donkey. The dominant wildlife are Walia Ibex, Gelada Baboon, Abissinian wolf, Leopard and Dukier. Tree species include *Erica arbonea, Hagenia abissinica* and *Juniperus procera.*

This sub-zone has the potential for sheep rearing and afforestation while the constraints are steep slopes, low temperature, erosion and deforestation.

2.1.3. Sub-Humid Zone

The sub-humid area in the Region consists of two sub-agro-ecologies, the tepid to cool sub-humid mountains (SH2-7) and the hot to warm sub-humid mountains (SH1-7). These sub-zones are described below in terms of their area coverage, existing farming systems, agricultural potential, constraints and possible research interventions.

The major production limitations in the sub-humid zone being rugged topography, shallow soil depth, land and fuel wood shortages and malaria infestation, the research should come up with efficient technologies and high yielding varieties to grow more than two crops per season, deliver improved animal breeds and husbandry techniques.

(i) Hot to Warm Low to Mid-Highlands Mountains (H1-7)

This sub-zone covers 2.36% of the area and parts of the administrative zones of Awi and West Gojam. It includes Dangla, Ankesha and Banja in the Agew Awl zone and Achfer and Bure in Mirab Gojam zone. The altitude ranges from 800 to 2,000 m.a.s.l. The annual rainfall is high (900 - 2,000mm) and generally. It has a well distributed LGP of 181-240 days with an annual PET of 1,300 to 1,700mm. The dominant soils are nitosol, arenosols, phaeozems, acrisols, lithosols, fluvisols, cambisols and vertisols.

The farming system is cereal/livestock based. It is also classified as teff/barely-maize zone. The other crops grown include finger millet, wheat, sorghum, and different oil and horticultural crops. The major animal species are cattle, goat, and donkey.

The area has great potential for crop intensification through multiple cropping. The major constraints are rugged topography, shallow soil depth, stoniness, and malaria infestation.

(ii) Sub-Humid Mountains Tepid to Cool (SH2-7)

This sub-zone covers 5316 Km^2, which is 3.02% of the Region. It is mainly found in the Awi administrative zone. It includes Ankash, Banja. Dangla, Fagta, Lokema and Guangua. The altitude ranges from 1,600-3,200 m.a.s.l. The mean annual temperature varies from 11-21 ^oC, receives a well distributed annual rainfall ranging between 700 to 2,200mm and has a longer growing period of 181-240 days. The dominant soils in the zone are nitosol, arenosols, phaeozems, acrisols, lithosols, fluvisols, cambisols, vertisols and luvisols.

The farming system is cereal/livestock based. Cereal farming is the predominant cropping practice. It is also classified as teff/barely-maize zone. Finger millet, wheat, sorghum and different oil crops are also grown. The major animal species are cattle, goat, and donkey The area has great potential for double cropping.

The major constraints identified in this sub-zone are rugged topography, shallow soil depth, stoniness, shortage of land and fuel wood, and malaria infestation.

2.2. Deficiency of the Agroecologial Zone Classification

The NRMRD of the Ministry of Agriculture (1998) classified the ANRS into 10 major and 18 sub-agro-ecological zones.

This classification is based on limited database on the natural resources (soils, water, and vegetation), existing farming systems and socioeconomic conditions of the different agro-ecologies. Since the agro-ecology map is also prepared on a macro-scale of 1:2,000,000, it could only be indicative for agricultural research and development planning.

Perhaps due to lack of database on climate (due to limited meteorological station to cover all agroclimatic Regions), areas with wide variations in rainfall, temperature regimes, PET rates, altitudes, vegetation cover, soils and land forms are classified in the smallest agro-ecological unit, which is sub-agro-ecological zone. For example, the Moist Mountains and Plateau, Tepid to Cool (M2-5), the largest sub-agro-ecology in the Region has wide variations in altitude, from 1,500 to 2,700 m.a.s.l rainfall (from 500 to over 1,000mm), other environmental conditions, farming systems and socioeconomic settings, although it is classified as a sigle sub-zone. As a result, areas with a typical dryland ecology, with marginal rainfall such as Sirinka area in North Wello is classified with Adet which is highly productive and a high rainfall area in East Gojam zone. Other sub-agro-ecological zones have also similar discrepancies.

Because the Region has varied and diversified agricultural environment for micro level and effective planning, it is important to have a clear understanding of the nature and dynamics of the agricultural environment, actual and potential land use, and major constraints specific to the ANRS' at least on a woreda level. This is not achievable from the present agro-ecology map.

The development of an indicative agro-ecological classification at macro-level is a step forward towards developing agro-ecologies with more similar features and homogenous characteristics which could cater for designing sound research strategies for food security and other research priorities based on sustainable resources management. Refinning agro-ecology zonation should continue to improve the quality of the database on micro level. It is the basis to identify research needs for the generation of technology that improves the production of the peasant farms.

3. POLICIES AND STRATEGIES ON AGRICULTURAL RESEARCH AND DEVELOPMENT

3.1. National Agricultural Development Policies and Strategies

In 1991, The Transitional Government of Ethiopia (TGE) enunciated two major policies to set the framework for the long-term development of the agricultural sector. The New Economic Policy followed by a Policy Framework Paper, which outlined the major reforms to improve the economy and to start the long process of economic recovery. It placed food security at the top of the development priorities of Ethiopia.

The policy announcement was followed by the articulation of the Agricultural Development-Led Industralization (ADLI) strategy for the long-term development of the country. The strategy aims to achieve rapid and sustainable economic growth by improving the productivity of agriculture and building up of agro-based industrial sector using local raw materials and labour intensive technologies. This is in line with the Government's long-term objective to structurally transform the economy in such a way that the relative weights of agriculture, industry and services change significantly in favour of the latter two.

During the 1993 and 1994 period, a National Agricultural Development Program (NADP) was formulated. The main objective of NADP was to increase national food production both in quantity and quality to adequately feed the population; improve the quality of life in rural Ethiopia through generation of higher income, reduction of poverty and improved nutrition; increase and diversify agricultural production for export to enhance foreign exchange earnings; and make the sector the driving force for the overall economic development of the country.

The main strategies of NADP include the following:

- Promoting sustainable crop and livestock production on smallholders farms through intensification and diversification of farm enterprises, conservation farming, grass root participation, strengthening of rural institutions, providing access to rural credit, and community awareness about the role of women in agricultural development;
- Facilitating technology transfer/extension to improve crop, livestock and fishery development through capacity building for agricultural technology multiplication and dissemination;
- Enhancing capacity for building assets in rural areas through up-grading water resources utilization and increased expansion of areas under irrigation, afforestation, and pasture development;

- Minimizing pre-and post-harvest losses through capacity building, development of appropriate pest control methods, using efficient food storage and local processing activities;
- Creating off-farm income generating activities through feasibility studies, promoting cottage industries and providing support to local artisans;
- Promoting production of food, export commodities and raw materials for industry on large scale commercial farming;
- Providing support to pastoral production systems through promoting and management of water points, fodder/pasture production, veterinary services, rural roads and appropriate extension service; and
- Increasing efficiency in marketing and distribution of agricultural inputs and products along with the promotion of support services to facilitate and sustain increased agricultural production and food security.

When applied at field level in the Regions, these national development policies and strategies failed short of generating tangible changes in farm productivity and output underlining the urgent need to design regional policies and strategies more tuned to the resource base and needs of farmers in the respective Region.

3.2. Regional Agricultural Development Policies and Strategies

The agricultural policy of the Region is based on the national policies and strategies i.e. to follow conservation-based and agricultural development-led industrialization but framed to relate to the Region's realities: natural resource base, agro-ecologies and present development potentials and constraints.

The major economic objectives of the ANRS are stated in the Five Year Development, Peace and Democracy Program. The document, enunciated by the Region in 1996, include the following as the main development objectives.

- Development of the economic and social sectors to produce sufficient food and improve general employment opportunities for the fast growing population;
- Setting up a better economic management system to cope with drought and other natural disasters;
- Laying the foundation for sustainable development in all parts of the Region; and
- Setting up a more equitable development among weredas and nationalities in the Region.

The 5 Year Development Program has the following strategies:

- Promotion of agricultural development-led industrialization along with conservation of natural resources;
- Intensification of agricultural production in high rainfall areas through higher use of inputs, credit and extension service;

- Increased agricultural production in drought prone areas through the promotion of traditional irrigation , construction of smaller dams and river diversions , and wider use of drought resistant seeds , credit , conservation practices of natural resources and extension service;
- Development of rural infrastructures such as rural roads and markets to enhance increased production and investment in the agricultural sector;
- Promotion of cottage and small scale industries and commercial enterprises for processing farm inputs;
- Development of human resources through short- term and mid-term training programmes; and
- Promotion of participatory development.

These are overall strategies. More specifically in the design of the Integrated Food Security Program for 1998-2002, an ambitious objective to double food production in five years period and a spatial approach was adopted in setting policies and priorities to achieve the agricultural development goals. Accordingly, the Region has been classified into three production areas/zones with different strategies.

Areas with sufficient rain and surplus production

Main objective is increasing production per unit area through promotion of technology based agriculture.

? * • increasing land under cultivation; not possible
- increasing the supply and distribution of fertilizer and improved seeds;
- reducing pre and post-harvest losses;
- strengthening rural credit facilities for farmers to facilitate input purchase;
- strengthening agricultural research; and
- expanding participatory extension system and packages.

Low rainfall and drought prone areas

Main objective is to minimize effects of low rainfall on agricultural production by smallholders.

- improving the supply and distribution of drought resistant seed varieties;
- promoting improved fertilizer application;
- expanding access to credit service;
- reducing pre and post-harvest losses;
- promoting water harvesting techniques; and
- enhancing agricultural irrigation possibilities on long run basis.
- ~~*~~ techniques to predict seasonal rainfall distribution and amount.

Lowlands with production potentials

Main objective is to encourage private investment in cash crop production for export and local industries.

- enhancing private investment;
- designing better land use plans;
- promoting local food processing capacity; and
- developing infrastructure facilities.

The identification of priorities and design of different development approaches based on, resource base and farming system of each production area is commendable. It has the potential of developing relevant technologies applicable for each and promoting extension activities in a more cost-effective manner. However, the potential benefits of these policies and strategies on the development of agriculture in the Region has been constrained by a host of problems not yet honestly acknowledged and adequately addressed. They include (i) unavailability of inputs on time and insufficient quantities; (ii) shortage of farm credit; (iii) the pervasive nature of insecurity farmers feel because the present land tenure policy denies them opportunities for ownership and investment in their land; and (iv) inadequate capacity of the research and extension system to effectively generate and disseminate improved technologies.

3.3. National Agricultural Research Policies and Strategy

Successive efforts have been made to develop national agricultural research policies and guidelines. The National Science and Technology Policy of 1993 identified agriculture and natural resources as priority sectors. Concerning agriculture, the objective was to increase agricultural production to meet the increasing needs of food security, and exports and industrial development. Increased production was to be realized through increased productivity of crops and animal resources, reduction of pre-and post-harvest losses, the use of irrigation and improved farm implements, and environmental protection. Identification of the country's ecologies, and studies to design and implement appropriate land use, sustainable conservation methods, mechanisms to control deforestation and ecological imbalance were identified as the major research thrusts in natural resources.

The National Science and Technology Policy was immediately followed by the drafting of the National Agricultural Research Policy and Strategy in October 1994. The objectives were to improve the country's agricultural research capability; to focus research on the major agricultural problems and enhance the development of improved technologies to enable the country to be self-sufficient in food production; promote sustainable development, conservation of natural resources and environmental protection; and co-ordinate research efforts of various institutions and national and regional research centers.

The major research agenda as defined by the policy were to:

- prioritize research programmes on small holder agriculture;
- focus on technology development which will boost agricultural production and reduce pre and post-harvest losses to increase supply for industrial uses, export and import substitution;
- promote technology development to support large scale commercial farming; and
- produce technologies which will support conservation of natural resources and environmental protection.

The policy also emphasises the importance of adaptive research, the need to establish research centers in major agro-ecological zones and to make research participatory where farmers, industrial and business groups as well as research and extension staff will determine the research agenda. The policy suggests the following strategies to implement the research agenda:

- carrying out researches to increase food self-sufficiency on sustainable basis;
- building capacities of research centers; and
- strengthening the research-extension-farmer linkage to ensure that research is demand driven.

The policy also makes provision for the establishment of a national research council and national and regional agricultural research institutes and centers. Working relationships between national and regional agricultural research institutes and centers have also been suggested.

These developments in research policies and strategies have been topped off by the establishment of the Ethiopian Agricultural Research Organization (EARO) in 1997 with the following mandate:

- formulating and/or reviewing of agricultural research and related policies;
- promoting, co-ordinating and monitoring of agricultural research;
- carrying out agricultural research in all areas of crops, animals and natural resources;
- delegating research responsibilities to regional research centers and higher learning institutions on agreed terms and/or contractual arrangements;
- creating relations with external partners including the international research centers; and
- popularizing research findings and technologies.

As summarized above both the National Agricultural Research Policy and Strategy (1994) and the mandates of EARO (1997) indicate that the support the national research system provides to regional research centers include formulating and reviewing agricultural research policies; delegating research responsibilities; promoting, coordinating and monitoring agricultural research of regional and national research entities.

3.4. Regional Agricultural Research Policy (and Strategy)

To date, the ANRS does not have regional agricultural research policy and strategy. This is despite the recognition by the regional government of its importance for making headway in enhancing technology-based agricultural development. It is expected that the Regional Agricultural Research Board may find this research master plan an essential input to formulate such policies.

In general observation, the regional agricultural research system seem to be constrained by lack of policies and capacity to generate and disseminate relevant and affordable technologies for smallholders. This is manifested by the lack of strategy and policy for the production and dissemination of improved farm implements; lack of effective technology packages for the livestock sector; lack of low input technologies for drought prone areas; and the poor performance of the crop technical packages currently being promoted through the extension programs.

The net effect of all this is that agricultural production in the Region is not technology based and dynamic enough to meet the goals of food security and sustainable development.

4. REVIEW OF AGRICULTURAL RESEARCH SYSTEM

The Ethiopian agricultural research system started about 50 years ago with the establishment of Ambo Agricultural High School primarily for training young Ethiopians. Through several stages of development, with its up and down phases, the country has now a national Research Organization with several research centres, sub-centres and trial sites in different agro-ecological zones and regional states of the country to generate technologies.

4.1. National Research System

The early work of research and development (R and D) in agriculture started in 1940's with the establishment of Ambo Agricultural High School followed by Jimma Agricultural Technical School in 1952, Debre Zeit Agricultural Research Station (now centre) and of the then Alemaya College of Agriculture and Mechanical Arts (now the Alemaya University of Agriculture) in 1955 through financial assistance of the United States of America.

The research work then was started with the introduction of exotic varieties of field and horticultural crops and dairy and poultry breeds. During the period, it was the Debre Zeit Research Station which was responsible to carry out research on poultry, cereal, pulse and horticultural crops and Jimma Agricultural Technical School was responsible for research on coffee. It was after the creation of the Institute of Agricultural Research (IAR) in 1966 as semi-autonomous full time research institution functioning under a Board of Directors, the establishment of research stations (now centres) in major agro-ecological zones started. These include Holeta Research Station for wheat, barley and dairy; Jimma for coffee and spices; Bako for maize; Debre Zeit for tef, wheat and pulses; Melka Werer for oil, fiber and fruit crops; Awassa for maize; Nazret for horticultural crops; and Mekele for sorghum. → Correction DZARC, 1997. (Mesfin Abebe and Tekalign Mamo (eds 1987).

In late 1960's and early 1970's, the Chilalo Agricultural Development Unit (CADU) and Wollamo Agricultural Development Unit (WADU) under the Ministry of Agriculture with the support of the Swedish government and the World Bank, respectively, were established as development projects with strong research input from Debre Zeit and Holeta Research Stations. It was during this period, that the early linkages between research and development with participation of farmers and extension agents started.

Until 1994, the IAR had been responsible nationally to coordinate all agricultural research activities conducted in research centres, to formulate national agricultural research guidelines and conduct researches in its centres and sub-centres located in different agro-ecological zones of the country. Its research disciplines are agricultural economics, agro-meteorology,animal feeds and nutrition, animal health, animal production, agronomy and/crop physiolgy, agro-forestry, crop protection (plant pathology and entomolgy),field crops improvement (breeding and genetics), food science, horticulture, soil science and water management, research-extrension, bacteriolgy, biotechnology, mycology, nematolgy and virology.

Over the last quarter century, several initiatives have been launched by IAR to improve the function, organization and co-ordination of agricultural research in Ethiopia. These initiatives have resulted in well functioning research programs and approach; to respond to the needs of the farmers. Yet the new system of regional state and specific development needs of the Regions came into effect only with the decenteralization in 1994.

By decree, the Ethiopian Agricultural Research Organization (EARO) which was established in June 1997 is responsible to provide relevant information service to the regional research centres and, upon request, give technical support and assistance to the extent possible. The linkage between federal (EARO) and regional research is also through participation in Annual Research Program Review and National Commodity Leaders having the capacity to lead R and D in commodity oriented program. The National Commodity Research Coordinating Centres (NCRCC) are Bako for maize, ~~Holeta~~ for tef, Kulumsa for wheat, Melkasa for sorghum and agricultural implements, Melko for coffee and Melka Werer for cotton. The National Commodity Research (NCR) and departments of various research centres are carrying out many experiments involving crops, livestock, agricultural mechanization, natural resources and agricultural economics. The EARO management provides centralized and decentralized technical and administrative assistance in support of NCR and other research programs.

4.2. Regional Research System

With the decentralization of the administrative body into the Regions, the research centres within the ANRS, which were under the federal research System (IAR), were transferred to the regional administration and become semi-autonomous in 1994. Under the new set up, the research centres plan, design and develop research programs. They are reviewed at regional and federal levels. The research activities include introduction, evaluation of crop and forage species and varieties, breeds of livestock, developing technologies to protect and improve the natural resource base, classifying, monitoring and testing control measures of diseases and insect pests.

With skeleton staff, the regional research centres cover the following research disciplines: agricultural economics and farming systems, animal (production, health, feeds and nutrition), agronomy and/crop physiology, crop protection (plant pathology and entomology), field crops improvement (breeding and genetics), horticulture, soil science and water management, agro-forestry (resource management) and research - extension. Considering the Regions overall agricultural development needs, the research program coverage is minimal.

The very limited research results obtained include the release of two field pea varieties (Sefnesh and Adet-1), and barley-variety Abay by Adet Research Centre. Sirinka has identified and recommended varieties of sorghum namely Dinkmash, Birmash, 76T1 # 23, M-36121, and Gambella 07. Other suitable crops which are identified include two varieties of sweet potato and white potato and varieties of pulses for low land namely Awash- 1,

Roba- 1, Mixican 142 (haricot bean), white wonder (cow pea) and Black eye bean as well as multipurpose tree species for different agro-forestry system. Sheno Research Centre recommended and released one variety of barley and identified and recommended forage crops for Semien Shewa. For several reasons, there has not been much contribution from research to improve the livelihood of the resource - poor farmers nor protect the natural resource base with particular emphasis on the degraded lands and depletion of genetic resource. The greatest weakness is that too often the researchers are taking too long time to recommend research results.

4.2.1. The Regional Research and Associated Establishments

Agricultural research operated under a national umbrella organization, the EARO, and the regional research centers, sub-centers and the associated establishment (ie., RTCs, Laboratories, Ranches, Seed and Poultry Multiplication Farms, etc.) came under BOA only four years ago. The Region at present has three Research Centers (with associated sub-centers and testing sites), namely, (i) Adet 7 testing sites), (ii) Sirinka (1 sub-center and 3 testing sites) and (iii) Sheno (with 4 testing sites). There are also three soil and water conservation research project sites (i.e. Andit Tid, Maybar and Anjeni) while two proposed research centers/sub-centers are under planning (Sekota and Shehdi-Metema)

The research support and/or associated institutions include, (i) two RTCs at Bahir Dar and Kombolchha), (ii) two cattle ranches (at Andassa and Metekel), (iii) two sheep farms (at Debre Berhan and Amed Guya), (iv) two poultry multiplication centers (at Kombolcha and Andasssa), (v) two Diagnostic Veterinary Labs (at Bahir Dar and Kombolcha), (vi) 1 Fishery lab (at Bahir Dar), (vii) two Plant Health Clinics (at Bahir Dar and Kombolcha) and (viii) 1 improved seed multiplication center (at Kunzilla). BOA is currently completing the planning of 3 pilot catchment-based agricultural land use and development with strong implication for research inputs.

The general research programs coverage for each of the three research centres are briefly described below.

Sheno Research Center

Sheno is situated at an altitude of 2800 m.a.s.l. with an annual precipitation of about 840 mm, with bimodal distribution, where 70% is recerved during the main rainy season (July -Sept) and 30% during the *belg* season. Research on Field Crops started in 1968 at Sheno as a testing site of Holetta Research Center. The focus was on highland crops - barley, wheat and Faba bean. Later in 1981, the work was extended to Enewari (IAR/ MOA's Agricultural Development Department (ADD) with programs on variety adaptation trials on tef, wheat, lentil, fababean and chickpea. The Sheno testing site was upgraded to a substation level in 1986 and crop improvement program took the responsibility of covering the research needs of the highlands of Semien Shewa. The center has trial sites at Ankober, Inewari, Chacha, Faji, Mehal Meda, and Molale. All are high altitude sites

and are used in screening for frost, belg season planting and aphid. The Field crops division is dealing with:

Cereals - barley, wheat
Pulses - Fababean, and field peas

Sheno has an area of 142 ha of which 37% is allocated for research and 41% for grazing. The facilities available are residential buildings, offices, stores, laboratory, field and laboratory equipment, office equipment as well as vehicles.

Sheno research and its trial sites in Ankober, Chacha, Inewari, Molale, Faji, Mida, Efesson and Tenta represent mainly moist to sub-moist, cold to very cold mountains and moist tepid to cool mountains and plateau.

Sheep breeding, nutrition and health, agronomy/physiology of crops (cereals, forage, high land pulses, potato), crop protection (pathology and entomology), crops improvement (breeding and genetics), soil and water conservation are the major research programs.

Adet Research Center

Adet was established in 1986 to undertake research in support of agricultural development activities in the mid to high altitude and high potential areas of Gojam and Gondar, situated at an altitude of 2,200 m.a.s.l. with an annual rainfall of 940 - 1490 mm, depending upon seasons. It has undulating terrian of its surroundings. Soil texture is clayish, with reddish and light soils (Nitosols and Alfisols) on the slopes and blackish soil (Vertio or Vertisols) on the bottom lands. The center utilizes nine trial sites each with an area of 2.5 ha which are administratively under the Regional Bureau of Agriculture.

The center has an area of 131 ha of which six hectares (ha) are used for research and about 79 ha for seed and forage production. There are two rivers flowing throughout the year within the boundary that can provide irrigation opportunities for off-season research/production activities.

Crops improvement (breeding and genetics), crop protection (pathology and entomology, agronomy/physiology (field, horticultural and forage crops), animal breeding/genetics (fogera), soil and water conservation, technology development for improved fish production are the major research programmes being undertaken by the center.

Adet research center and has trial sites in Woreta, Bichena, Dabat, Debre Tabor, Finote Selam, Injbara, Woreta, Kosober and Mota representing moist, tepid to cool mountains and platues, mid to high altitudes and high potential areas. Thus, all major agro-ecological zones of the Region are not covered by the research centres and sub-centres.

Sirinka Research Center

Sirinka Research Center established in 1987 covers tepid to cool moist mid to high altitude agreocology. It is located at an altitude of 1920 m.a.s.l. with an annual rainfall of 1059 mm. The soils in both Sirinka and Kobo are Vertic to Vertisols. The center conducts on-station and on-farm research activities in three agro-ecological zones. On station activities are being conducted at all sites except at Kone.

The center has 40 ha and 30 ha at Sirinka and Kobo, respectively. In terms of facilities there are residential, office, laboratories, stores, and auxiliary buildings. There are also farm machinery and implements, office equipment, laboratory equipment and vehicles.

Sirinka research and its trial sites in Kobo (sub-center), Sekota, Mersa, Estayesh, Gimba, Kone and Chefa represent high and mid altitudes, cool to cold and moist to sub-moist and warm conditions with Kobo sub-centre representing dry low lands.

Natural resource conservation and improvement (agro-forestry) agronomy/physiology of low land crops, plant protection (pathology and entomology), animal feeds and animal husbandry, socio-economic problems of farmers are major activities at the center.

The research centres as they exist today are incapable to meet the challenges for the development of agricultural sector and protect the natural resource base of the Region.

The overall research program coverage is limited and inadequate to meet the needs of the Region. The disparity between various research programs coverage is very wide. The research programmes are Narrowly based with relatively better coverage on field crops. There are nill or limited activities on animal science, horticultural crops, management of natural resources including agro-forestry and farm mechanization. There are no research programs for agricultural marketing, post-harvest handling, processing and agricultural economics and farming systems.

Inadequate manpower development plan poor research feedback system, weak organizational structure and management and lack of research focus are also the major problems faced by the Regional research system.

4.2.2. Research Organization and Management

The management of the regional agricultural research and associated research support services (except Fisheries, plant health clinics, veterinary labs and Kunzilla Seed Farm) is entrusted to the Regional Agricultural Research Board (RARB) which is accountable to the Regional Council. The Board operates under the 1993 federal agricultural research policy and strategy.

After regionalization, the research set up is led by a Board with no representation from the farming community. The Board is responsible to the ANRS Council, but reports through the Head, BOA. It administers agricultural research, production and rural technology centres. Its power is not clearly defined and thus can not give the leadership needed for research and development. Additionally, the Board having eight other centres to administer not related to research, can not provide the necessary guidance and services to the research staff. Under the Head of the Bureau of Agriculture, there is a coordinating unit.

The present relationship of the regional research centres with EARO is through Annual Research Program Review and National Commodity Leaders. Thus, it is not getting the necessary guidance and technical backstopping and other supports it used to receive, except for the National Commodity Research (NCR) and other specific research programs approved by EARO management.

4.2.3. Technology Development

The regional research centres as organized now are incapable to handle all research needs due to lack of skilled and experienced staff and inadequate infrastructure and facilities. The technologies developed in the past have not been adequate and in some cases inappropriate to contribute to the production and productivity of the regional agriculture. In most cases, the technologies developed are not within the reach of the resource-poor farmers and socio-economic level. Generally, small peasant farmers can hardly afford to purchase inputs such as fertilizers and pesticides on continuous basis, unless integrated management practicies are incorporated to increase efficiency of or reduce application of chemicals.

4.2.4. Partnership and Networking

Partnership with parastals, NGOs and the private sector is not strong. The only visible partnership is with government nurseries under BOA, Chefa Prison Farm and Care Zegae. Partnership with these sectors has a positive bearing not only on technology development but also on production and productivity of agriculture. The separation of regional research system from the federal (EARO) has limited the former access for mainly literature/ information service and technical back-stopping support. As a result, there is a visible isolation and frustration among research staff of the Region.

After decentralization, the centres have maintained their relation with the federal and other regional research centres through the Annual Research Program Review and National Commodity Leaders located at different centres of the country. These two forums are mutually useful networks for exchange of information and planting materials. The regional research system, being at its formative stage, has not yet established its own international links such as with the CGIAR centres and universities for exchange of information and other support necessary for research undertakings. The access for information/documents from EARO library is limited. Thus, the Region's research centres have to go a long way to

develop its own connection and establish the network with other institutions within and outside the country for exchange of information and other materials.

4.2.5. Research-Extension Linkage

There is no strong and effective research-extension-farmer linkages in the Region. The Research - Extension Liaison Committee (RELC) has been operational for many years to enhance research-extension-farmer linkage. It replaced the Input Co-ordination Unit as an important interface between research and extension at all levels of the government structure. However, it has not been effective and did not provide the services for which it was established. Among many reasons, farmers were not represented. The Coordination Unit under BOA also does not have the staff with necessary experiences to coordinate the research centres. There is thus a missing link to address farmers' problems and disseminate research results.

4.2.6. Physical Facilities and Human Resources

The present skilled manpower of the research centres are not adequate in number, qualification, experiences and critical skills required for the respective discipline. There are only 19 MSc, 44 BSc and 68 diploma holders in all the three research centres. Moreover, the research cadres are young with limited experience. The various research programs (natural resource management, socio-economic, post-harvest handlings, processing, marketing, irrigation, farm-mechanization) needed do not have the expertise required including specialists for coffee, sugarcane, vegetables, fruits, spices etc,.

The present infrastructure, facilities and equipment are not adequate in number and quality to undertake researches as may be required by the different disciplines. Inadequate supply of inputs for laboratories and fields, poor maintenance of equipment and shortage of transport facilities are identified among the major limitations for research activities. Library and documentation facilities are not adequate for scientific communication. The present staff houses are not connected with telephone lines. There is no internet service in all the centres. There is a shortage of staff housing and office space.

5. GAP ANALYSISGAP ANALYSISGAP ANALYSISANALYSIS

5.1. Deficiencies of the Regional Agricultural Research System

In the preceding review the major constraints identified in the agricultural research system of the Region are (i) limited agro-ecological and program coverage, (ii) inadequate technology development, (iii) poor system of technology transfer and adoption, (iv) inadequate research organization structure and management and (v) lack of agricultural research policy. This chapter makes an in-depth analysis of the problems and provides a framework for subsequent strategy development and programme formulation.

5.1.1. Limited Agro-ecological Coverage

The number of research centers in the Region were in adequate and not evenly distributed on the major agro-ecological zones. As a result, research programmes do not address the specific production constraints prevalent in all AEZs. Some of the important and highly potential agro-ecological zones considered for crop and animal production do not have any research establishments. These include all sub-zones of M1, M2 (except M2-5, SM2-5), SM1-3 all sub-zones within SM2 and SM1.

5.1.2. Inadequate Programme Coverage and Technology Development

The current strategy is to increase food production, hence its focus on field crops, (cereals, pulses and oilseeds). Research on animal husbandry (breed improvement, health and feed resources) animal feed and nutrition, plant protection, farm research-extension linkages, agricultural economics, institutional and policy studies have remained an adjunct to the field crops research. This commodity approach has resulted in the non-commodity research areas to be ignored or to remain small or in some cases not being considered at all. Such areas include natural resource management and environmental protection research, biodiversity and habitat conservation, farm mechanization irrigation and drainage, farm forestry and range land resource management.

(i) Natural Resource Management

Natural resources embrace soil, water, biodiversity and forestry and their relationship to land productivity and land use efficiency. The decline of agricultural productivity caused by the diminishing capacity of the natural resource base is well understood in the Region. This decline is due to several factors such as increasing population, which exerted pressure on existing natural resource base. This stress has resulted in shortages of fuel wood, drying up of streams and springs, decreased grazing area, loss of genetic diversity, eroded and depleted soils.

POINTS FOR DISCUSSION

1. Concepts and Objectives
2. Organizational Structure and Mode of Operation
3. Approach
4. Gap Analysis → priorities against available resources.
5. Action Plan
6. Budget and Institutional Arrangements
7. Major Limitations of the Document
8. Recommendations

Nevertheless, except for some soil and water conservation researches at Adet and Sirinka and at the old Soil and Water Conservation Research Project Sites (Andit Tid, Maybar and Anjeni) there is hardly any research on natural resources management. Neither the Sustainable Agriculture and Environmental Rehabilitation Program nor the on-going research project on Policies for Sustainable Land Management in the Highlands have institutional home within the research centers and research management system of the BOA.

Establishment of new ones and strengthening existing ones to intensify researches on natural resources management is tmely. Conducting research on such issues lends itself to integrated, multidisciplinary methods and using systems thinking and analysis. Such kind of a research programme is completely lacking in the current Region's research agenda.

(ii) Dry Land Farming Research Program

Dry land farming research in general and agronomic research in particular was given little attention by both policy makers and researchers in the Region. This resulted in lack of effective coordination mechanism in dry land agriculture in general and dry land farming agronomic research in particular.

Agronomic studies were not multidisciplinary and the research programs were not integrated with other relevant disciplines such as agro-meteorology, hydrology, soil science, crop physiology, protection and socio-economics. Moreover, research on Agro-climatology and modeling, Soil Fertility Management, Soil and Moisture Conservation, Cropping Systems and appropriate Farm Implements did not receive any attention.

(iii) Animal Improvement Research

Research in animal improvement and development of feed resources is weak. The programs on artificial insemination (AI) and availability of improved or cross-breeds are not on the agenda. Other classes of animals such as poultry, goats, horses, mules and donkeys have not been included in the animal improvement program. Only little work has been carried out in beef cattle, dairy cows, bees, poultry and fishery.

The research on animal feed resources has always been included in the research program but research success has been minimal for lack of continuation. Only little work has been done also in animal health.

Beef

As cattle meat research has only recently been established as a separate entity (1997), there are enormous gaps between existing research findings and desired outputs. Only little work has been carried out in beef cattle nutrition, feed resources and management, beef physiology, beef cattle breeding and genetics, beef cattle reproduction, beef technology, beef economics and policy research and extension.

Dairy*Dairy****Dairy***

The major weaknesses of the dairy cattle improvement program in the country include (a) lack of proper attention to identification, characterization, evaluation and improvement of indigenous dairy animals, (b) the use of cross breeding as the only method of improvement for all production systems and (c) no or little effort exerted towards creating or forming a new or synthetic breeds which are suitable for the different production systems.

The modern dairy production sector that uses pure dairy cattle or crosses lacks systematic breeding program that aims at continuous increase of milk production from available resource. This sector also does not produce elite bulls for upgrading of indigenous animals for small holder production system.

In order to bridge the gap, new research programmes should be developed to: identify and improve livestock breeds for beef and dairy production; to improve their feeding, health care, reproduction, husbandry and management; increase off-take rates and slaughter weights, improve meat handling and processing methods. Moreover, the research programs should include marketing and socio-economic studies as well as on-farm studies to compliment the on-station programs.

ApicultureApicultureApiculture

Apiculture research is relatively new. Thus, research gap is extremely large. The geographical races of honey bees found in the different agro-ecological zones of the Region are not yet identified and characterised. The merits and demerits of the races in their respective ecology need a detail research. Selection of honey bee races with desirable traits and breeding of the selected races has not started.

Identification and registration of honey bee flora in different agro-ecological zones was not exhaustively done. The value of each honey plants as a source of nectar or pollen or both and its potentiality for honey production has to be assessed. Potential honey source plants and their flowering season in the different agro-ecological zones need to be studied, evaluated and selected.

Fisheries

The state of fisheries and aquatic resources research is poor as compared to other animal science sub-sectors. There is no national institution that co-ordinates the research component. Research outputs generated upto now in the country are unbalanced in addressing the different water bodies and disciplines. Early studies made were limited to limnology and fisheries of a few Rift Valley lakes. In spite of all the studies conducted so far, much still remains to be done in limnology, fisheries and other aspects of the aquatic resources in the Region.

Thus, fisheries and the aquatic environment quantitative assessment (i.e the physical, chemical and biological aspects of lakes and rivers) of the trophic dynamics and associations of organisms in the transfer of energy, nutrient cycling, eutrophication and pollution need research emphasis.

Animal Health

Disease prevalence and lack of appropriate control measures are among the major factors constraining animal production across all production systems. Diseases, especially the vector and vector-borne, constitute the most important constraints to animal production in pastoral, agro-pastoral and crop/livestock production systems.

Research on systems development for disease surveillance, monitoring and presumably forecasting and more effective diagnostic measures against important animal diseases is lacking.

Some breeds could be completely refractile while others are highly susceptible. An assessment of the tolerance levels of indigenous breeds to some diseases has not received research attention in the Region. Hence, efforts should be geared towards identification and characterization of these breeds under different levels of disease severities.

(iv) Feed Resources and Management

Forage and pasture seed scarcity has been a major bottleneck to introduce improved forage production systems to the farming community. There is information gap as to whether forage seed production under local situation is really feasible or not. The effect of local climatic factors including rainfall distribution, photo-period, temperature, humidity, wind and presence of natural pollinating agents on seed production is not yet studied. Possibilities and methodologies of forage and pasture seed production under the influence of the local environmental factors need to be assessed.

The highland AEZs are characterized by mixed crop/livestock farming system. In the face of the highly increasing demand for arable land in the highlands, allocation of land for pasture crops seems difficult. An alternative promising approach would be fitting forages into the existing cropping system without displacing food and cash crops. This approach has not received research attention it deserves. There is a real need to concentrate research efforts on this line in order to generate alternative technologies that integrate forage and food crops production.

Most of the screening and evaluation of forage crops was based on on-station condition and yield performances of recommended forage crops were not tested under on-farm condition. Improved pasture crops production techniques should be assembled from previous research findings and tested under small-scale farm levels involving farmers

(v) Nutrition and Physiology

In the highlands, crop residues provide up to 50% of the total feed requirement of livestock but their quality is known to be poor. Treatment options to achieve optimum utilization of crop residues are not studied under local circumstances. Information on the economic and biological efficiency of the different options need to be generated to develop feeding system for various classes of animals.

Grazing trials to determine carrying capacity of a given forage crop are not carried out. Studies on the interaction between nutrition and reproduction and physiological basis on nutrient partitioning are lacking.

To date, there are no data on nutrient metabolism and requirement of local animals under fluctuating nutrient supply. Thus nutrient requirements of our local breeds and their crosses need to be studied. Possibilities to utilize non-conventional animal feed resources such as poultry excreta, dried blood, rumen content and other wastes from slaughter houses, alga content, etc., are not yet adequately studied and utilization methods need to be developed.

In vivo data on nutritional characteristics of the major feed resources are lacking. Studies on intake, animal response trials etc., need to be incorporated to develop a practical feeding guideline for different classes of livestock. Mechanisms which controls intake of low quality basal feeds and definition of physiological basis on intake regulations need to be elucidated. In addition, when new crop varieties are released, the straw should be evaluated for nutritional quality and quantity parameters.

(vi) Field Crops Research

Breeding and Genetics:- Research on field crops mainly breeding and genetics research have relatively received adequate emphasis in the research system. Nevertheless, those improved crop varieties released by the system did not show significant impact on agricultural productivity and development. The major problems, aspects from seed multiplication and distribution, associated include (a) the improved varieties are not acceptable by farmers because of certain traits, or are unsuitable to specific growing conditions and management, (b) the extension staff are either few or not capables enough to diffuse new technologies into the farming community, (c) narrow genetic base of germplasm resources of field crops for some economically important traits, (d) lack of improved varieties for most AEZ of the Region, (e) limited breeding effort on quality aspects of different crops and (f) lack of basic genetic knowledge on some important traits of different crops.

Agronomy/Physiology:- Agronomic practices appropriate for farmers circumstances in most AEZs for different crops are not developed. There is lack of suitable and improved cropping practices for most AEZ of the country. Soil fertility and fertilizer recommendation for different soil types and cropping systems are inadequately addressed.

Little attention is given to organic sources of fertilizers. Lack of studies on agro-meteorology and crop modeling. Lack of adequate knowledge on stress physiology of field crops are common phenomena.

Crop Protection:- Some disciplines and aspects of crop protection have not been given due emphasis. There is inadequate information on weeds associated with crops and their control measures in most AEZ. In spite of the heavy losses they cause, little or no research is being carried out on desert locust, armyworm, grasshoppers, birds (Quelea) and rodents. In this respect it is imperative to coordinate research programs with the Desert Locust Control of East Africa whose Headquarters is in Addis Ababa. Little attention is also given to innovative pest management strategies such as the use of botanical, and biological control using indigenous organisms against pests and diseases. There is limited inventory of indigenous knowledge on pest management practices in the Region.

Thus, the Region must develop alternative options for the management of insect pests, diseases and weeds. Crop protection research and development effort in the Region should be seeking economically viable alternatives and intensify research in such fields as dynamics of pests, crop losses in on-farm, cultural control, biological control, host plant resistance, botanicals, reduced tillage, acceptable cropping systems and integration of all relevant tactics.

(vii) Horticulture

Research in horticulture is at its infancy. There is no research programme to develop technological solution to post harvest constraints of the resource-poor farmers. The most common processing such as tomato paste and juice have not been developed in the Region. There is no study of off-season vegetable production under irrigation to supply when the demands of the produce are high in the local and regional markets. Research in organizing marketing and quality control including distribution of the produce to the markets is not established. No studies are made on local and regional market demands of various kinds of horticultural produce to advice farmers accordingly.

In spite of several constraints referred to for technology development, the technologies developed in the past have not been adequate and in some cases appropriate to meet the needs of the small holder farmers who are the major contributors to food supply. In many cases the technologies are inaccessible. Thus, it is necessary to revisit the past research work to reshape the strategies in technology development so that future research will solve the diverse set of problems of production, handling, processing, storage, transport, marketing and consumption.

(viii) Agricultural Mechanization

The non existence of a mechanization research center in the Region despite the various agricultural mechanization problems has deterred the generation of technologies that

could have alleviated drudgery and improved the quality of work in the process of agricultural production. There are no researches to develop pre-harvest technology, harvest technology, post-harvest technology, mechanical power technology small scale irrigation and water harvesting and livestock feeds and products processing technologies.

Though there are two rural technology promotion centers in the Region, technologies they have been introducing were hardly demand oriented or within the economic reach of the farmer as most of the work they have been doing were on imported prototypes.

Farm size in the Region is dwindling (less than two hectares per household) indicating hand tool technology as the prevailing level of mechanization. However, no hand tool introduction has been observed in any of the rural technology promotion program. Thus, there is an urgent need to embark on generation of those technologies that improve the productivity of the small-scale farmer in the Region.

(ix) Socio-Economic and Research-Extension Linkage

Even though such research center has some staff dealing with the above research areas, except some preliminary surveys to identify farmers problems in the immediate vicinities of the centers, there has not been any systematic FSR or socio-economic studies on constraints of the dissemination are adoption of technologies; impact assessment of recommended technologies on farm productivity; problem of farmers involvement in research formalities, and integration of farmers indigenous, knowledge in recommended technologies.

5.1.3. Lack of Research Focus

Judging by the content of the agricultural research in the ANRS, it appears that programes are not fully based on farmers' felt needs and priorities nor are based on policies described above (chapter 3). For instance, the policy on food sufficiency/security calls for diversification to minimize risks and for research to give priority on natural resource management and environmental protection. Nevertheless, research continues to focus on field crops improvement albeit with some success. Adet currently (1999) currently runs 105 individual pieces of research titles. But their activities do not appear to be problem-solving on priority basis. The potential for increased fruit, vegetable, root and tuber crops, stimulants (coffee, gesho, etc.), sugarcane and spices/condiments with or without irrigation is considerable. Horticultural research program is weak to make any impact. On the other hand farmers' interest in horticultural crops is observed increasing.

5.1.4. Inadequate Organizational Structure and Management

The organizational and management problems are related to the fact that it is less than 4 years since ANRS took over the management of research within the Region from ~~EARO~~ IAR. Some of the programs are in transition from EARO management to BOA and the centers.

A recent SIDA review mission has dealt with this issue at length and this study generally concurs with its conclusions and recommendations.

After regionalization there is no competent regional body to coordinate and guide regional research programme. The present relationship with EARO is through Annual Research Programme Review and through National Commodity Leaders.

5.1.5. Inadequate Manpower Development and Planing

Manpower development planning in connection with the tertiary institutions does not exist. Some of the skills needed in research at present are not adequately covered by existing courses and areas of specialization in the institutions of higher learning (AUA, Wondo Genet, Mekele College). Skills required in Natural Resource Management/ Environmental Protection, Biodiversity and in Research Support programs are not adequately covered. They are not adequately taking advantage of placing "Thesis research" to be part of the Regional research program and the use of joint research and teaching appointments are not common. The largest bulk of research staff is made up of first degree (BSc.) and Diploma holders, none of whom had training and experience in research when leaving their respective institutions to join the job market.

5.1.6. Lack of Effective Technology Transfer and adoption

Extension services to introduce improved technologies and systems of some sub-sectors like animal science and farm implements to the farming community have been a neglected area. Very few farmers realize the existence of high yielding dairy cattle or the improved pasture and forage crops. There is a huge gap in information dissemination systems through activities such as on-farm research/demonstration and extension activities.

The following joint activities which are necessary at the research-extension interface are not observed in the Region:-

- Technology verification and on farm trials
- Technology demonstration and field days
- Technology packaging approval and official release
- Design and development of information material
- Design and conducting of training events for extension field personnel and farmers
- Seed, breed and prototype multiplication
- Establishment of pilot projects of all sorts

Research and Extension Liason Committee (RELC) was established in 1986 at both National and zonal level to enhance horizontal and vertical integration of research, extension and farmers. The primary function of RELC was to review and approve

research proposals and extension recommendations, identify training needs and oversee the operation of research-extension-farmer linkages. RELC's operation was largely affected by frequent changes in staff and organizational set up of MoA that resulted in frequent deployement and reshuffling of committee members. RELC was considered as part time activity. Decision making power was not clear and legal. There was no active particpation of farmers in RELC activities. Because of these factors, RELC has not been effective to address the need of the Region. Thus, farmers have not benefited from RELC.

5.1.7. Inadequate Feed Back System

Technology testing, integration and production are discrete and identifiable activities in the interface between research and extension and constitute the essential linking mechanism between the two. These are shared functions that are ideally performed in close coordination and collaboration. The technology testing and integration steps should be seen as feedback mechanisms to make sure that the technology generation phase is attuned to the demands of the market place at the delivery end of the system.

Perhaps, the most important problem of the research approach is that it is not sufficiently problem and goal oriented and farmers are not full partners of the research enterprise To weaken the approach even further is the inadequate research-extension-farmer linkage. Research results are more directed to BOA as annual research reports instead of going to the farmers through Zonal and Woreda agricultural offices. This study will attempt to address this important issue of strategizing research programs and rationalization of the use of resources.

5.1.8. Lack of Regional Research Policy

As stated above, the Federal Government has in 1993 formulated national agricultural research policy and strategy but the ANRS does not have a regionally-based research policy and strategy. This gap will, in part, be met by the output of this consultancy, Agricultural Research Master Plan but cannot be a substitute.

6. PROPOSED STRATEGIES, RESEARCH FOCUS AND PRIORITY SETTING

6.1. Research Strategy

The regional agricultural research strategy is developed to meet the overall objectives of:

(i) Generating appropriate production technologies addressing priority constraints,
(ii) Facilitating their transfer to clients (farmers, etc) resulting primarily in improving rural and urban food security and income, and
(iii) Maintaining the sustainability of the agriculture resource base.

The formulation of this strategy is based on the principles of:

(i) Use of natural resource base as the foundation for the Region's development;
(ii) Conservation oriented and sustainable production;
(iii) Client oriented and participatory;
(iv) Traditional agricultural production system and indigenous knowledge as building blocks;
(v) Consideration of the socio-economic setting and
(vi) Integrated development approach.

6.1.1. Agro-ecology Based

About ten major agro-ecology zones exist in the Region ranging from semi-arid to tepid to cool sub-moist mountains. The natural resource base (soil, water, climate etc.), farming systems, economic and social settings vary with different agro-ecologies. Most of them are suitable for food crop production while some are more useful for export commodities and some show a fragile environment which exclusively require conservation works.

Past research activities were commodity based and not conducted on agro-ecological context. Existing research centers cover only 2 of the ten major agro-ecologies in the Region. Sirinka and Adet, M2-5 and Sheno SM2-5 AEZ. Moreover, within these two AEZs, there are varied sub-zones with enormous variations in resource potentials, production constraints and socio-economics each requiring distinctly different research attention. This indicates that agricultural problems significant in most of the important agro-ecologies are either inadequately served or not addressed at all (about 33%) by existing research establishments. Reorganizing research establishments and designing research programs to address production and resource management problems typical to each AEZ is necessary.

Thus, the strategy is to base the research work on agro-ecology which ensures the reproduction of technology generated at one place to similar zones elsewhere, for minimizing duplication of efforts and reducing cost. The efforts to cover as many AEZs as possible and further characterization of agro-ecological zones should be accentuated to promote effectiveness in the research system.

6.1.2. Watershed Based

Watershed management is the use, regulation, treatment of land and water resources of a watershed to accomplish stated research and development objectives. Watershed provides a natural geographical boundary within which the socio-ecological interactions and interrelationships can be studied, analyzed and appropriate development plans prepared and implemented.

Research should be conservation-based and in turn conservation also need to be watershed-based. The EARO is considering the watershed based research as one of the research strategies and some researches have been already started at federal level.

The strategy is to make research interventions through integration of technologies and local practices within the natural boundaries of a drainage area. This promotes optimum development of land, water, biomass resources and the ecosystem in a sustained manner. Watershed as a unit requires researchers of various disciplines to take a highly interdisciplinary approach.

6.1.3. Client Oriented and Participatory

To date, the regional research program was not participatory in that it did not allow stakeholders (i.e. farmers, development workers, extension experts etc.) to genuinely participate in the planning and evaluation of research. Particularly, small farmers who are end users of research technologies never came to the picture when research problems are identified and programmes designed.

Most research outputs were developed with insufficient on-farm research and ignorance of farmers conditions. As a result, farmers' perception, ambition, problems and priorities as well as economic and social problems were largely neglected. Now, it is realized that research has been bypassing the small-scale farmers who constitute about 95 of the rural population.

Thus, the proposed strategy encourages farmers' participation which ensures better understanding of the socio-cultural, socio-economic and ecological conditions by which the decisions of the farming community are influenced. This is believed to promote the search for new solutions instead of depending exclusively on outsiders experience. The strategy also facilitates feed back of information to the larger research process and

encourages farmers, etc. to participate so that their problems, needs and priorities form the basis in identifying and designing effective research programs that develop appropriate technologies.

6.1.4. Indigenous Knowledge Based

Through time, farmers in the Region have developed very complex production systems. To understand this system researchers should be talking and listening to farmers. There is a general failure to appreciate and make use of accumulated knowledge of farmers on agricultural researches. A better understanding of events on farmer's field and the place of the farm in the overall economy would improve scientists' awareness of his/her needs and requirements.

Therefore, the proposed strategy aims at giving value to and base research on the traditional agricultural systems and practices. Conversely, there is a need to integrate modern technologies with traditional practices. Such an approach is proposed to build on traditional practices by increasing scientific understanding of agro-ecosystems.

6.1.5. Effective Research-Extension Interface

Technology components which have been developed in the experiment stations and laboratories are tried out on farmer's fields in association with extension agents to determine whether they are fit to the local environment with the objective of obtaining an early feed back. Technology testing on farmer's field has been part of agricultural research. However, since the physical reach of the research centers is limited, the extension service, which is geographically wide spread, is increasingly enlisted to perform the technology testing function.

The technology testing and integration steps should be seen as feedback mechanisms to make sure that the technology generation phase is attuned to the demands of the market place at the delivery end of the system, the farmers.

Agricultural communication specialists and research extension liaison officers on the research side; a counter part research extension group technology verification and packaging team at the Bureau of Agriculture side will be necessary to facilitate the interface activity. The strategy proposed is to supplement the interface activity with joint regular functions including technology verification, on farm trials, demonstration and field days, technology packaging, approval and design and development of information material.

6.1.6. System Perspective/Multi-Disciplinary

The Region has physical features, which vary within short distances. Farmers have developed highly diversified farming systems forming different niches in each agro-

ecological zone. The different production systems including crop, livestock, and forestry are highly integrated.

However, past research approach has largely been component based and has been sensitive only to answer problems sector by sector. This is revealed by the organizational setup and research programs of both Sirinka and Adet. The research programs focused on crop commodities gave little or no attention to natural resource management and animal science. Single commodity or activity approach was governing the research system. This setup did not rely upon or encouraged system approaches in which linkages among various components is important. The tendency of researches to concentrate on single commodity has been one of the major reasons for limited impact of research results on small farmers production.

The proposed strategy is to make the research multidisciplinary having problem-solving orientation against the backdrop of complexity in farming patterns. This necessitates conducting research within the closely defined agro-ecology and socio-economic settings of the farming community by understanding the resource endowments production systems and management practices.

Apparently, a system approach requires devoted, team-based management and linkages among disciplines, institutions and farmers. In fact, scientists' should be encouraged to develop the culture of team work and team building by including farmers as partners in research right at the entry point into new or reformulated research programs.

6.1.7. Partnership with Parastatals, Private Sector and NGOs

Parastatals are playing important roles in development which are supported by research of their own and research centres of the Region and Federal. Some of these parastatals are Debre Brhan Sheep Breeding Station, Kombolcha Poultry Breeding and Multiplication Centre, Robit Prisen Farm and Ethiopia Seed Agency. Parastals are better funded, have better links with markets, can diversify their research interests and can contract out their research needs to other organizations instead of creating their own research capacity. Thus, the Regional research centres have obvious advantages of pooling resources.

If private entrepreneurs have their own research capacity, the research centres will adjust their activities to deal with problems that private sector will not cover or is less likely to cover. This will avoid duplication of efforts and be cost effective. In the future, a number of agribusinesses are expected to opt for contracting research services to research centres depending on their capacity and capability. Thus, they contribute greatly to the agricultural research and development efforts of the Region.

Although, some NGOs, supported from external sources, are short-lived, they can participate on-farm testing, verification, multi-locational trials and dissemination. NGOs associated with agricultural production, agro-industry, agro-forestry and natural resources

development are useful partners to researchers. NGOs are important actors in research that is local and community based. They have the ability to mobilize external funding and at involving local communities in self-help and development efforts. Many NGOs have close links with the rural poor and strong concern for their welfare and interests. Most of them are very receptive to new technologies and ideas which are applicable to resource-poor farmers.

Thus, the strategy is to integrate parastatals, the private sector and NGOs in technology development and transfer, particularly for them to participate in on-farm trials, demonstration and production of certified seed and planting material. All the activities mentioned are cost effective and would provide technology flow and feed back mechanism more easily.

6.1.8. Capacity Building

The current technical manpower at research centers is inadequate both in number and qualifications. They need to be strengthened with qualified and experienced researchers to meet the regional research needs adequately.

Moreover, more manpower is necessary for the envisaged higher level regional research system. In the short-term, mobilization of scientific manpower from the regional organizations (e.g. BOA), retired senior researchers as consultants and recruiting others from available markets is considered short cut to alleviate the current shortages. In the medium and long-term young BSc holders should be recruited and trained for higher degrees.

The facilities of existing research centers are inadequate though some centers are better equipped than others. Existing centers should be strengthened in phases in facilities and equipment in terms of offices, residential, buildings, social centers, libraries, laboratories communication facilities, etc. New research centers and sub-centers covering the major agro-ecological zones should be established with full-fledged facilities and other required infrastructure. Adequately manned and sufficiently equipped research establishments meet research challenges more competently than otherwise.

6.2 Research Priority Setting

The ANRS development objectives involve a broad spectrum of concerns in the natural resources management, field crops improvements, horticulture crops promotion animal sciences development, agricultural mechanization, socio-economics and research extension, dryland agriculture and plant protection. These areas of concerns (program categories) are all equally important for the research to promote and support development objectives of the Region. However, there is a need to set priorities in the process of research programs and sub-program formulation within each areas of concerns or program category.

The purpose of prioritizing is initial determination of research rankings (high, medium and low), which defines the general position of the research program/sub-program vis-a-vis different criteria set.

Although there are at least five priority setting methods[1], the **Weighting Score Approach** was selected. The method is relatively simple, and requires less data which is easy to obtain. Relative weights are attached to the criteria (or to the objectives for which the criteria measure attainments) to arrive at the set of priorities.

The general prioritization criteria were based on evaluation of program/sub-program's contribution(s) to (i) natural resource conservation; (ii) food-self sufficiency/security; (iii) level of research/technical aspect; (iv) relevance to producer and consumer group, relevance to foreign exchange earning/saving; general importance of the program/sub-program and other technical and socio-cultural issues. Moreover, other crieteria specifically useful for programes and sub-programes with in each category have been considered prioritize them more objective.

Weights placed on these criteria are compiled and worked out on the basis of views obtained from agricultural staff, farmers, research directors, policy makers, and some clients before the initial analysis. One of the means used in obtaining the weights was conducting the initial analysis with all weight placed on the efficiency objective (income generation, foreign exchange earning, natural resource rehabilitation, etc.) and then choosing the weights attached to other objectives after estimating trade off or the forgone regional benefits (such as income). Thereafter, a list of programs and research areas for the Region were developed.

The following general criteria were used to establish priorities within programs/sub-program under each category of research program.

I. National Resource Conservation

1. Enrich soil fertility
2. Reduce erosion
3. Contribution to echo system conservation

II. Food Security/Self Sufficiency

1. Value of production - area production, productivity
2. Value of food (energy, protein, fat, vit, min)
3. Present and future demand

[1] *(1) Weighted scoring method*
(2) Use of economic surplus techniques in a benefit/cost analysis
(3) Linear and dynamic programming
(4) The estimation of economic models which use historical data to measure the benefit of previous research as a guide to the future, and
(5) Development and use of simulation models

III. **Import Substitution**
IV. **Raw Material for Local Industry**
V. **Export**
    1. Current value
    2. Future Market Potential

VI. **Income Generation**
    1. Employment generation
    2. Income from the produces

VII. **Potential Impact on Research**
    1. Probability of success (time frame)
    2. Researchability
    3. Research opportunity (germplasm)

VIII. **Adaptability to Diverse Agro-Ecology**

The weight attached to each of the eight criteria varies according to the objective of research category. For the field crops research category food security/self-sufficiency attracts more weight while for the natural resource management category it is less appealing.

Based on the above and other criteria, research programs under each research category are classified as high, medium or low priority. Based on the ranking, their implementation were scheduled as short-, medium- and long-term activities (see technical report of each sub-sector).

6.3. Research Focus

The research strategy proposed for the Region will give a special focus to address the major problems constraining agricultural production systems. The farming system is predominantly smallhoder based, which constitute about 95 % of the farming community. The smallhoder farmers are resource poor and economically weak with little ability to withstand risk. Their holdings are small and scattered. The research activities to impact quickly on production and other problems should focus on these and other realities of the Region.

6.3.1. Participatory

Research program formulation approaches practised so far were top down although more recently farming systems research and farmer participatory research are getting wide acceptance. Therefore, the regional research programs will be planned to actively involve farmers. The program content or research focus of the various research programs will be properly planned and executed involving farmers. Research strategy is envisaged to

increase agricultural productivity per unit area, mostly through the use of improved technologies. The existing research main and sub-centers will be strengthened and new ones established in the different agro-ecologies to generate suitable agricultural technologies which address the problems of small farmers.

6.3.2. Smallholder Farmer Focused

The small farmer is the major contributor to the Region's agricultural/food production. These farmers, however, use hand tools, backward animal drawn and agricultural equipment and none or inadequate agricultural inputs (fertilizer, pesticides, etc.) in its production activities. This has limited growth in productivity and general agricultural output from the sector is extremely low. Priority should be given to this sector if the Region is to achieve its objective of food self-sufficiency.

Smallholder farmer can hardly afford purchased inputs on continuous basis, particularly fertilizers and chemical pesticides. Thus, research should focus on integrated nutrient management practices to increase efficiency of applied fertilizers by smallholder for both too-wet and too-dry conditions. Determination of economic return on the use of bio-fertilizer (farm yard manure, compost and green manure) on selected cash crops, incorporating integrated pest management (IPM) in crop pests control, study on landraces with short duration crops and varieties should be priority activities.

Study to determine suitable horticultural crops for intercropping and closer planting, management of feed and feed sources for small ruminant and poultry should be focus of research for smallholders.

Agro-horticultural system, where fruit trees are integrated in farming system, could add significantly to the overall agricultural production including food, fuel and fodder, conservation of soil and water and stability in production and income of the resource-poor farmers.

The basic principle and system of technology development is to focus on resource- poor farmers' needs and disseminating it for effective adoption on their fields. Thus, the research will be need-driven within the socio-economy setting of the smallholder and long-term impact on the environment.

6.3.3. Agro-Ecology Focus

There are about ten major agro-ecology zones in the Region. The potentials and limitations of each agro-ecology differ from one another. Some AEZ are more suitable for production of agricultural commodities/services which are given high priority for achieving regional objectives such as food self-sufficiency/security, foreign exchange earning or natural resource rehabilitation.

In addition to the reorganization of research establishments by agro-ecology, focusing research activities on those zones with highest potential for meeting specific regional priorities is important. For instance the tepid to cold moist mid highland (37.55%) with adequate length of growing period where moisture is not a problem has the potential of growing all sorts of crops including fruits and vegetables. The sub-most tepid to cool mid highland (25.12%) and the sub-moist hot to warm lowlands (5.43%) also grow economically important crops like cotton, sesame, ground nut and a whole range of cereals, pulses and oil seeds and are the homes of livestock. The research can focus on these zones (for example) if quick and cost effective results are to be achieved in terms of meeting those regional requirements.

6.3.4. Conservation Based

Agriculture is the main stay of the economy, livestock being an integral part, of the farming system in the Region. Degradation of land and water have been an important constraint for agricultural growth. The main agricultural problem are low productivity due to soil erosion, low soil fertility, poor drainage, moisture stress in the lowlands and poor soil management practices.

The impact of erosion was manifested among others, in reducing the soil depth and moisture holding capacity and loss of plant nutrients. The highlands of the Region suffer from severe soil erosion and degradation leaving annually considerable areas of crop land unable to provide reasonable production levels and some even having to be abandoned. It has been estimated under the national erosion hazard assessment that 1.1 billion tones of soil (58% of the nation's total loses) are lost from the Amhara Region each year (ARCS, 1997).

The regional conservation and food-security strategy and the Soil Conservation Research Project have expressed concern on the level of degradation, its impact on productivity and on the need for conservation-based development, which is also true for the research. The minor attention given in research justify the need and focus to follow conservation based research. For enhancing land productivity in these potential areas, effective cropping and grazing practices that favour conservation should be researched. Therefore, research focus should be conservation-based and in turn conservation also need to be watershed-based.

6.3.5. Commercial Agriculture

To stimulate growth and development in the Region, commercial agriculture should be promoted aggressively. For this, the land tenure policy, land-use system and other conditions must be conducive. The present systems and limited technology packages will inevitably impede the development of commercial agriculture.

Although substantial proportion of food supply will continue to come from small farmers' fields, the population growth will increasingly put pressure on food supplies. Large-scale farms should be considered to fill the gap in the food crop production and produce commodities for export earning. Though a number of agricultural commodities need the attention of the research, priorities need to be set as there is resource limitation to address all at a time.

To stimulate commercial farming, in addition to improvements on policies on land tenure, mechanization, irrigation and fertilizer usage will be major inputs. Research in these areas facilitate the establishment and development of commercial agriculture. Necessary research programs for encouraging commercial farming include fertilizer trial with major food crops (teff, wheat, barley, sorghum, maize) to derive location specific rates of recommendation; crop specific fertility experiments for coffee, vegetables, roots and tubers and fruits; coffee breeding/selection for high-yielding and resistance to Coffee Berry Disease (CBD); coffee agronomic practices to develop packages for the banana-coffee and other production systems and nutritional requirements; development of location specific recommendations for sustainable land use; assessment of techniques to conserve and utilize soil moisture for crop production; feed and feed-sources in fattening beef cattle, sheep and goats and cost-benefit analysis will be needed. The above research outputs will have a direct bearing on smallholders' farmers.

7. PROPOSED RESEARCH PROGRAMMES

The Regional development emphasis is on the improvement of agricultural productivity which is expected to finance the development of other economic sectors. The Region's agriculture, however, is severely constrained by unabated deterioration of the resource base particularly soil and water, traditional and backward production system and inadequate tenure arrangement which failed to motivate the farming population to maximize production and productivity through its rational utilization.

The regional government is making headway to redress this dismal situations of agriculture which is even unable to feed the population. Designing regional conservation strategy (RCS), development of conservation based food security program and the formulation of this Agricultural Research Master Plan are some of the efforts to alleviate the constraints of agriculture. Production problems which are given priority by the regional development policy and those needing research attention have been identifying research programs.

This Master Plan has considered, identified and proposed over fifty major research programs under the following categories:

1. Natural Resources Management and Environmental Protection
2. Field Crops Improvement
3. Horticulture Development
4. Animal Sciences
5. Agricultural Mechanization/Engineering
6. Socio-Economic and Research Extension
7. Dry Land Agriculture
8. Plant Protection
9. Research Support Services

Each identified program is summarized in terms of (a) rational for proposing it, (b) envisaged approach to conduct it, (c) expected output and (d) requirements for its successful implementation. The major programs within a category are further divided into sub-programs, prioritized and their implementation is time framed in short, medium-and long-term

7.1. Natural Resources Management and Environmental Protection

The need for NRM/EP research in the Amhara Region is more pronounced than elsewhere in the country except Region 1 which shares with it similar problems of resource degradation and environmental changes including increased frequency of droughts and famines. The Amhara Region leads the country in having the highest rate of land (soil and water) degradation (57%) due to unsustainable agricultural practices including high rate of deforestation and overgrazing as well as cultivating steep slopes

without any conservation measures. NRM/EP research in the Amhara Region is thus urgently needed and accorded highest priority in the Master Plan to find out ways and methods to optimally use and maintain the resource base (soil, water, forests, plant and animal germplasm, etc.,) for production and environmental protection.

The major research programmes identified under the NRP/EP category are soil and water conservation, soil fertility and plant nutrition, soil micro-biology, forestry research, farm/agro-forestry research, irrigation and drainage and management of vertisols, bodiversity and habitat conservation, ecosystem rehabilitation and wasteland management, watershed management research, agricultural and natural resources policy and institutional research, and NRM/EP research support activities.

7.1.1. Soil and Water Conservation (SWC)

Extensive and sever land degradation is evident throughout the Region. Soil erosion, moisture stress in the lowland areas, shallow soil depth, low soil fertility and poor drainage are major soil related problems. Indiscriminate forest/tree clearing, overgrazing, cultivation of steep slopes, poor soil management and farming practice, population pressure and absence of proper soil conservation measures have contributed to sever soil erosion consequent to which, soil productivity is reported to decline at a rate of 2-3% per year.

In an effort to combat degradation and rehabilitate the resources, intensive SWC programs have been on going. However, research on natural resources in general and SWC in particular could be evaluated as not sufficient. This is in terms of needs and its integration with the farming system, agro-ecological coverage, introduction to and adaptability by the farmers, alleviating the regional soil erosion problem and increasing the agricultural productivity.

Cognizant of the need to develop effective, low cost, easily adaptable and applicable (by small farmers) soil conservation measures and considering the regional conservation strategy and priority, the following major SWC research sub-programs are proposed:

1. Biological/vegetative soil and water conservation researches,
2. Indigenous soil and water conservation practices researches,
3. Watershed based development research,
4. Physical SWC research,
5. Water harvesting and moisture conservation research,
6. Socio-economic and SWC incentive system research,
7. Erosion, run off and modelling research,

The sub-programs listed from 1 to 3 have been given 1st priority, sub-programs 4 and 5 are 2nd priority, while sub-programs 6 and 7 are considered as 3rd or low priority. However, researches on moisture conservation and water harvesting should be considered as "high priority" in the low land areas.

The implementation of these SWC sub-programmes are proposed to be participatory (stakeholders involvement), adaptive (use of research results and technical information on similar environment), co-operative (joint researches undertaking) and geomorphic (socio-economic and farmers attitude assessment).

This program will have an overall outputs of supporting the reduction of soil losses to tolerable level, development of effective SWC technologies for different agro-ecological zones with an ultimate goals of enhancing agricultural productivity and sustainability.

To successfully conduct these sub-program, strengthening existing SWC research project sites, establishment of new centers and sub-centers at different agro-ecological zones with necessary facilities, manpower and allocation of budget and materials are need.

7.1.2. Soil Fertility and Plant Nutrition

The research has generally been part of the crop improvement program. There is no comprehensive work done to formulate the fertilizer recommendation rates for different crops in different agro-ecological zones. The attempts of ADD (1962-1971) and NFIU (1986-1996) ended up with the formulation of blanket recommendations for different crops irrespective of agro-ecological variations. Therefore, there is still an increased need for agro-ecological based research on the use of inorganic fertilizer vis-à-vis organic matter (i.e green manure, farm yard manure and other locally available nutrient sources).

In the past all fertility research works were confined to cereal crops and there was no similar work on horticulture and forestry based land use systems. Soil fertility declines and plant nutrients are lost due to soil erosion, removal of crop residues and farm yard manure and aftermath grazing. Under the prevailing poor soil and plant nutrition conditions, micro-nutrients are becoming more limiting to production in the Region. Research must, therefore, focus on this new trend and re-assess the existing NPK blanket recommendations and establish new packages for the major cereal and horticultural crops grown in different soils and AEZ of the Region. Selection of plant genotypes for nutrient stress area is also important due to the fragile nature of the environment in the Region.

Soil fertility and plant nutrition research must be agro-ecological and allow the participation of the research centers, higher learning institutes and farmers.

The implementation of appropriate strategies will ensure the development of technologies, such as fertilizer application rate for micro and macro nutrient by major ecological zone, that can alleviate current production constraints and increases yield. Moreover, locally available low cost fertilizer will be identified and be used as substitute for inorganic fertilizers. Relevant information on soils of the Region will be compiled and be available for the community. There will be a smooth linkage and information flow between centers and stakeholders. Unit the year 2020, the Region will have developed fertilizer recommendation based on soil test.

The achievement of the research can only be visualized if the Region allows the establishment of coordinating centers for each identified production problem and develop/provide the required manpower and facilities in quality and quantity.

7.1.3. Soil Microbiology

During the last 20 years, the cost of inorganic fertilizers increased astronomically and this has forced most of the developing countries to look into other options. The large amount of fertilizers applied into agricultural fields caused ground water pollution due to high nitrogen mobility. Now this situation and fertilizer policy of this country forced researchers to work on the importance of microbes on N- fixation and nutrient mobilization. However, until today little has been done in this direction and more effort is needed to utilize microbes in full scale. ANRS is one of the major pulses growing Regions of the country. Therefore, the introduction of rhizobium inoculation will raize production through improvement of soil fertility.

Since it is related to soil fertility and plant nutrition research work, the research on soil microbiology follows the same approach, (i.e. agro-ecological approach) and employs similar procedures. The lion share of responsibility for collecting, identifying and characterization of microflora and fauna will be given to research centers and higher learning institutes in the Region. Initiation of the research requires the development of both lab and field facilities as well as staff in short-term.

Identification and characterization of local soil rhizobium, mychorizal, etc., will enable the Region produce inoculants which are low cost inputs and means to improve soil fertility.

7.1.4. Forestry Research

(i) Research on Plantation Forestry

In general, forestry research has been directed to state or government plantations which are based on exotic species (focused on *Pinus* spp. *Eucalyptus* spp. *Cupressus lusitanica. Grevillea robusta. Casuarina equsitifolia).* Of the indigenous tree species that have received limited research are Cordia africana, Olea africana, Juniperus procera and Afrocarpus gracilior (Podocarpus).

Nearly all forestry researches have been of silvicultural in nature. There is no adequate information on the management and economics of the plantations. Some long-term plantation forestry projects such as the Gondar Fuelwood/Pole projects have useful data on cost and benefit of growing plantations on both marginal lands and croplands.

Compared to food crop farming, on-farm eucalyptus woodlots (under high densities and short rotations) are more profitable with a ratio of 125:1 over a 20-year period.

The genetic base of the exotic tree species being grown is narrow and efforts need to be made to introduce more and new land races and provenance. The provenance trials of Eucalyptus spp are underway and that of Gravillea robusta is in the process through regional research network.

There is an increasing eucalyptus die-back, often during prolonged dry season, for which micro nutrients such as Cobalt, Molybidium, Manganese, etc., are suspected to be the causes. Research through bioassays similar to the that carried out on 28 and 40 year old plantations of cypress and eucalyptus compared to the native forest in the Managasha State Forest is needed.

(ii) Research on Bamboos and Reeds

Both highland and lowland bamboos and reeds are important resources that have not received research attention. While highland bamboos and reeds are over exploited such as in the Awi (Injibaara) zone, lowland bamboo (the solid stem shimel, Oxynanthera abyssinica) is not. Instead, it is annually burned down while some goes into The Sudan.

Research on highland bamboo and reeds is urgently needed for their increased role and use in land husbandry, cottage industry and other uses. Research on the selection of good cultivator (including introductions from SE Asia), propagation and management (harvesting) should be a priority. Some of the work can be contracted out to Wondo Genet Forestry Collage where some researches are already underway. EARO, through FRC can also provide technical support in planning the research trials. The GTZ-assisted bamboo project in Region 1 needs to be consulted before a full scale program of research and development is mounted.

7.1.5. Agroforestry/Farm Forestry

The central focus of the NRM/E research should be agro-forestry and farm forestry based land use and resource management The two sub-systems adequately combine sustainable and more effective use of the natural resource base including the physical environment agro/farm forestry give nearly all of the products needed by the community (food, feed, fuel/energy, shelter through construction wood, and increased cash income per unit of land). This will not negate the food self-sufficiency/food security policy of the ANRS as it is possible to produce more food (grains, milk, meat) as well as other more valuable primary and by-products. These two sub-programs, especially the agro-forestry research needs to be a joint planning and implementation activity with the crop improvement program, especially the cereal crops research.

The MPTs that have received research attention in the agroforestry research programs include; Leucana leucoccepohala, Sesbania sesban, Gliricidia sepium. Cajanus cajan, Tephrosia vogeli, Cassia spp (Australian acacias) Grevillea robusta, Acacia albida (Faederbia albida), tree lucerne and Croton macrostachys. Despite the 10 to 15 years of agroforestry research in the country and involving many institutions, including regional programs and international research centers such as ILCA and ICRAF, there is no agroforestry technology identified, field-tested and packaged for farmers to adopt.

Farm forestry has had even less formal research attention. Farm forestry development is generally farmers' developed practice. The most popular and common farm forestry practices are trees in homesteads or home compounds on farm boundaries and as small on-farm woodlots. Farm woodlots and trees on farm boundaries is dominated by Eucalyptus while homestead tree panting is dominated by coffee, geho (Rhamnus prinoides), fruit trees (guava, papaya, citrus) and some times few Eucalyptus trees and some fodder shrubs (i.e., Leucaenaa, tree leucerne, Sesbania, etc.). There is some traditional live fencing using local trees such as chivha (local name for Ficus thonningi) and sensel (Adathoda schimpriana) but this has not been researched on.

7.1.6. Irrigation and Drainage and Management of Vertisols

There is very little hard data on irrigated agriculture outside some older research done by the Melka Werer Research station of the former IAR. Yields of irrigated crops, such as maize and rice both in the drylands and in the mid highlands (woina dega zone) are high. But benefits from irrigated vegetable and tree crops as well as root and tuber crops are likely to be even higher as evidenced from the Eastern Highlands (Harar) where rain-fed cereal (maize and sorghum) farming gave only ETB 1,000 and 2,000 respectively while irrigated mixed farming including vegetables and fruits gave up to ETB 60,000. Potato growing is on the increase in Gojam and Gondar, with and without irrigation and incomes are high. There is a need to establish those and other facts through research. The required courses of action to advice peasant farmers on small scale irrigated agriculture need to be developed.

ILCA in collaboration with IAR and ICRISAT has carried out an extensive vertisol drainage research and technology design and field-testing using collaborating farmers. The wheat (improved) on drained vertisols were nearly four times the controls. Research is needed to find out how long could these drained vertisols maintain their inherent fertility because of the heavy investment (for the poor farmer) of the broad based mower (BBM) and there is some empirical data to suggest that they in fact loose their fertility relatively fast if SOM management and chemical fertilizer are not part of the management practice.

High-density tree planting on swampy and seasonally flooded lands is becoming more common as a means of draining the land by lowering water table. In Australia and New Zealand, this technology is commonly in use. The most commonly used species are

Sesbania aculiata. S. sesban. S. grandiflora and Eucalyptus spp. A lowering of the water table to 1.9m in 10 years was possible, after which, the land can be used for arable crops. Much of the Tana basin (Dembia, Fogera, Gorgora, and Dangla-Zege peninsula) and the N.E. highland valleys in N.S Wollo can benefit from this technique. Research must identify suitable species and method of their establishment and eradication, once the site is adequately drained.

7.1.7. Ecosystem Rehabilitation and Wastelands Management

The ANRS is the home of many once productive lands but now wastelands where all vegetative material was removed and the soil completely lost, leaving rocky landscapes. On the other hand, deforestation and cultivation of sloppy lands with out the use of appropriate land husbandry practices has rendered many low lying flat lands flooded and highly silted up. Both of these types of lands are out of production. The Semien Shewa and Wag Hamra administrative zones have the largest proportion of denuded highlands while Semien and Debub Wollo and Oromiya zones as well lands adjoining Lake Tana have large seasonally flooded plains.

Removing all forms of human activities in the first type of degraded ecosystems may be the entry point of any effort or rehabilitation, the options for the second type include both physical and biological means of rehabilitation as described above. Research needs to identify such areas and prescribe rehabilitation methods.

At the center of the land use policy, is the issue of how long must the age-old rain-fed peasant agriculture be allowed to continue. Are forestry and tree farming and livestock production better alternative production and land use systems, if research and extension support could be increased? Certainly, these are less extractive systems (soil fertility) and returns to land, labor and capital used in the production system appear to be much higher than from cereal farming. The farm economy of the kotu farmers of the Hararghe Highlands and that from East Africa, especially from Eastern and Central Kenyan highland, the Chaga farmers of Northern Tanzania, farmers of Central Burundi is much robust and farmers are more food secure and socio-economically better of than their counter part from the Amhara central highlands who are neither food self-sufficient nor food secure (for lack of increased cash income).

There is no formal and organized research on land use/capability in the Region to be of any use in the present effort of land use planning and policy formulation. The GIS/Mapping unit of BOA is new and small to be an effective planning tool. There is no georeferenced information on natural resources and socio-economic conditions (i.e., Soils and Terrain Digital Databases to link with research data and survey information on soil degradation and soil conservation) for use in land use planning and to be able to monitor the change of land qualities (Productivity) over time.

7.1.8. Agricultural and Natural Resources Policy and Institutional Research

There are several agricultural and natural resource policy and strategy documents and a 5-year Food Security Development Plan. The 5-year Food Security development plan (1998-2002) links natural resource conservation concern by stating that agriculture must be conservation-based.

But all these lofty goals and stated objectives, including the Regional Conservation Strategy (RCS), are not being vigorously pursued. The research centers and the research staff in the natural resource management and the farming system are not involved either. The research centers sometimes conduct socio-economic and diagnostic surveys on zonal, and commodity or thematic levels but this data is seldom used.

Institutional arrangements and their strength often determine the effectiveness of the research and extension service program. The research structure in the Region and the institutional organization of BOA are still evolving. Institutional structures and horizontal and vertical relationships should be allowed to gel and solidify to steer and guide research and the implementation of this Research Mater Plan will benefit greatly as itself contributes to this positive process.

7.2. *Field Crops Improvement Research Program*

The cereal crops are dominant occupying 73% of the cropped land followed by food legumes and oil seeds (The Seed System Publication: No.19, 1996). Under the diversified agro-ecological conditions, the major cereal crops produced in the Region are teff, sorghum, barley, wheat and maize. The estimated total area under crop production is about 4.5 million hectares, producing approximately 3.5 million tons. The recurring problems are low productivity due to unavailability of appropriate technologies.

Inspite of all research efforts to increase food production, there still remains a wide gap between actual and potential levels of food production. The objective of the field crops improvement research is to raise productivity farm lands which are already under cultivation to levels approaching the potential capacity of the soil and plants through generation and effective adoption agro-ecology based technologies, while enhancing the sustainable use of the resource base.

Crops important in the Region are classified under high, medium or low priority researchables over the plan period. The field crops improvement research effort on prioritized programs will be on applied and adaptive research in the short-term (2000-2005). Basic research will be initiated on selected programs in the medium-term (2006-2011). Applied and adaptive researches will identify useful technologies and innovations from EARO and external sources and selection activities from landraces.

7.2.1. High Priority Field Crops Research

(i) Priority Crops

Tef, barley, sorghum, wheat, maize, fababean, field peas chickpeas and oil crops (noug and linseed) are identified as high priority field crops for research.

Tef is the most important and extensively cultivated cereal in the ANRS. Storability and high nutritive value of the grain as well as drought and water-logging tolerances, make this crop a suitable cereal in the Region. Tef not only constitute major staple food but its straw is an important feed for livestock and plastering wall mixed with mud.

Some useful researches have been initiated and carried out on this crop. Improved varieties with shorter and longer maturity periods, as well as drought tolerance, have also been developed at Debre Zeit research Center. Nevertheless, none of them are widely adopted by the farmers.

Barley is a staple food in the mid to very high altitudes and an important base for locally brewed beers and other processed traditional foods. But the average yields are rather low (1 ton/ha). The main cause is lack of high yielding widely adapted varieties.

Sorghum is an important cereal for the drier areas of the Region. It is a staple food of many people and an important base for locally brewed beers and other traditional foods. Several varieties are released but these are not widely adopted by the farmers of the Region. The current research program at Melkasa Research Center has useful advanced lines. There are some varieties released for commercial cultivation, but none of the varieties has been widely adapted by the farmers, perhaps because they do not conform to the local production requirements.

Bread wheat is not a historical crop while durum wheat is a traditional staple food in the Region. Yields of wheat have remained low, averaging 1.2 t/ha. In spite of low yields, the importance of wheat has increased as a food and cash crop. A number of varieties have been released, particularly bread wheat and widely adopted by the farmers.

The current research program will be continued, with particular emphasis on the utilization of improved materials developed at the IARCs, Kulumsa and Debrezeit Research Centers.

Maize is not a historical staple food in the ANRS but there has been a significant increase in production. The current research program in the Region is weak but this program will be strengthened and particular emphasis will be given on the utilization of improved materials developed at Bako, maize national commodity program for high potential and lowland irrigated areas.

The **pulses** research programs have an overall strategy for increasing the production of food legumes to complement the cereal crops in providing high value food for local consumption and export.

The **field pea** and **chickpea** are becoming important cash crops to the resource poor farmer in addition to their use as food crops. They are widely grown as late reason crops when the farmer the rain on set is late.

Noug and **linseed** are the high priority research programs in the Region. These are important food and oilcrops and their byproducts are also useful in the livestock industry.

(ii) Research Activities

The proposed research activities for these high priority field crops in the different AEZ's will include (i) collection and evaluation of local and exotic germplasm; (ii) Selection of high yielding disease/pest resistance and lodging resistance varieties for high potential and abundant rainfall and surplus producing areas; (iii) develop varieties from landraces by pureline and mass selection for marginal and high potential barley growing sub-zones; (iv) development of varieties with stable yields, disease and pest resistance for the different agro-ecologies; (v) selection of high-yielding varieties of malt quality (barley) and resistance to pests and diseases for high potential areas; (vi) testing of varieties that have been developed, through on-farm trials, to assess their yield stability and acceptability to farmers in the different agro-ecologies; (vii) develop drought and Striga resistance varieties (maize and sorghum); (viii) Introduction and adaptability of improved varieties with resistance to diseases and pests for high potential and abundant rainfall areas and for low moisture areas; (ix) initiation of germplasm development in the medium term (2005-2011); (x) initiation of hybrid maize development, particularly open pollinated maize varieties; and (xi) maintenance of breeder seed of released varieties.

(iii) Expected Research Output

Expected outputs of the research activities on the high priority crops include: (i) Release of one variety in 5 years and thereafter one variety every second year which is high yielding and resistance to pests/diseases which is suitable in the different agro-ecological zones both for high potential and marginal areas, (tef); (ii) Selected of high yielding varieties for resistance to pests, lodging and low moisture, (all); (iii) Improve the germplasm pool in relation to disease and pest control, (all); (iv) Breeder/basic seed unit in place, (all); (v) Release of two varieties in 5 years and there after one variety every second year for high potential areas, (barley); (vi) Release one variety in 5 years and thereafter one variety every three years for low moisture areas, (barley); (vii) Expansion of the germplasm pool, (all); (viii) Released drought tolerant, short, high yielding one variety of sorghum in 5 years and thereafter one variety every three years; (ix) One variety resistant to Striga released in 5 years and one variety every four years, (sorghum); (x) One variety in 10 years thereafter one variety every five years of resistant to bird damage, (sorghum); (xi) Release of one variety every second year which is high yielding and

disease and pest resistance suitable to different AEZ's, (wheat); (xii) New varieties released to specific environments (eg. low moisture), (all); (xiii) Adaptive OFR recommendations in place, (all); (xiv) Two high yielding disease resistant varieties released in a 10 year perspective and thereafter one variety every 5 years, (faba bean); (xv) Drought tolerant varieties released in a 10 year perspective and thereafter one variety every 5 years, (all); (xvi) One improved variety of field pea released in a seven year perspective. Thereafter one variety every four years; (xvii) Two drought tolerant varieties released in 10 years time and thereafter one variety every five years, (field pea); (xviii) Frost tolerant variety released in a 10 year perspective. Thereafter one variety every five years, (field pea); (xix) High yielding disease/pest resistance varieties released for high potential areas. One variety every five years and threafter one variety every three years, (chickpea); and (xx) One improved landrace in 5 years in noug and two improved landraces or cross breeding varieties of linseed in 5 years time released. Thereafter for each crop one new variety every second year.

7.2.2. Medium Priority Field Crop Researches

Grasspea and **lentils** from pulses, gomenzer, sufflower and sesame from oil crops and cotton are given medium priority in the field crops research.

Finger millet is a cultivated cereal in the less fertile areas. The average yield obtained in farmers' fields is low. There is very little research at Melkassa Research Center along with sorghum program. Only 2 varieties are released this year (1999) and one of them for the millet growing areas of the ANRS.

The resarch base for these crops is still very weak. Current research is limited to selection of high yielding varieties under irrigation while the work on rainfed cotton is very weak. The Program will focus primarily on: (a) A baseline survey to identify production constraints,
(b) Collection, characterization and evaluation of local and exotic germplasm; (c) Performance evaluation of some high yielding varieties through on-farm trials;(d) Introduction and adaptation trials for high yield and disease resistance; (e) Screening grasspea for low ODAP content.

Major outputs from the research include (i) Release one high yielding with low ODAP varieties in grasspea in a 10 year perspective. Thereafter two varieties every five years; (ii) Release two high yielding varieties in 10 years. Thereafter one variety every three years; (iii) One variety each of gomenzer and safflower released in 10 years. Thereafter one of these crops every five years; (iv) One variety of sesame released is 5 years and one variety every three years for lowland areas which are productive; (v) One variety released every five years the low land productive areas; and (vi) Improved germplasm pool for different trials.

7.2.3. Low Priority Field Crops Research

Many other crops classified as minor field crops are grown in the ANRS. These include oat, rice, haricot bean, cowpea, lupin, ground nut, castor pean and kenaf. They grow in small areas and production levels are low. Given some improvement in physical and financial resources, the research program might include these crops which are not currently in the priority list. Research on these crops will be restricted to collection, maintenance, and limited testing of improved germplasm as it becomes available.

7.2.4. Program Coordination

The different programs have general objective of generating applied and adaptive technologies to support a sustained increase in grain production in the Region. Each program will be coordinated by a program leader located in one of the center's and other centers will be cooperating with a minimum number of research staff and technically anserable to the Team Leader (See Technical Report).

7.2.5. Resource Requirement

Scientific and technical personnel, and research facilities, in terms of laboratory and office buildings, equipment, etc are required for field crops research program. The base cost for construction, laboratory and field equipment, vehicles and machinery office equipment furniture and supplies is estimated at 143 million Birr.

The training budget for the next five years for Ph.D. with a total of 24 man years 15 MSc level training with a total of 30 man years and short-term training about 4 months each with a total of 20 man month is estimated to 9.2 million Birr.

7.3. Horticultural Crops Research Program

Horticultural crops are important source of food and nutrients for humanbeings and feed for animals. They can be important for export market within and outside the country and major source of raw material for the agro and other industries and contribute greatly to the regional and national economy. Above all, they can increase the income of the resource-poor farmers by optimizing the use of their farm holdings and family labour while protecting the environment.

There are no reliable statistics on horticultural crops. Because, the production are generally contained to home gardens, mixed plantings and scattered. Until recently, the government of ANRS has not given high priority to the horticultural crops research. The crops thus had remained largely neglected at regional and national levels. They have not thus been

important contributors to the daily diet of the large segment of the population and economy of the Region.

Future prospects for increased production and development of horticultural crops are not only dependent on research alone but also closely linked with the current and future polices of the regional government and the nation atlarge. The horticultural crops include roots and tubers, vegetables, fruits, spices, stimulant, industrial and other crops.

7.3.1. Researchable Horticultural Crops

Roots and Tubers:- Potato and sweet potato play an important role in domestic food systems in the Region and contribute greatly in the cash flow to the smallholders income. Cassava, yam and taro along with cooking banana when developed can supply the bulk of carbohydrates and a significant amount of protein and nutrients in the diets of the Region. Suitable varieties and quality planting materials, diseases, insect pests, post-harvest losses and marketing are important problems.

Vegetables:- Shallot, onion, hot pepper, cabbage, carrot etc have wide adaptability and can fit into varying cropping systems under diversified agro-ecological conditions and contribute substantially to the smallholders income. Low yields and poor quality of the produce are major problems on some of the crops produced at present. The main attributes are unavailability of seeds of suitable and high yielding varieties/cultivars, presence of diseases, insect pests, poor handling of the produce, lack processing technology and system of marketing as well as extension services.

Fruits and Nuts:- Include sweet and sour sop and cheremoya, avocado, cactus, cashew nut, banana (dessert and cooking), custard apple, casamiroa, citrus, date palm, fig, grapes (table and wine), guava, kai apple, loquot, macadamia nut, mango, mulberry, papaya, passion fruit, pineapple, pomogranate, strawberry, temperate fruits, tree tomato, white sapote etc. They contribute greatly to human nutrition and protection of degraded lands and enrich the ecosystem. Some of these fruits grown are sources of cash income to many farmers in the Region. The major constraints to farmers are unavailability of suitable varieties/cultivars and quality planting materials, diseases and insect pests, lack of post- harvest handling and processing technologies and marketing systems.

Stimulant Crops:- Coffee is becoming an important cash crop for the Region. In the next ten to twenty years, the cash contribution to the smallholders with prospects as an export crop from the Region will give it a comparative advantage over other commodities. Presently, yield is generally low. Plantations are mixed and small scale. The major constraints are nutrition, diseases, pests and appropriate package of technologies for production.

Chat is one of the indigenous plant specie's in the country. Its production is quite diverse and expanding at regional and national levels. It has a wide agro- ecological coverage in sub- moist to moist moisture Regions but can not be grown economically in hot dry areas. It is a highly valued cash crop at national and regional levels next to coffee. It plays an important role in the country's economy particularly as an export commodity to neighbouring countries. Constraints are appropriate package of technologies for production, prunings, post- harvest handling, including packaging, storage and transportation.

Industrial Crops:- Sugarcane is produced as a cash crop in many parts of the Region predominantly scattered and small scale mainly for chewing. The major constraints are unavailability of suitable varieties/cultivars to cater for processing as well as technology for processing the present production at cottage level (small scale) to cater sugar for local consumption.

Other Crops :- Include herbs and medicinal plants in the Region. Very limited information is available on the use and values of most of these plants. The major worry for the Region and country atlarge is the continued extinction of most of these plant species.

7.3.2. The Research Agenda

1. At this state of affair in the production of food for self sufficiency, nutritional requirement and protecting the natural resource base, there is a need to plan, establish and carry out research in some of the horticultural crops identified to above.

2. The research will give particular emphasis to identify suitable technologies for production, post-harvest handling, processing and marketing of horticultural crops, the lack of which has been a severe limiting production factor.

3. Other activities include collection, introduction and identification of varieties/cultivars that give high yield and quality products, developing effective control measures against diseases and insect pests and improved management practices (irrigation, fertilization, weed control, harvesting and other cultural practices), post-harvest handling, processing and marketing. Quality and nutritional value assessment of the developed varieties/cultivars, products utilization, developing specialized farm implements and study the economical aspects of the crops are other fields that should be given research attention.

7.3.3. Research Strategy and Approaches

The research strategies for increased production and productivity of horticultural crops include, in short-term, wider application of existing technologies such as the immediate use of the varieties and accompanied agronomic practices for roots and tubers, vegetables, fruits, coffee, spices and sugarcane already identified and selected by EARO research

centres and released by the National Seed Industry Agency (NSIA) along with the available package of technologies. In the mid and long-term, the strategies include development and/or adoption new technologies for identified production constraints of the farmers. To succeed, at reduced cost and time, the research centres must apply the above strategies.

Participatory approach involving farmers and extension workers from time of problem identification to verification of the technologies developed will be pursued. This will enable the researcher to base his/her priorities on broader set of factors.

7.3.4. Expected Research Outputs

Planning horticultural crops research for the period of 20 years is not an easy task when considering the overall resource requirement. The horticultural research would, over this period, contribute toward overcoming the various constraints affecting the production and productivity of the natural resource base (land, water and human). According to the strategies and programs laid - out, it is conceived to produce amicable technologies to protect the degraded lands and enriching the ecosystem while attaining food and nutrition requirements. In the short to medium term, the expected output from the horticultural research include the following.

(a) Varieties of some root and tuber, vegetable, spice crops that are adapted to major agro-ecologies will be developed,
(b) Technology to reduce post-harvest losses for potato, shallot, onion, tomato, avocado, papaya, leafy vegetables will be developed,
(c) Package of technologies for production of the above crops will be made available;
(d) Fully developed tissue culture facilities established and production of plantlets of root, tuber, fruit and spice crops for distribution to farmers ;
(e) Package of technology for production of some fruits, coffee, sugarcane and chat will be developed ;
(f) Technologies for small scale processing of some selected vegetables, fruits and spices will be developed;
(g) System of marketing would be established ; and

In the long-term the regional research centres will have adequate number of staff and technicians trained up to appropriate level of skills required through fellowship in the field of breeding/genetics, agronomy/physiology, plant protection, post-harvest technology, processing and marketing. Inadition to continuation and strengthening the above activities, scion and rootstock of major fruit crops adapted to various agro-ecologies will be developed in the long-term.

7.3.5. Research Requirements

The skills of the research staff development through formal and on-the-job training in the area of breeding/genetic, agronomy/physiology, crop protection, post-harvest handling,

processing and marketing as well as through specific programs (study tour, conference and workshop) to aquire new skills in the development of research programs will be pursued.

Investments are required for infrastructures (laboratories and offices) for new centres and sub-centres, laboratories and fields equipment exclusive maintenance of infrastructures and vehicles, chemicals and other expendable items.

7.4. Animal Production Improvement and Feed Resources Development Research Program

7.4.1. Animal Production Improvement Research Programs

Animal production is a major component of the agricultural economy of the ANRS and goes beyond direct food production (meat, milk and milk by products). Farmer obtain cash income from sales of animals and their products. Livestock serves as living bank for many farmers and have a critical role in agricultural intensification process through the provision of draught power and manure for fertilizer and fuel. Animal ownership ensures varying degrees of sustainable farming and economic stability.

In Ethiopia, as well as in ANRS, there is lack of official statistical data on productivity, supply and demand of animal products. The overall contribution of animal agriculture to the regional economy and especially their multipurpose contribution to food and other uses are not quantified. An adequate quantity of balanced nutrition's of food is a primary indicator of quality of life, human welfare and development.

The regional animal science research programme consists of large and, small ruminants, poultry, equines, fishery and apiculture. The research program for each of the sub-decipline are outlined in terms of rationale, approach, requirement and outputs.

(i) Large Ruminants

Despite the important role cattle play in the economic and social affairs of the people in the ANRS, little effort, if any, is made to develop the sub-sector. In less than 10 years the human population of the ANRS is expected to increase by about 27% in relation to the human population to day 1999 (CSA). This can aggravate the food deficiency in the Region, particularly food of animal origin in the country as well. The challenge to the regional state is, therefore, how to meet the expected rise in demand for livestock products.

The cattle research program will be based on the improvement of Fogera cattle, through cross breeding, selection and management of milk and meat production while identification and improvement of other potential indigenous breeds in the Region will also be considered.

At present the large ruminant (Dairy and Beef) research center does not exist in the Region. Therefore, in the short-term the large ruminant research focuses on capacity building in terms center establishment and strengthening through manpower development which includes mobilization, recruitment and training and provision of required facilities.

In the medium-term applied research in collaboration with the federal research centers can be incited to develop appropriate technologies that can bring about improvement on production. In the long-term selection and dissemination of high yielding animals in terms of milk and meat are expected to be released together with appropriate technological packages.

Animal science research in ANRS will follow multi-deciplinary and hotislic in nature with the recognition of the social, economic, natural resource and the farming system in research planning and implementation and adequately cover the major agro-ecolgies of the Region. Dairy and beef cattle are among the major programs.

Establishment of full fledged research centers, sub-centers and testing sites in representative agro-ecological zones; allocation of adequate budget; and national and international collaborations to exchange manpower, material and other technical support, training etc.; are the major requirements to carryout the above research activities in large ruminants,

(ii) Small Ruminants

The ANRS accounts for 33.4% and 38.5 of the National sheep and goat population respectively. This share plays a significant role in foreign exchange generation to the Region and the national economy atlarge. The sub-sector also provides row material for carpet production.

At present there is only one sheep research center (Sheno) in the Region. This center is not able to satisfy research requirements of small ruminant in the Region where varied agro-ecologies prevail which impact on their genetic makeup and production system. Thus, there is a need to strengthen the existing center and establish new ones to meet the objectives of improving small ruminant productivity.

The sheep improvement program will be based on the improvement of Menz sheep through cross breeding, selection and management. Major research focus will be (i) Undertake survey to identify small ruminant indigenous genetic resources; (ii) Collaborate with National program in the characterization; (iii) Evaluation and improvement program of potential indigenous breeds; and (iv) Develop effective mechanism for the multiplication and on-farm evaluation of improved genotypes and management packages.

Research on small ruminant will be multidisciplinary. Team composed of experts in breeding, husbandry, feeds and nutrition, health and socio economics will be conducting the research. The former ILRI center at Debrebrhan will coordinate research on small

ruminants (sheep and goat), with sub-centers at Warailu and Amedguya. Sirinka research center will focus on goat research. Only very few indigenous breeds of sheep and goat types have been identified todate.

In the short-term plan at the newly proposed centers focus on capacity building. At the established centers like Sheno, reorganization of the sites will be made. Meanwhile well described production system study will be known.

In the medium-term, superior indigenous sheep and goat breed (types) in the Region will be characterized, and identified. Problems related to improvement of indigenous sheep an goat will be known. In the long-term methods for improving and enhancing sustainable small ruminant production system will be developed.

Establishment of new centers and reorganizing of the existing small ruminant research center for conducting effective research activities and allocation of adequate funds are required. Moreover to encourage researchers and support services to undertake research efficiently, availability of suitable living conditions, adequate training and incentives to researchers should be facilitated.

(iii) Poultry Research

In view of rural based development strategy the country is following, poultry development is the priority area. Poultry in the Region are important in the economic and social life of the rural community which is severely malnutrited and alarmingly poor. There is a serious need to improve the nutritional status of the population especially children and suckling mothers. Poultry play important role in family income. Improvement of its production has practical and immediate implications for betterment of the economic status of rural families.

Very serious loss (>60%) chicken mortalities prevail. Simple research supported improvements in the management could drastically reduce losses and result in visible impacts. Fast impacts are envisaged in poultry development if supported with research.

Two research centers namely Andassa and Sirinka are suggested to be developed to cater for poultry research in the moist and sub-moist agro-ecological zones respectively. These centers will focus on poultry production problems in coordination and collaboration with the breeding and multiplication centers in the Region, regional laboratories and the Federal programs. The research centers will conduct researches in collaboration with and participation of the Ministry of Agriculture staff and the farming community.

(iv) Apiculture Research

The ANRS is endowed with diverse meltiferous flora base and climate with other agro-ecological factors which suits for honey production. Inspite of the potential to apiculture resource, the production and productivity is low.

Apiculture research strategies is developed on the basis of perceived constraints. Identified research programs are proposed to be implemented at Adet, Sheno and Sirinka. The former is proposed to serve as regional apiculture research co-ordination center.

Since apiculture research is not existing in the Region, technical research results may not be expected in the short-term. In the long-term, production and marketing constraints are identified, different honeybee races and diseases investigated and preventive and controlling measures devised. Identified melliferous flora, improved productive performance through solution can also be achieved. Honey and wax processing and marketing studies are made. The results enhance promotion of the sub-sector with substantial increase in yield, and supply to domestic cottage industry.

Capacity building in terms of manpower, equipment, facility and other infrastructure in short to medium-term are required to implement the research program in the Region.

(v) Fishery Research

The Amhara Region is endowed with plenty of water resources including lake Tana containing substantial quantity of fish stocks. There are also smaller lakes like Haik and Mailer in the Region. However, the productivity (<2000 tone/year) of these water sources in terms of fish, etc. harvest is much lower (JEREB 1997). This large aquatic resources demand for research efforts geared toward exploiting the resource potential.

Fishery research program will be based at Baher dar and operates in connection with the research programs on Lake Tana. A similar research station will also be established at the northern-most part of Lake Tana, in Gorgora town. Both will operate in multidisciplinary approach and in collaboration with each other.

To start the fishery research more competently, there is need to re-assign research staff based on the research program to be implemented. The short, medium and long-term manpower and facility requirements are determined based on the type of research and volume of activities to be implemented.

Following the capacity building in the short-term, technologies for improving the productivity of fishery resources in the water bodies of the Region will be generated.

(vi) Equine Research

The ANRS contributes 27% of the horse, 41% of donkey and 39% of the mule population of the country (CSA). Despite the significant role they play in the production system, no attention has been given to improve their productivity.

Based on the criteria set (Rural base and potential for response to research) to rank different species to be handled in the research program this category of animals recieved least priority. At manpower and facility status for this research is nill. Thus, the

probability of successes is low, and time scale for a brake-through and adoption of newer technology seems longer.

To build up the regional capacity (to start equine research programs), attempt will be made to make full use of the research findings and experiences from other regional or federal research institutions or international sources of similar environment.

In the short to medium-term research results that could bring about impact will not be expected. However, increased equine research capacities can be created. In the long-term different equine types could be identified and recommended for their uses and adoption of research results by the smallholder.

7.4.2. Feed Resources Development Research Programe

(i) Forage and Pasture Research

Feed shortage in quantity and quality particularly in dry and wet season are limiting factor, hindering animal growth, reproduction and production. Infact, over use of feed resources (natural pastures, crop residue and after math) have lowered productivity, increases soil erosion and land degradation.

The accelerated growth of the population is demanding more food. But, cultivated land is increasing, reducing the grazing land, increasing livestock pressure. Thus, there is an urgent need for technological innovation that will raise and sustain productivity of forages, livestock and crop productivity.

The objectives of pasture and forage research programmes are to introduce high yielding quality forages to increase meat and milk production and increased use of animal power.

Support services will be established to collect, conserve and test germplasm, seed production, feeds and soil analysis. Germplasm will be assessed for different environments, also determine and improve the nutritive value of existing and developed feed resources. Initial stage of forage evaluation of introduced forages will be compared with indigenous materials, performance in the cropping system and soil and crop improvement aspect. Evaluation of multipurpose trees in different agro-ecological zones its use management and utilization for feeds and other purposes. Forage legume evaluation in crop-livestock farming system for the provision of feed, soil and crop improvement.

Selecting major agro-ecological zones of potential for forage, pasture and livestock production is necessary. The targets are smallholder farmers followed by agro-pastoralists, pastoralist and nunchees. Establishment of joint and collaborative programs with development and research institutions such as the regional Bureau of agriculture, Biodiversity Institute and International Livestock Research Institute for the germ plasm

programme are essential. Collaboration with disciplines in crops, agroforestry, forest, soil and water conservation will be valuable.

Expected outputs are that high yielding, quality forages for small-holder agro-pastoralist farmers are identified and developed; introduced forage species in the farming systems are accepted; factors affecting forage yield are known. Crop improvement as related to crop residue quality for livestock feed understood and feeding system based on forages of improved nutritive value developed.

Trained manpower at PhD and MSc level are required for the existing and proposed centers. Technical personnel and selected farmers will also be trained in collaboration with training institution. Facilities and equipment in the existing centers will be strengthened, while infrastructure such as housing, offices, equipment, laboratories, stores and transport facilities will be provided.

(ii) Animal Nutrition Research

The Region has a great potential for livestock production. It supports approximately 1/3 of cattle, sheep and goat of the nation, with an average holding of five animals per smallholder farmer. In the cattle milk and meat-feeding programme, the major problem is insufficient nutrition for growth, reproduction and lactation performance and meat quality. Dairy animals produce a litter/day of milk for a period of seven month. Thus, feed resources do not meet maintenance requirement. The problem will be alleviated by introducing appropriate forages as well as improving existing feed resource to improve milk and meat yields.

Multidisciplinary approach where scientist from different related disciplines, extension and development agents and farmers work together where the problems are identified, goals, objectives and priorities set and expected outputs established. The research will be applied, adoptive and collaborative.

The animal nutrition research will have section under animal science to improve livestock production by using existing feed staff, introducing appropriate supplements and identify nutritional problems and provide solution through research. Small ruminants nutrition research will be to increase milk and meat production and the objective to alleviate problems in milk and meat production. Appropriate feeding strategy for improved milk and meat production in smallholders farming system will be developed. For animal power, the outputs will be identification of dry season feeding, development of strategies for fattening draught oxen and feeding strategies to improve nutrition of female animals.

It is intended to have two major nutrition laboratories in the Region. A minimum of four trained staff at MSc level will be required and a good number of research assistance, and technical and support staffs will be required. Facilities required are houses, offices, laboratories, computers, telephones links, photographic equipment and vechiles.

7.5. Agricultural Mechanization Research Program

The term Agricultural Mechanization is used as an overall description of mechanical aids employed in pre-harvest (land preparation, crop establishment, weeding), harvesting and post-harvest (handling, storage, processing) operations in the process of agricultural production. Three sources of power-humans, animal and engine-are used to provide energy for these mechanical aids. Accordingly, there are three levels of mechanization: hand tool, animal power and mechanical power technology. These three levels of mechanization technologies should be carefully selected and must be appropriate to the receiving environment to achieve increased production and productivity.

A balanced application of bio-chemical (improved seeds, fertilizer), physical sciences based (irrigation, machinery) and socio-economics (input delivery and output recovery) technologies are necessary if growth in agricultural productivity and over all production are to be attained. In intensive type of agriculture where land is limited, the potential of bio-chemical inputs can only be realized with the use of improved agricultural mechanization technologies which create an enabling environment for the inputs to perform satisfactorily.

The agricultural research, be it on national or regional level, so far has been focusing mainly on the development of crop and animal husbandry techniques. The research system has to integrate agricultural engineering (mechanization, soil and water engineering) as well. Currently, the Regions does not even have the center to handle such a responsibility let alone a strong mechanization research program.

In agricultural mechanization research category, mechanization level study in the Region, development of pre-harvest, harvest and post-harvest as well as animal science technologies development are the identified research programes.

7.5.1. Agricultural Mechanization Level Study

Before embarking on a full-fledged mechanization research activity, the level and type of agricultural mechanization appropriate to a locality (i.e be it hand tool, animal or mechanical power technology) needs to be studied taking into account the agro-ecology (soils, climate, vegetation), socio economics and technical knowhow of the community. This is the corner stone of agricultural mechanization study. This helps in constraint identification monitoring changes and fine tune the research agenda that suit the changing environment.

In this study, a techno-economic study group, sociologist, land use and soils experts should work together and for a common goal. The research problem is identified, worked-out adequately and given shape at this level and is transferred to the technology generation group to have any impact on development.

As a result, an agricultural mechanization level study a document and map (hand tool, animal power, mechanical power) for the major crop and livestock production agro-ecologies will be made available to guide the mechanization research activities of the Region.

7.5.2. Crop Mechanization Research

Crop is very important both for food and export. Cereals and pulses grow almost in all agro-ecologies of the Region. Thus, crop is given high priority and the other areas need to follow it. The research on crop mechanization emphasizes on the pre and post harvest technologies which complete the normal production cycle of a typical smallholder farmer. Because of their importance in crop production and geographic coverage in the Region, pre-harvest technology research programmes for the moist (M2-5) and sub-moist (SM2-5) mountain plateau zones have been formulated separately.

(i) Pre-harvest technology sub-program

The moist mountains and plateau zone (M2-5)

This agro-ecology zone covers 33% of the Region, has high potential and contributes the largest portion of the Region's crop production. It has adequate LGP and more than two crops are possible provided there are efficient tools and implements. Besides, the zone has varied types of soils like vertisol, luvisol and nitosol which require land forming

operations with proper tools. The appropriate physical environment created by tillage, land forming, planting, inter cultural technology and equipment will help reap the full benefit of both the local and improved varieties.

The study ranges from analyzing crop-soil implement relations, the physiology of the seeds as to the degree of pulverization needed for germination to studying the crop geometry which help design planting equipment to the degree of compaction required to enhance the proper emergence of the plant.

As a result of the research effort, it is envisaged that a well tested agricultural mechanization pre-harvest technology for land preparation, planting and interculture for cereals, pulses and oil crops grown in the zone will be made available for the farmers.

The sub-moist mountain and plateau zone (SM2-5)

The sub-moist mountain and plateau zone is the second major cereal production area in the Region. It covers some 22% of the Region and has varied soil types including vertisols, luvisol and nitosol. The LGP ranges from 90 to 120 days. In some places, however, moisture is a serious problem timeliness being the biggest issue. Completing all essential farming operations in time is critical to get good yield. This requires efficient

land preparation and land forming implements which create the proper environment to the plant and that do not expose the soil moisture to evaporation and efficient planting equipment that deposit the seed to the proper depth.

As moisture stress is a critical problem, water harvesting and small-scale irrigation technologies will be generated. It is not only the hardware but also the cultivation methods and options appropriate to the agro-ecology zone that should be considered.

A well tested agricultural mechanization technology and equipment for land preparation, planting and interculture for the different crops grown in the zone will be made available.

(ii) Harvest technology sub-program for root crops

Root crops like potato are widely grown in the sub-moist zones of the Region. These are food security crops and need to be harvested well with out any wounds to enhance their shelf life and reduce from infection.

Clean harvesting requires improved technology which is within the economic reach of the farmer. It is not only potato, groundnut also requires same handling technology to fetch good money for the farmer.

A well tested equipment for root crops harvesting shall be made available to farmers involved in their production.

(iii) Post-harvest handling sub-program for the moist and sub-moist zones

Oil seeds, cereals and pulses, coffee, sugar-cane, fruits and vegetables are the main crops grown in these zones. Rice is grown in the moist lowlands around Lake Tana where lack of hulling machine has been reported many times. Pests, specially storage pests, are prevalent in this zone. Proper storage technology and processing techniques are necessary to minimize losses and increase farmers income. The moist zone has high rainfall and the during setting of the short rain before the crop in the field is harvested hastens the farmer to harvest when the crop is still wet, which indicates the necessity of proper post-harvest handling technology.

A concerted effort in this area will make available well tested agricultural mechanization technologies and equipment for post harvest handling; transport, storage and processing of sugar cane, oil seeds, cereals, pulses, coffee, fruits and vegetables for the sub-moist and moist mountains and plateau and rice hulling equipment for the moist lowlands agro-ecology zones of the Region.

7.5.3. Animal Science Technology Program

(i) Livestock Technology

Livestock is an important component of the agricultural research program. Proper livestock housing and feeding that create conducive production environment and ensure maximum potential exploitation of the animal are required.

Feed processing from alternative sources could be an option to look into as conventional feed which is scarce. Proper and economic processing equipment for animal produce should be explored adequately.

A strong research program in this category will make available well tested agricultural mechanization technology for livestock housing, feed and animal produce processing.

(ii) Apiculture and Fishing Technology Development

Honey is an important commodity in most agro-ecology zones of the Region. The farmer fetches good money from honey and wax. So does the country earn foreign exchange from exporting specially wax. If this income generating sector is supported with modern technology of hives and extractors, a better income could be generated both for the farmer and the country atlarge.

A strong mechanization research program will deliver well-tested agricultural mechanization technology for bee keeping, honey and wax extraction.

(iii) Draft Animal Power Study

Most farmers in the Region have either one or no ox, which makes it difficult to finish most agricultural operations in time specially in the sub-moist zones where the growing period is very short.

Looking for alternative sources of power like equines and proper harnessing system to make use of the potential draft power of the animal is one intervention area where the mechanization research program can do well on. Such effort will help make available well tested alternative animate agricultural draft force and harnessing system for the poor farmers of the Region.

7.5.4. Mechanical Power Technology

The agricultural policy of the Region requires that a certain percentage of the farming sector be involved to produce more and above the subsistence level of household food

requirement. This requires the deployment of large hectares into production and the use of mechanical power technology like tractors and combines.

Different tractors and combines are available on market. The research should be involved in the selection of appropriate ones to the receiving environment (soil type, topography, type of crops grown, etc.). This will be based on generation of base line data including on the history of the performance of the different machinery introduced in to the country, documentation of performance data and development or adoption of test procedures that help the selection of these power units and implements.

As the result, the research will deliver base line data and information on suitability of agricultural machinery for the Region.

7.6. Socio-Economics and Research-Extension Research Programmes

The research programme in Agricultural Economics, On-Farm Research and Research-Extension Linkages. will provide a framework to improve the efficiency of research in designing technologies appropriate to the needs of farmers; will assist in modifying the present strongly compartmentalised research programmes; improve the relevancy of agricultural research and extension services; enhance the development of cost-effective research programme, and provide objective data to enable policy review. The three identified research programmes under this research category are on (i) agricultural economics, (ii) on farm research and (iii) Research-Extension-Farmers Linkages.

7.6.1. Agricultural Economics

The research program in Agricultural Economics has the objectives of development of data base on the farmers needs and priorities, production and marketing constraints and other variables .

It could also assist in modifying the present strongly compartmentalized research program and enhance institutional capacity for impact assessment. As a result, it could thus make research more demand driven and relevant.

To carry out this, it is proposed to put together the present agricultural Economics and Research-Extension Linkage units into one to ensure a more reasonable number of qualified staff and functional activities. It is also proposed the staff with continuous training on sampling techniques, data analysis, and evaluation methods. Adequate budgetary support will also be made for fieldwork.

7.7. Dryland Agriculture Research

About half of the arable land in the ANRS falls within the dryland category,which include the arid, semi-arid, sub-moist and parts of the moist area. A total of 49 out of 96 weredas

in the Region found in the dry land areas are identified as drought prone areas. They are dominantly prevalent in Semien Shewa, Oromia, Debub and Semien Wello, Wag-Hamera, Debub and Semien Gonder administrative zones. Most rural people (95%) living in these areas depend on small-scale dryland agriculture. Mixed agriculture where both crop and animal production are more or less equally important except in the arid Regions where animal production predominates.

The dry areas suffer several forms of environmental degradation. Increasing demand for land for arable crops have partly contributed to the clearing of forests. In pasture areas primarily overgrazing causes land degradation. In the forest areas the cause is excessive cutting both for fuel-wood and other purposes.

Thus, there is an urgent need to harness soil and climate resources in an agro-ecological balance sense for sustained and increased agricultural production in the dryland areas of the Region. Effective technologies are needed to sustain dryland agriculture. The primary socioeconomic concern which should be taken into account is that dryland agriculture is very complex and a high-risk enterprise. Thus, a system approach and risk management are key issues.

The dryland agricultural research program aims at the developing agro-ecologically based technologies to improve productivity and profitability in a sustainable manner through generation, assessment, refinement, transfer and effective adoption of appropriate innovations. Based on these objectives to achieve in the dry land areas, the following research programs and activities are proposed.

7.7.1. Agro-climatology and Modeling Research

Agro-climatology

Climate is the major factor influencing agricultural productivity and sustainablity in the dryland areas. There is a need to develop agronomic management practices for different agro-ecologies that are weather sensitive and minimize the influence of climate fluctuations on resource degradation.

Understanding the weather variability is of paramount significance for optimizing crop production and design appropriate resource conservation strategies. The research proposed aims at studying the agriculture climate in relation to planning and assessment of crop production potentials, establishing crop-weather relationships for all the major rainfed dryland areas and evaluating the different techniques of crop microclimate modification for improving the water use efficiency and productivity of major crops grown in the different AEZ of the Region.

In the short-term it is planned to collect and document all available climatic data, check the reliability of the records and organize them in a computerized data bank. The

available long-term data will also be analyzed to determine the onset, final rain date, LGP, incidence of dry spell etc. The build up of weather database will continue through establishment of meteorological stations on representative sites in the major agro-ecologies of the dry areas in the Region. The capacity will also be upgraded through training of staff , building research facilities and infrastructure.

In the medium and long-term agro-climatological analysis will be done to develop methdologies to optimally use the products available from the meteorological service for economic and environmental benefits through agricultural planning and management.

Modeling

Crop models can assist in assessing the impact of climate, crop, soil properties along with management practices and enhance the application of experimental results to other seasons, sites and management practices. This is important in areas with divers agro-ecologies such as the ANRS. Thus, the provision of validated models would allow the problem of site specificity to be relaxed to some degree, without incurring the resource expenditure that would be necessary for large scale field experiments. Computer based assessments of various varieties and management factors in different parts of the Region would yield information to help ensure that only the most promising technologies would be selected for field testing in particular areas, thereby enhancing the results of the research process.

Thus, the modeling research program conceived is a step in the direction of helping to increase the efficiency of transfer of technology, both in the design of appropriate packages for smallholder farmers and the extension of the results.

In the short-term research programs will focus on building up the minimum database required by crop simulation models under dryland farming conditions. Existing appropriate models which deal with the major agricultural production constraints for the dryland areas of the Region would also be selected after validation using data from specific areas.

In the medium and long-term, the database and appropriate growth simulation models on various scenarios (to use models as decision support tool for) different stake holders including researchers, extension experts, development workers, policy makers and farmers will be created. The models will also be use for setting priorities for risk related agronomic research.

7.7.2. Agronomy and Crop Physiology Research

The lack and use of inappropriate agronomic management practices is limiting crop production in the Region. The problems are related to poor management of soil, fertility, use of mono-cropping, inappropriate tillage methods, weed infestation and general lack of proper resource management practices. Because of its critical importance to crop

productivity, it would be necessary to consider crop management research to develop appropriate agronomic management practices, which lead to the urgent task of attaining food security and protecting and enhancing the natural resource base of the fragile environment of the dryland areas.

In the short-term and medium-term, for the purpose of identifying areas of future research intervention, the traditional drought copping agronomic management practices used by farmers in the dryland areas will be documented. The development of appropriate cultural practices including land preparation time, rate and methods of planting will be given due emphasis. To address the problem of seedling emergence, crop species and varieties with efficient seedling emergence and establishment will be screened. Integrated weed control methods including physical, chemical and biological will be worked out in a multidisciplinary approach.

The long-term research programs will focus on verification of agronomic practices on-farm trials to verify on station based research results by involving farmers and other stakeholders, studying the effects of different kinds and amounts of surface applied organic materials on soil sealing and crusting, and on soil aggregation and stability. The minimum amount of crop residue that is needed for significant increases in soil water and crop yield under dryland conditions will be worked out.

7.7.3. Cropping Systems Study

The major crop system in the dryland areas of the Region is predominately cereal-based intensive mono-cropping system which lacks diversification. This has led to environmental degradation in terms of soil nutrient depletion and pest infestation. The increase of weed infestation of the parasitic weed (striga) and insect pest infestation (stalk borer) on the major cereal crops deserve a special mention.

To develop appropriate crop and cropping systems which fit to the growing conditions and arrest the resource base degradation and increase crop yield on sustainable bases, the following research activities are proposed.

In the short-term, research will, in collaboration with crop breeders, focus on selecting drought tolerant crop species and cultivars that can fit to the low and variable rainfall conditions of the dryland. Inter-cropping, alley cropping and crop rotations involving on-station and on-farm research and socio-economic analysis studies will be conducted. This believed to counteract the problem of monocropping and lack of diversification by using available germplasm or its introduction.

In the medium to long-term, since water stress is major production constraint research will concentrate on development of physiological methodologies for screening crop species and varieties to assist breeders in selecting and developing drought tolerant crops and cultivars. Morphological and physiological traits and study mechanism for drought resistance will

be identified. Delineation of the potential areas appropriate for different cropping systems such as mono-cropping, inter-cropping, double/single cropping in the different dryland farming agro-ecological zones of the Region will be given emphasis.

7.7.4. Soil Fertility Research

Soil fertility is a declining asset in much of the Region. The reasons for it vary widely in the different agro-ecological zones.

The research strategy proposed to address the soil fertility problem is based on the concept of integrated soil fertility management (ISFM) approach. Soil fertility and nutrient management should be based on soil resource conservation, biological nitrogen fixation and input efficiency.

In the short and medium-term the research programs will mainly focus on fertility studies to determine the interaction of both organic and inorganic fertilizer application on nutrient availability and cycling, soil physical, biological and chemical fertility under dryland farming conditions. Develop soil-test based fertilizer recommendations of the major crops for major soils and land use systems in the dryland. Conduct fertility studies particularly those involving the use of inorganic fertilizers in conjunction with soil water conservation and establishing and strengthen capacity for soil fertility and plant nutrition research.

In the long-term the following research activities are proposed:

(i) Conduct long-term studies to determine nutrient removal and use efficiency of the major crops and cropping systems for the different agro-ecologies; (ii) Establish fertilizer rates on the basis of total nutrient requirements and availability of nutrients through soil, organic and biological sources while taking into account fertilizer efficiency; (iii) Assess the effect of legumes in crop rotations for improving soil physical proprieties such as aggregation, structure, bulk density and water holding capacity; (iv) Study the long-term impacts of fertilizer, tillage, organic residues application on soil organic matter content of the major soils under water stress conditions; (v) Study the effect of different cover crops, crops and cropping systems, and agroforestry/farm forestry on soil erosion control, fertility maintenance and productivity; (vi) Develop *Fertilizer Augmented Soil Enrichment Strategy* (FASE) through the use of inorganic fertilizers.

7.7.5. Agronomic SWC and Management Research

Water stress is the bottlenecks to successful crop production in the dryland areas of ANRS. It is the major cause for low yields and sometimes total crop failures leading to poverty low standard of living. The research activities will focus on conserving and managing soil and rainwater resources with water as a nucleus of all production activities.

Traditional agronomic, soil and water conservation and management will be documented and their sustainable component and ways to integrate them to modern systems studied. Such approach will allow building on traditional practice by increasing the scientific understanding of agroecosystems. The soil and water conservation research activities will be both arable and non-arable land. Integrate agronomic studies with watershed based research and development to increase crop production on sustainable basis. Study the use of conventional biological soil and water conservation methods including the use of crop residues, green manuring, etc.,

7.7.6. Forage and Pasture Development Research

Animal feed is scarce and is one of the important causes for overstocking due to insufficient grazing areas. The need to improve the quantity and quality of forage for animal feed is recognised.

In the short-term the research will give due emphasis on collecting the available forage and fodder species and promote appropriate ones. Fodder legumes with fast dry matter accumulation rate and high efficiency of nitrogen fixation and determination of their suitability for integrated forage and food crops production systems that do not affect normal crop production will also be screened.

In the medium to long-term strategies to improve the quality of natural pastures through over and under sowing and related management techniques will be developed. The availability of forage seed is a constraint in forage production. Selection of productive pasture species both under rain-fed and irrigated conditions will get due attention.

7.8. Plant Protection Research Programme

7.8.1. On-Farm Testing of Technologies

Cereals, pulses, vegetables and oilseeds are the major group of crops grown in the Region. Although seed yields of over 4000 kg per ha for cereals and pulses and over 30 tons per hectare for vegetables have been achieved on experimental plots, estimates of regional average range between 0.6 to 1.6 t/ha. Insect pests, diseases and other biotic and abiotic constraints are responsible for the low level of productivity of these crops in the Region.

Research efforts have been directed towards developing improved technologies over the last several years and various components of IPM have been studied. Sources of resistance have been identified and resistant accessions were crossed with commercial cultivars and these have been tested and lines with good levels of resistance and agronomic characters have been developed.

These technologies need to be verified, popularized and transferred to users to help increase productivity, food production and nutrition needs of the Region. On-farm testing of pest-resistant, high-yielding varieties of cereals, pulses, oil seeds and vegetables; on-farm testing of botanicals against storage pests; on-farm testing of integrated striga management technologies; on-farm testing of integrated management of smuts on sorghum shall be given high priority.

The research shall be conducted in the major crop growing areas with the involvement of crop protection staff, agronomists, economists and extension staff of the BOA. The expected outputs are resistant varieties with acceptable qualities, increased use of improved technologies, reduced pest damage and increased yield.

Investment in vehicle office equipment, adequate and experienced research staff are required to undertake the research programme. Adequate collaboration of BOA staff and involvement of farmers in all the research activities are important.

7.8.2. Establishing Baseline Information

Initial efforts to tackle agricultural pest problems in the Region concentrated on the survey and identification of major pests on major crops and establishing their economic importance. A fair amount of data on crop losses caused by major pests has been generated from loss assessment, chemical screening trials and preliminary surveys in limited areas. Damage by some pests has not been quantified in spite of their importance in the Region.

There is also a need to conduct systematic and comprehensive survey on the dynamics of diseases, pests and parasitic weeds in the Region at regular intervals. An exhaustive survey covering the major cereal, pulse and oilseed growing areas has to be carried out to compile a baseline data on the extent of the pest problem, types of species, host-range and farmers traditional control practices.

A network of yield loss estimate experiments shall be developed for cereals and pulses against major pests (cereal rusts, cereal aphids, chocolate spot of faba bean; stalk borers on maize and sorghum; grasshoppers [including degeza] on tef) in major production areas strategically located across the Region.

The expected output from these research activities include accurate estimate of crop loss on farmers' fields, economic importance of major pests, pest management interventions under existing farming conditions, reference document complete with all relevant information on the major pests and severity and distribution maps, information on the existing rust races and virulence spectrum of the pathogens are known.

Investment in vehicle office equipment, adequate and experienced research staff are required to undertake the research programme. Collaboration of BOA staff and involvement of farmers in all the research activities are important.

7.8.3. Biological Control

Biological control is one area of crop protection that has not received due attention it deserves. The few attempts that were made to introduce biological control agents from abroad in recent years failed primarily because they were done without much understanding of the agro-ecological and cropping systems and the native natural enemies complex. Recent studies have shown that a large number of indigenous parasitoids and predators do exist in the complex and diverse agricultural systems in the Region.

The major objective of this study is to enhance the use of non-chemical pest management methods in general and of IPM in particular. The specific objective include
to determine the contribution of indigenous natural enemies to the control of pests, further explore the species composition of natural enemies and to elucidate the influence of farming practices on natural enemy numbers. Suggested research activities include survey for entomopathogens of locusts and armyworm, collection and identification of entomo-pathogens against storage insects of cereals and pulses, and survey of insects and pathogens for use in biological control of parasitic weeds.

A thorough understanding of the role of native natural enemies in the control of pests; improved data base on native natural enemies; improved understanding of the relationship between natural enemy abundance and farming practices; increased use of IPM approaches; and reduced dependence on chemical pesticides by farmers are the major research outputs.

7.8.4. Technology Generation

Currently there are on-going research activities on host plant resistance against insects and diseases and a good number of accessions are at an advanced stage of testing. However, these have been carried out separately under the respective disciplines.

Research into replacing chemical pesticides with locally available materials for the control of storage pests has shown that neem and pepper tree can give effective control of storage pests. It is very likely that the use of these materials will increase in the immediate future if the merits of this technology can be demonstrated to farmers.

Strategies for management of pests in crops thus need to be devised in an integrated bean management scheme simultaneously considering different constraints present in the production system. The study will be conducted in two stages on-station and on-farm. Routine screening procedures for resistance against insects, weeds and diseases will be followed. This will apply to both preliminary nurseries as well as advanced materials.

Suggested research activities include study the agronomy of the neem tree and the pepper tree, studies on host plant resistance in cereals, pulses and oilseeds against insects, diseases and parasitic weeds, identification and improvement of *striga* resistance

Major objectives of food science study as research support activity are (i) reducing post-harvest losses by determining the best time and method of harvest, handling techniques after harvest; (ii) collect information on traditional food preparation methods and identify processing constraints; (iii) investigating food crops and animal products for industrial uses; (iv) identifying crop varieties that are suitable for different purposes (fresh and processing); and (v) developing processing techniques appropriate for household and cottage industries.

Research activities in food science in the short-term include (i) conducting surveys on utilization of crops and animal products; (ii) assisting researchers in developing varieties; (iii) assessing post-harvest losses of crops and animal products; (iv) determining pre-and - post harvest factors that affect quality; (v) developing proper handling practices (harvesting, packing, transportation, storage and marketing); (vi) Identifying crop varieties for processing; (vii) developing appropriate processing technologies for household and cottage industries; (viii) Study nutritional components of major crops.

In the medium-term (i) continue short-term research activities; (ii) develop artificial drying methods of crops; (iii) evaluate suitability of wet and dry coffee drying machine; (iv) develop processing technologies for most crops, animal products, snacks and convenient foods; (v) initiate studies to utilize crop and animal products; and (vi) establish quality parameters for horticultural crops;

In the long-term (i) continue short and medium-term research activities; (ii) identity appropriate packaging materials for different food products; (iii) establish processing technologies for waste management; (v) initiate studies on controlled atmosphere storage; and (vi) write manuals on post harvest technologies (quality parameters, processing etc.).

7.9.3. Soil Survey and Classification

Soil is storage place for water, a medium for root growth and an anchorage and reservoir of mineral nutrients. It is also an important media in crop and livestock production. Hence through the soil survey and classification characterisation in terms of chemical, mineral and biological soil properties and type, identification and soil mapping is very important and essential. Survey and classification of soils of some research centers and sub-centers have been made. Existing survey results are broad and more detailed work is needed to provide the necessary information to the researchers for exhaustive research results. Even-though there are soil survey reports and soil maps at reconnaissance level conducted by the Abay and Tekeze River Basin Studies (1:250,000), they are not adequate (detailed enough) for micro planning.

For this purpose a unit composed of team of experts which includes professional in soil survey or pedology technical assistants, a cartographer and GIS specialist is needed.

This unit should be established only at research center level and from where operation be made to sub-centers and trial and other sites. Also serves specific needs within the Region is

being under the respective research center. The unit should be supported and equipped with necessary soil and water laboratory facilities at research center level.

The unit could also provide support service for the regional soil studies on some selected small scale irrigation projects and other areas.

7.9.4. Information Management System and Service

Information service involves the collection, management, presentation, dissemination and use of research results. It include research, extension and user sub-systems.

The stuff of agricultural information system consists of research findings, reports, recommendations, extension messages, technologies and innovations which are reported in various technical and progress reports of the research centers. But as of now, the research system is characterized by lack of adequate data base and weak networking of information system among research centres including poor libraries and reference sources.

The main objective of the new information management service is to establish a strong agricultural technology data base and dissemination system, improved publication and documentation service, and an integrated monitoring and evaluation system. This will be supported in integrated manner by equipment, training and improved management of the information service. Major activities to be performed in information management system and services are: (1) improving and expanding diagnostic and other surveys to cover the major agro-ecological zones and the production system in the mandated geographical areas of the research center; (2) enhancing the capacity of the center to establish technology data base using information from the center, and other research establishments dealing in similar ecologies and farming system; (3) enhancing the center's capacity for dissemination of technical information in language/s understandable by potential users through brochures, technical manuals, production guidelines and training materials, and radio and tv programmes; and (4) improving follow-up and monitoring system on adoption rate, constraints there of and to evaluate impact on production and welfare of rural people, and produce policy recommendations.

7.9.5. Land Use/Land Capability Research

The ANRS is currently preparing a draft land use policy and regulations as well as a forestry policy under a separate contract to CEDEP. There is also an on-going agriculture and natural resource policy study spearheaded by IFPRI and ILRI under a memorandum of agreement (MOU) with BOA. The recently completed river basin studies also make important input to determine land use and land capability.

8. INSTITUTIONAL DEVELOPMENT AND CAPACITY BUILDING

8.1. Institutional Development

The foundations to guide and manage the agricultural research system within the Region are laid down through institutional development. Adequate emphasis is given in identifying institutional/organizational gaps in the Region's research organizations. At present, the regional agricultural research system consists of a Board, a Coordinating Unit, and three Research Centers and a sub-center. The Board has a membership of 14 including the managers of the research centers, cattle ranches and rural technology centers and representatives of relevant government bureaux. In its short time of existence, its operation has not been found to be impressive and very effective to provide leadership for many reasons the membership does not include farmers' and business sector representation; its deliberations have often been dominated by administrative issues dealing with problems of cattle ranches and rural technology centers and the Board's mandate and responsibilities vis-à-vis EARO have not been clear.

The Co-ordinating Unit has only been a temporary arrangement. Though it was supposed to coordinate the research activities of all research centers in the Region, the task is too much for it as it is understaffed and does not have the capacity and orientation to provide direction and effective technical leadership.

The research centers are few, understaffed and not well equipped. More importantly, they acutely lack experienced professional staff and competent technical leadership. As they have few sub-centers, they have been forced to concentrate in the vicinities of the centers. Hence, agro-ecologies, far from the research centers, are not catered for. There also seem to be some confusion on research approach to follow i.e. commodity, discipline or agro-ecology based.

In general, there is limited co-ordination among programs/divisions within a Center and among centers in the Region. The separation of these centers from the federal system has left them with no backstoping in technical leadership. The up shot of all this is, to date, they trend to routinely carry on research activities in the mode of the old IAR withstanding the different environment and needs of the Region. As a result, they have not managed to generate adequate technological innovations that significantly address production constraints of farmers in the Region.

The overwhelming view is that the situation calls for a formalized institutional structure to co-ordinate and lead the regional agricultural research system to support the objective of the Region for technology-based agricultural development. The new proposal consists of a Board, a Regional Agricultural Research Institute, Research main Centers, Sub-centers and Testing sites.

8.1.1. Regional Agricultural Research Board (RARB)

The proposal intends to make the Board independent, lean and very effective in strategic planning of the regional agricultural research system.

Powers and Duties of the Board

The Board will have the following powers and duties.

1. Overviews and directs the formulation of agricultural research policies and strategies;
2. Determines the research priorities of the Region, supervises and follows up their implementation;
3. Approves the structure of the Regional Agricultural Research Institute and the directives in which the personnel of the Institute will be administered;
4. Reviews and approves the annual research program including appointments and training;
5. Reviews budget of the Institute and submit to the regional government for approval;
6. Develops collaborative working relations with the extension service and other relevant institutions in the Region and with EARO;
7. Advises the regional government in all matters related to agricultural research; and
8. Determines its own internal rulers and regulations.

Members of the Board

The Board shall have a chairperson and members who will be appointed by the regional council.

1. Head, Economic Sector of the Regional Council	Chairperson
2. Head, Bureau of Agriculture	Member
3. Head, Bureau of Economic Development	Member
4. Head, Bureau of Water Resources Development	Member
5. EARO Deputy Director of Research	Member
6. Two representative of farmers groups(one women)	Member
7. One representative of the business sector	Member
8. One representative of Higher Education	Member
9. Two senior scientists*	Member
10. Director of the Regional Agricultural Research Institute	Member and Secretary

* *(They consist of one from the Research Centers and the other from the public at large)*

8.1.2. Regional Agricultural Research Institute (RARI)

The Institute will be an autonomous regional apex body for the regional agricultural research system with the following objectives and duties.

Objectives and Duties of the Institute

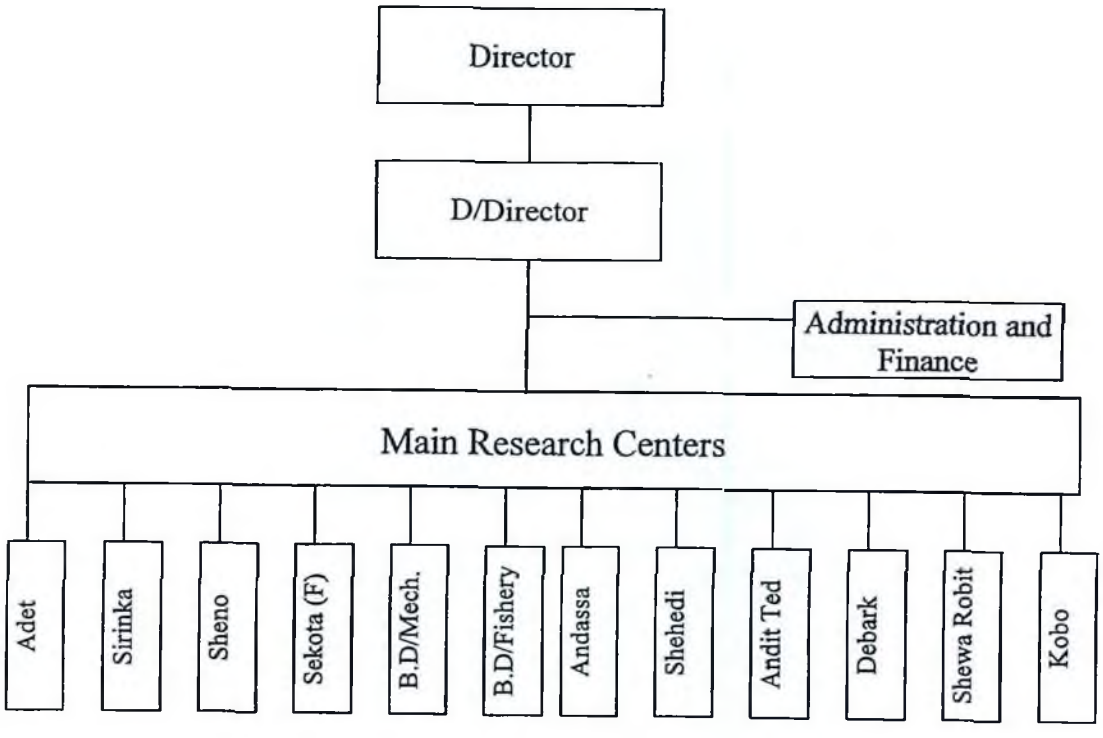
The objectives and duties of the institute are the following.

1. Leads and ensures effective running of the main research centers to generate, develop and adapt agricultural technologies that will focus on the agriculture needs of the Region;
2. Co-ordinates agricultural research activities of the research centers, higher learning institutions and other establishments within the Region;
3. Builds-up a research capacity (employing researchers, planning their training, finding resources and providing facilities) and establishes a system that will make agricultural research efficient, effective and development needs based;
4. Reviews, monitors and evaluates research programs;
5. Establishes a close functional linkage with the regional Extension Service to popularize and enhance the utilization of agricultural research results;
6. Collaborates with EARO on research programs, staff training, information and documentation;
7. Liaises with national and international research bodies to support the research activities in the Region; and
8. Facilitates the publication and dissemination of research findings.

RARI Organogram

RARI is directly accountable to the Board while all Main Research Centers report to it. It is assumed that the lean organizational structure of the Institute facilitates smoother and more effective relationship with research establishments where the former co-ordinates and leads activities of the later more easily. The Institute will be lead by a Director and a Deputy Director with other relevant support staff. By the end of the short-, medium- and long-term, the Institute will have been co-ordinating 6, 9 and 12 Main Research Centers respectively. The organogram of RARI is shown in Fig.2.

Figure 2. Proposed Organogram for Regional Agricultural Research Institute (RARI)



8.1.3. Main Research Centers, Sub-Centers and Trial Sites

(i) Main Research Centers (MRC)

There are currently three main research centers in the Region; viz, Adet, Sheno and Sirinka. Kobo is a sub-center for the later. Already decision has been made to set up another Main Center at Sekota with emphasis on natural resource conservation and development. Efforts will be made to gradually (i) establish additional main centers, sub-centers and trial sites (ii) provide adequate staff and facilities and (iii) create enhanced working and living conditions. The establishments will be in areas representative of major agro-ecological zones.

Each Main Research Center will have carefully selected and prioritized research programs that will reflect its researchable problems of the mandate area and general areas of excellence. The major research program categories are (i) natural resources management, (ii) crop science, (field and horticultural crops), (iii) animal science, (livestock, apiculture fisheries, equines, feed and animal nutrition) (iv) dry land agriculture, (v) agricultural-mechanization and (vi) agricultural economics and research-extension. All research

centers may not have all of these programs as it all depends on the potential and constraints of the agro-ecology. Thus, the technical staff mix as well as facility requirements differ accordingly although composition of the administrative staff may be similar. List of minimum administrative staff requirement is shown on Annex 2.

Responsibilities of MRC

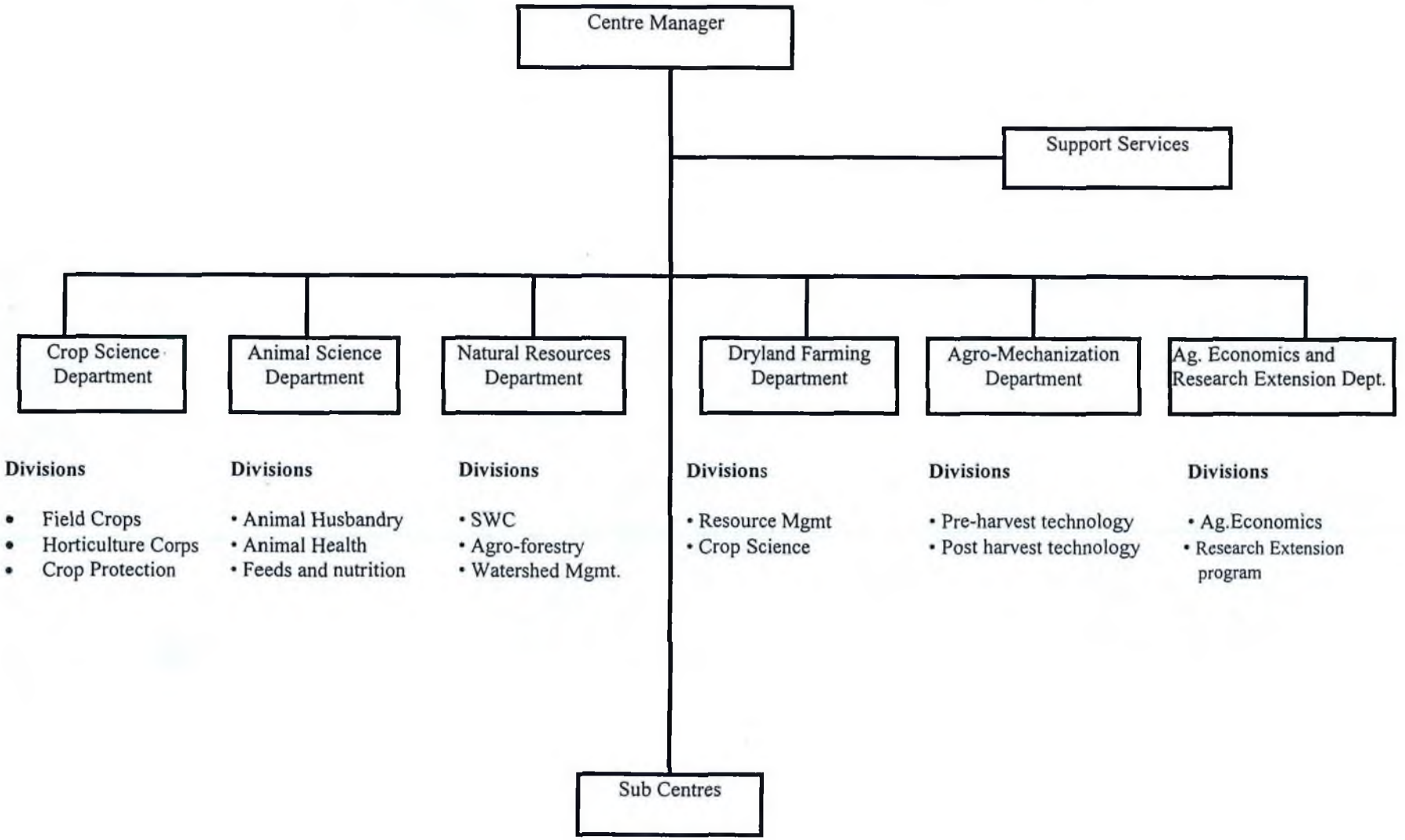
The general responsibilities of a Main Research Center include:

1. survey and identify production problems and technology needs of farmers in the mandate area;
2. establish and facilitate a formal forum for the explicit participation of farmers and extension staff annually to prioritized the researchable problems, design and review (e.g. through the Zonal Research-Extension-Farmer Liaison Committee);
3. enhance farmers' participation in technology development through on-farm trials and pre-extension demonstrations in collaboration with extension staff;
4. execute the approved research programs effectively;
5. carry out intermittent short-term on-station or on-farm training for extension staff and farmers based on seasonal activities and/or new research findings;
6. keep the doors of the center and sub-centers open for informal visits, stage field days for farmers in the surrounding communities and the public at large in order to expose its programmes and progress;
7. propose to the Institute the establishment of sub-centers and testing sites in representative agro-ecological zones as needed; and
8. produce progress and annual reports or papers on research findings.

MRC Organogram

The structure of a Main Research Center has been proposed (Figure 3). There will be six departments representing major areas of research (i.e. Crop sciences, Animal science, natural resource management, Dryland agriculture, Agricultural mechanization and Agricultural Economics and Research Extension). Under each department there are divisions representing more specific area of research (discipline) within that department. The number and composition of the departments and divisions in an MRC depend on its general areas of excellence and research mandates for which it is established.

Figure 3. Proposed Organogram for Main Research Center



Support Services at MRC

It is proposed that each research center will have essential support services relevant to the focus of its research programs. The support services are likely to include information and documentation facilities; laboratories; other service units which could be used in common by the various research programs and will enhance the effectiveness of the total research effort of the center.

(ii) Sub-Center (SC)

At present there is only one sub-center, 'kobo' under Sirinka Main Center. The staff and facility requirement and hence the general responsibility of a sub-center is considerably lower than that of a main center. Head of a sub-center is accountable to the manager of the main research center Tentative list of minimum administrative staff requirements for a sub-center is shown on Annex 2.

Duties and Responsibilities

Depending on the potential of the agro-ecology where the sub-center is located, it co-operates in generating useful information/data for analysis and review at main center level to which it reports. The more specific duties and responsibilities include the following.

1. Based on the research trial schemes designed by a Main Research Center, carry out variety trials and agronomic studies on field and horticultural crops;
2. Undertake experimental work on diseases, insects and weeds to be carried out at the field;
3. Conduct management studies on natural and improved pasture as well as on introduced forage crops;
4. Survey on potentials for livestock and other agricultural production;
5. Undertake the research work aimed at developing a better soil and water conservation and management systems; and
6. Carry out trials designed by the Main Research Center in the respective discipline.

(iii) Trial Site (TS)

A trial site is a fenced site (2.5-5ha) chosen for its representation of an agro-ecology. These sites are important links of the Research and BOA's extension services. Most 2-5 ha experiment (trial) plots are administered by BOA. At present there are 23 trial sites distributed in most administrative zones of the Region. There is no technical and/or administrative staff deployment nor is permanent infrastructure but the fence.

8.2. Capacity Building

Capacity building, in terms of facility and manpower development, creates the ground for effective and efficient operation of the research institutions established. It is a long-term process especially when it involves human resource development. Physical facility development and manpower training constitute the major components of capacity building in the coming twenty years.

8.2.1. Establishment of New MRS, SC and TS

At the end of the plan period (ie. 2020), there will be a total of 12 (9 new) Main Research Centers, 15 (14 new) Sub-centers and 17 trial sites functioning in the Region. The existing research centers will be strengthened in manpower, infrastructure and facilities to bring them to a full-fledged Main Center status. These research establishments represent 10 different agro-ecologies which are agriculturally important and/or need natural resource rehabilitation. These agro-ecologies, distributed in all administrative zones, cover 81.44% of the Region's landmass. Figure 1 show MC, SC and TS agro-ecological distribution by the end of 2020.

The currently uncovered areas include those uninhabited or sparsely inhabited areas (Arid zones, gorges, mountain areas and lakes) which are at the moment agriculturally less important. Tables 2 and 3 show the list of main centers, sub-centers and trial sites and their distribution by agro-ecology by end 2020. Establishment schedules of the research establishments in the short-, medium and long-term are shown on Annex 3.

Table 1. List of Main Research Centers, Sub-centers and Trial Sites by 2020

Main Center	Sub-Center	Trial Site
Adet	*Bichena*	*Ankober*
Sirinka	*Kosober*	*Chagni*
Sheno	*Wereilu*	*Enewari*
Sekota (F)	*D. Brehan*	Achefer
B.D/Mech.	*Amedguya*	Fogera
B.D/Fisher	*Arerti*	Finoteselam
Andassa	*Anjeni*	Mota
Shehedi	*Maybar*	Merawi
Andit Ted	Woreta	Stayish
Debark	Dabat	Geregera
S. Robit	D. Tabor	Gimba
Kobo	Tseda	Habru
	Chilga	Hara
	Chefa	Chacha
	Lalibela	Mehalmeda
		Molale
		Faji
(12)	(15)	(17)

Figure 1. Research Centers, Sub-Centers and Trial Sites of the Amhara National Regional State by the End of 2020

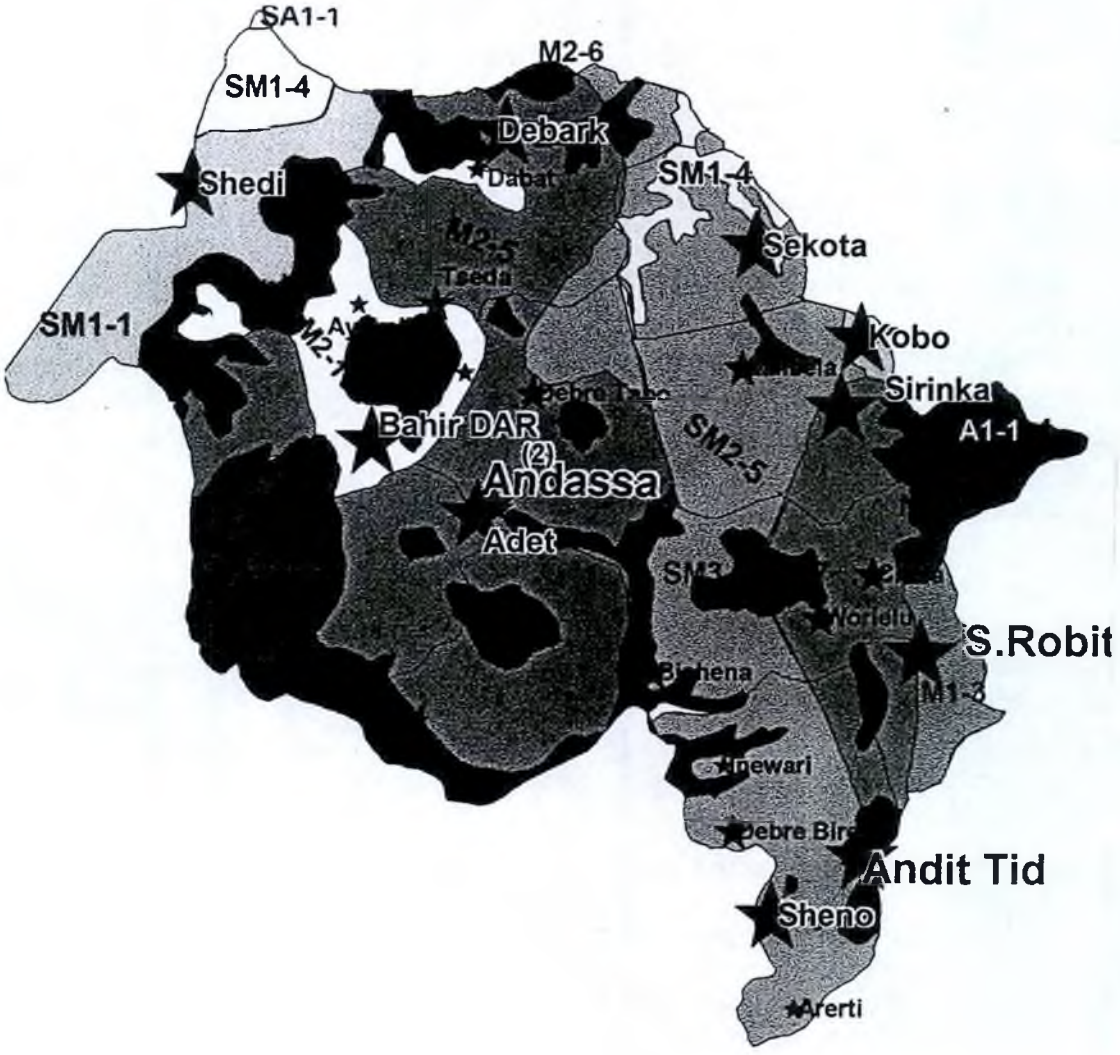


Table 2. Agro-ecological Distribution of Research Establishments by 2020

AEZ	Area (Km^2)	%	Research Establishment			
			Main center	Sub-center	Trial site	Total
M2-5	58,449	33.21	4	5	2	11
SM2-5	38,881	22.09	1	5	3	9
SM1-1	11,130	6.32	1	-	-	1
M2-1	7,884	4.48	2	2	3	7
M3-7	7,041	4.0	1	2	3	6
SM1-4	5,958	3.39	1	-	2	3
SH2-7	5,316	3.02	0	1	1	2
SH1-7	4,162	2.36	-	-	1	1
M1-3	3,787	2.15	1	-	2	3
SM1-3	742	0.42	1	-	-	1
All not covered	32,666	18.56	-	-	-	-
Total	176,002	100	12	15	17	44

8.2.2. Physical Facility Development

Physical facilities are presented in terms of (i) buildings, (ii) equipment (iii) furniture and (iv) supplies and expendable items. Major activities in the short-term are strengthening of the existing three main research centers and the sub-center and establishment of another 3 MRC, and 13 SC and operating 24 TS. During the medium to long-term (2006-2020) establishing 6 additional MRC and 3 SC and operating 17 TS are the major activities. These activities involve the construction of different categories of buildings, purchase, distribution and installation of equipment, furniture and supplies and expendables.

(i) Buildings

The activity is a primary step in physical capacity building. Buildings will be constructed under categories of (a) office; (b) residence, (c) laboratory and (d) others (which include stores, shades, green house and lathouse). During the first six years of programe implementation, a total of 40,475 m^2 building space will be built at a cost of 111.7 million birr. At the end of the plan period (i.e 2020) another 59,150m^2 building space will built at a cost of 163.2 million birr. Over the plan period a total of 99,625m^2 building space will be built at a cost of 275.0 million birr. (Annexes 4, 5, 6,).

Equipment

Under this category transport facilities (vehicles), farm machineries, office and workshop equipment etc, are procured for field, laboratories, offices and other working sites. The total preliminary cost estimate for equipment required for strengthening the existing research centers and for the new establishments is about 121.64 million birr over the 20 years. This is 33.7 million birr, 45.2 million birr and 42.8 million birr for the short-, medium- and long-term respectively (Annexes 4, 5, 6).

(ii) Furniture

Furniture is required for all buildings including offices, laboratories, social centers, conference hall, residences, libraries, workshops and guesthouses. The total cost estimate for the purchase of furniture over the plan period is 20.1 million birr i.e. 7.02 million birr, 7.01 million birr and 6.03 million birr in the short, medium and long-term respectively. (Annexes 4, 5, 6).

(iv) Supplies and Expendables

Under this category supplies and expendables are vital for full utilization of the physical facilities (buildings offices, laboratories, etc.), equipment (office, field laboratory) and furniture. The estimated costs for the short-, medium- and long-term are 6.8 million birr, 1.1 million and 18.9 million birr respectively. Total cost of supply and expendables until 2020 is computed at 26.8 million birr.

8.2.3. Human Resource Development

Manpower is perhaps the single most important factor determining the proper and efficient functioning of the Research System. Human resource development and management are thus critical for achieving the Region's desired research goal which centers around "increase in productivity" of the resources (land, labour and capital) employed in the agriculture business. Nearly half of the envisaged implementation costs of the RARMP (i.e. 441.2 million birr) goes to human resource development.

There are two categories of manpower in the research establishments-technical staff and administrative support staff. The technical staff which includes researchers, technical assistants, surveyers, etc. are directly involved in the research work. This group of staff require high levels of long-term training (PhD, MSc or Post graduate Dipl.) more than the administrative staff do.

The total training cost in the short-, medium- and long-term by research category are shown on Table 3 under long and short-term training. Training classification with PhD and MSc are assumed to take 3 and 2 years respectively. All trainings requiring under 3 months are considered short-term. The following Table shown financial schedule for short- and long-term training in the short-, medium- and long-term.

Table 3. Training cost in the short-, medium- and long-term by research category

('000 Birr)

Research Category	2000-2005		2006-2010		2011-2020		Total 2000-2020	
	Long	Short	Long	Short	Long	Short	Long	Short
Natural Resource Management	1800	4800	2400	12000	2000	18000	6200	34800
Soil and Water Management	6339	2010	6090	2820	2520	4020	14949	8850
Field Crops and Dryland Agriculture	5576	4800	6960	6400	5280	6400	17816	17600
Crop Protection	6880	2400	5160	2400	3000	2400	15040	7200
Horticulture Crops Improvement	2860		7560		8260		18680	
Animal Production Improvement	12960	2400	21600	46000	12960	56000	47520	104400
Animal Feeds and Nutrition	1800	242	1560	242	480	242	3840	726
Agricultural Mechanization	720	-	1680	8401	2120	1440	4520	9841
Agri. Econ. Research and Extension	2160	8060	2400	16105	2640	40300	7200	64465
Total (+15% Contingency)	**47259**	**28419**	**63722**	**108523**	**45,149**	**148,122**	**1560130**	**285064**

(i) Technical Staff

Currently the Region's agricultural research system is critically constrained by inadequate number of trained and experienced technical staff to undertake researches more competently. There is also shortage of experienced administrative staff to facilitate the activities of the researchers.

There is an urgent need to embark aggressively on human resource development through long and short-term trainings and other skill upgrading schemes. Trained manpower requirement both for the existing and the new research establishments over the twenty years are 129, 267, 10, 449 and 510 at PhD, MSc, DVM, BSc and Dipl. level respectively. For the promotion of manpower development through training in tertiary and secondary degrees, a total of 1,122 man year training program at a total cost of 441.2 million birr i.e. 156.1 mill and 285.1 mill birr for long and short-term trainings respectively is envisaged. Technical staff requirement at BSc/BA level is assumed to be met directly from domestic Universities and Colleges. Nevertheless, provisions are made to up grade technical assistants from Diploma to a First Degree or so level depending on the need. Table 4 shows number of trained technical staff required by level of education and training costs by category of long- and short-term for all the research establishments over the plan period by research category.

Table 4. Trained Manpower Requirement by Research Category over the Plan Period

Research Categories	2000-2020					Total	
	PhD	MSc	DVM	BSc	DiP	No.	%
Natural Resource Management	18	79	-	126	117	340	25
Soil and Water Management	9	18	-	58	85	170	12
Field Crops and Dryland Agriculture	19	29	-	55	55	158	12
Crop Protection	21	17	-	21	42	101	7
Horticulture Crops Improvement	16	37	-	49	45	147	11
Animal Production Improvement	26	51	10	57	73	217	16
Animal Feeds and Nutrition	4	12	-	41	71	128	10
Agricultural Mechanization	4	12	-	6	22	44	3
Agri. Econ. Research and Extension	12	12	-	36	-	60	4
Total	**129**	**267**	**10**	**449**	**510**	**1365**	**100**

Over the twenty year period a total of 1,365 technical staff will be trained and/or recruited from the market. The proportions of research staff required with tertiary, secondary and primary degrees are 9%, 20% and 33% of the total technical staff requirement respectively.

Trained manpower requirement for the natural resource management and soil and water management research categories took 37% of the total. This is logical and imperative from the point of view of the huge task the NRM/E research is expected to undertake in reversing the natural resources degradation which is threatening the

very existence of the farming populations and the agricultural system environment as a whole.

Training requirements for animal production, feeds and nutrition and field crop, agronomy and protection constitute 26% and 19% of the total. The higher requirement for the animal production improvement research is to revitalize the large animal resources (livestock, poultry, apiculture, fishery and equines) in the Region which homes over 30% of the nation'sanimal resource.

Horticultural crops production improvement research requirement for trained manpower constituted 11% of the total. In view of the huge potential the Region has for horticultural crops production and the enormous benefits that can be obtained in improving nutritional status and incomes of the people, the planned training is considered reasonable.

In addition to long-term training (PhD, MSc, etc.) 3,784 man month short-term (up to 3 months) skill upgrading programmes are planned. The human resource development requirements for the respective research category in the short-, medium- and long- term are shown in Annex 7.

(ii) Administrative Staff

Administrative staff is required to support and facilitate activities of the researchers. Adequately qualified and experienced support staff is necessary to ensure the proper functioning of the research establishments in their daily routine. Minimum manpower requirement list of administrative staff by type of responsibilities is attached (Annex 2). Tables 5 shows the number and level of education required of the administrative staff for 9 Main Research Center and 21 sub-centers.

The level of training and type of decipline of the administrative staff can easily be obtained from the market. Nevertheless, peridical skill upgrading trainings are required to improve the efficiency of the research system bureaucracy.

Table 5. Administrative Minimum Staff Requirement by Level of Education for the New Research Establishments

Level of Education	Administrative Staff		Total
	MRC	SC	
MSc/Ma	9	-	9
BSc/BA	18	-	18
Diploma	81	42	123
Certificate	56	84	140
Other	135	84	219
Total	**299**	**210**	**509**

9. ACTION PLAN AND RESOURCE REQUIREMENT

9.1. Action Plan

Research programes identified and their implementation over the plan period are detailed in the respective technical reports. Institutional development, capacity building and carrying out of research programmes have been planed for the short, medium- and long-term. The schedule of activities in each planning period is planned to facilitate the program implementation in the next phase. The overall frame of activity implementation in the short, medium and long-term are the following.

Short-term (2000-2005)

Major activities to be carried in the short-erm include the following:

(i) Identifications, land acquisition and establishment of 3 main research centers and 6 sub-centers.
(ii) Strengthening the three existing Main Research Centers and one sub-center.
(iii) Building up of infrastructure and center development-install basic facilities such as electricity, water and telephone
(iv) Procurement of field and laboratory equipment
(v) Human resource development through 342 man year (long-term) and 317 man month (short-term).
(vi) Initiate research projects based on the strategy and identified and prioritized program for the mandate area
(vii) Problem identification of the AEZ and characterization of the production system and genetic resource base
(viii) Undertake adaptive and verification of generated technologies (Testing and adopting technologies at local and formal levels taking in to account the priorities, opportunities and resource constraints of farmers).
(ix) Develop documentation and information system
(x) Conduct applied and adaptive researches
(xi) Develop document for medium-term research programs

Medium-term (2006-2010)

In addition to continuning activities that have been started in the short-term, the following will be implemented.

(i) Strengthen established centers through

- manpower development
- infrastructure building
- Equipment procurement

(ii) Based on the short-term priority continue to undertake research Programs
(iii) Strengthen on farm research activities
(iv) Technology development and release
(v) Status review/evaluation at the end of year 2005
(vi) Strengthen adaptive and applied research and initiate basic research
(vii) Develop long-term research programs

Long-term (2011-202)

(i) Continue strengthening centers and sub-centers in terms of
- Manpower development
- Infrastructure building
- Equipment Procurement
- Documentation and information systems

(ii) Continue strengthening on farm research activities
(iii) Status review/evaluation at the end of the year 2000
(iv) Continue strengthening basic, applied and adaptive research
(v) Technology development and release
(vi) Implementation of the 5 year research programs plan

9.2. *Resource Requirement*

Major resources required for the proper establishmet and running of the envisaged research system are land, manpower and finance. The infrastructural and facility requirmenets have been described in the previous chapter (8.2.2.).

(i) Land Requirement

The land requirments per research main center and sub-center, have been estimated at 100-200 ha and 50-100 ha respectivley. Depending on the availability of land in the locality where the research establishment is to be set u and the nature of the researches to be conducted, the upper limit may be requested for. Total land requiremnt for the new 9 MRCs and 21 SC is estimated at 900-1,800 ha and 1,050-2,100 ha respectively.

(ii) Manpower Requirement

While deployment of trained manpower is crucial, basic changes in polices and principles governing recruitment conditions of services and performance are essential. Not only the market supply of such scientists is short but also recruitment conditions may not be good to attract scientists from major cities.

The technical staff mix and number for each research establishment vary according to the research mandate and general excellence of the research center. Nevertheless, the administrative staff composition is more or less is similar.

Total manpower requirement for strengthening the existing research centers and new establishments is estimate at 1,362 technical and 509 administrative support staff. The level of technical staff for all research establishments at end of the plan period is computed on the basis of research programs identified and planed to be executed under the respective research categories.

The composition of the technical staff by level of education is PhD (9%), MSc (+DVM) (20%), BSc (33%) and Diploma holders (37%). The phase requirements of the technical staff by level of education and category of the research are shown on Annex 7. The required administrative staff mix in all the new research establishments by level of education is 2%, 4%, 24%, 28% and 43% Masters, First Degree, Diploma, Certificate and below, in that order.

(iii) Financial Requirement

The preliminary cost estimate for implementing the agricultural research master plan is Birr 1,164 million over the plan period (2005-2020). The total financial expenditures by category of the research programmes are shown on the following table.

Table 6. Preliminary Cost Estimates by Research Category (Million Birr)

Research Category	Planning Period (2000-2020)			Total
	Short-term	Medium-term	Long-term	
Natural Resource Management	32.8	55.3	79.4	167.5
Soil and Water Management	49.5	48.7	30.7	128.9
Field Crops and Dryland Agriculture	26.2	47.4	42.9	116.5
Crop Protection	30.4	18.6	18.6	67.6
Horticulture Crops Improvement	12.7	22.6	33.8	69.1
Animal Production Improvement	39.2	86.3	101.6	227.1
Animal Feeds and Nutrition	19.3	15.9	15.8	51.0
Agricultural Mechanization	7.2	15.0	30.6	52.8
Agri. Econ. Research and Extension	20.6	34.6	76.7	131.9
Total (+15% Contingency)	**273.5**	**396**	**494.5**	**1,164**

Capital and Operational Expenditures

The total capital and operational expenditures estimated at 701 mill birr (60%) and 463 mill birr (40%) respectively. Training costs are categorized as capital expenditures in this document. Table 7 shows the preliminary implementation cost estimate of the agricultural research master plan at end of the plan at end of the plan period, i.e. 2020. The preliminary cost estimates in the short-, medium and long-term by category of expenditures are shown on Annex 8.

Table 7. Preliminary Cost Estimates by Type of Expenditure (2000-2020)

(Million Birr)

Research Category	Expenditure Category		Total
	Capital	Operation	
Natural Resource Management	117.1	50.4	167.5
Soil and Water Management	92.5	36.4	128.9
Field Crops and Dryland Agriculture	88.8	27.7	116.5
Crop Protection	50.5	17.1	67.6
Horticulture Crops Improvement	45.7	23.4	69.1
Animal Production Improvement	39.9	187.2	227.1
Animal Feeds and Nutrition	34.2	16.8	51.0
Agricultural Mechanization	37.4	15.4	52.8
Agric. Econ. Research and Extension	108.7	23.1	131.9
Total (+15% Contingency)	**701**	**463**	**1,164**

9.3. Sources of Finance

The anticipated sources of finance for realizing the master plan are classified into two major categories, regional (domestic) and foreign (external). The Domestic sources include mainly federal and regional contributions. Foreign sources are bilateral, multilateral or NGO assistance in terms of grant or loan. The following Table shows regional/domestic and foreign (external) financial contributions in the plan period.

Table 8. Preliminary Cost Estimates by Source of Finance (2000-2020)

(Million Birr)

Research Category	Expenditure Category		Total
	Regional	Foreign	
Natural Resource Management	117.1	50.4	167.5
Soil and Water Management	88.4	40.5	128.9
Field Crops and Dryland Agriculture	65.0	51.5	116.5
Crop Protection	40.5	27.1	67.6
Horticulture Crops Improvement	46.3	22.9	69.1
Animal Production Improvement	87.7	139.4	226.7
Animal Feeds and Nutrition	36.3	14.7	51.0
Agricultural Mechanization	25.1	27.7	52.8
Agric. Econ. Research and Extension	46.0	85.9	131.9
Total (+ 15% Contingency)	**635**	**529**	**1,164**

About 635 mill birr (55%) the total preliminary cost estimate is expected to be covered from the domestic sources while 529 mill Birr (45%) from foreign sources through grant or loan arrangements. Financial outlays in the short-, medium and long-term by the envisaged sources are summarized on Annex 9.

10. CONCLUSION AND RECOMMENDATIONS

10.1. Conclusion

The research centers are few (only three), understaffed and not well equipped. More importantly, they acutely lack experienced professional staff and competent technical leadership. The poor employment conditions and inadequate incentive have deterred experienced and competent researchers from joining the research systems. As there is only one sub-centers, the research centers have been forced to concentrate in the vicinities of the centers.

These centers are not established with consideration of the diverse agro-ecolgies of the Region. There are many agro-ecologies not covered by the research system and hence the particular production constraints of farmers in a particular AEZ are not addressed by the research.

The regional research centres, as organized now, are incapable to handle all research needs due to lack of skilled and experienced staff and inadequate infrastructure and facilities. The technologies developed in the past have not been adequate and in some cases inappropriate to contribute to the production and productivity of the regional agriculture. In most cases, the technologies developed are not within the reach of the resource-poor farmers and socio-economic level.

The present infrastructure, facilities and equipment are not adequate in number and quality to undertake researches as may be required by the different disciplines. Moreover, inadequate supply of inputs for laboratories and fields, poor maintenance of equipment and shortage of transport facilities are also major limitations of the research activities.

There is no research programme to develop technological solution to post-harvest constraints of the resource-poor farmers. The most common processing such as tomato paste and juice have not been developed in the Region. There is no study of off-season vegetable production under irrigation to supply when the demands of the produce are high in the local and regional markets. Research in organizing marketing and quality control including distribution of the produce to the markets is not established.

There are no researches to develop pre-harvest technology, harvest technology, post-harvest technology, mechanical power technology small scale irrigation and water harvesting and livestock feeds and products processing technologies.

Though there are two rural technology promotion centers in the Region, technologies they have been introducing were hardly demand oriented or within the economic reach of the farmer as most of the work they have been doing were on imported prototypes.

The commodity approach dominated the research system. This approach has resulted in the non-commodity research areas to be ignored or to remain small or in some cases not being considered at all. Those ignored research areas include natural resource management and environmental protection research, biodiversity and habitat conservation, farm mechanization irrigation and drainage, farm forestry and range land resource management and animal (apiculture, fishery, poultry) researches.

The regional research program was not participatory in that it did not allow stakeholders (i.e. farmers, development workers, extension experts etc.) to genuinely participate in the planning and evaluation of research. Particularly, small farmers who are end users of research technologies never came to the picture when research problems are identified and programmes designed.

The research approach is that it is not sufficiently problem and goal oriented and farmers are not full partners of the research enterprise. To weaken the approach even further is the inadequate research-extension-farmer linkage. The lack of critical skill needed and shortage or unavailability of required facilities and infrastructure and limited agro-ecological distribution of the research establishments are important problems in the Regions agricultural research system.

There is no strong and effective research-extension-farmer linkages in the Region. The Research - Extension Liaison Committee (RELC) has been operational for many years but without adequate output. Its operation was affected by frequent changes in staff and organizational set of the ministry of agriculture and decision making power was not clear and legal.

The foundations to guide and manage the agricultural research system within the Region are laid down through a Board, a Co-ordinating Unit, and the three Research Centers and a sub-center.

In its short time of existence, the Boards operation has not been found to be impressive and very effective to provide leadership for many reasons including the membership does not include farmers' and business sector; its deliberations have often been dominated by administrative issues dealing with problems of cattle ranches and rural technology centers and the Board's mandate and responsibilities vis-à-vis EARO have not been clear.

The Co-ordinating Unit was supposed to coordinate the research activities of all research centers in the region. The task is found to be too much for it as it is understaffed and does not have the capacity and orientation to provide direction and effective technical leadership.

There is limited co-ordination among programs/divisions within a Center and among centers in the region. The separation of these centers from the federal system has left

them with no backstopping in technical leadership. As a result, they have not managed to generate adequate technological innovations that significantly address production constraints of farmers in the Region.

Generally the regional agricultural research system seem to be constrained by lack of policies and capacity to generate and disseminate relevant and affordable technologies for smallholders. This is manifested by the lack of strategy and policy for the production and dissemination of improved farm implements; lack of effective technology packages for the livestock sector; lack of low input technologies for drought prone areas; and the poor performance of the crop technical packages currently being promoted through the extension programs

10.2. Recommendations

The overwhelming view is that the situation calls for a formalized institutional structure to co-ordinate and lead the regional agricultural research system to support the objective of the region for technology-based agricultural development. To achieve this the reestablishment of a Board, a Regional Agricultural Research Institute, Research main Centers, Sub-centers and Testing sites is recommended.

The Board should be independent and lean to ensure effectiveness in strategic planning and guiding of the regional agricultural research system. An autonomous Institute (which is a regional apex body), Main Research Centers which actually designe and conduct researches and sub-center (which are collaborators of the Main Research Centers) should be established.

To ensure the proper implementation of proposed research programmes and the generation of required technologies, there should be a total of 12 (9 new) Main Research Centers, 15 (14 new) Sub-centers and 17 trial sites established in the Region.

Main Research Center and sub- center establishment should be Agro-ecology based and the center should have carefully selected and prioritized research programs that will reflect its researchable problems of the mandate area and general areas of excellence.

To ensure effective functioning and proper discharge of research responsibilities, the existing research centers should be strengthened in manpower, infrastructure and facilities to bring them to a full-fledged Main Center status.

The current technical manpower at research centers is inadequate both in number and qualifications. They need to be strengthened with qualified and experienced researchers to meet the regional research needs adequately. For this, in addition to human resource development effort, basic changes in policies and principles governing recruitment conditions of services and performances should be made.

Researches should be conducted in multidisciplinary manner having problem-solving orientation against the backdrop of complexity in farming patterns. This necessitates conducting researches by taking into consideration the socio-economic settings of the farming community, understanding the resource endowments, production systems and management practices.

Although program categories are all equally important for the research to promote and support development objectives of the Region, there is a need to set priorities in the process of sub-program formulation within each program category.

Because the farming system is predominantly smallhoder based which constitute about 95 % of the farming community. Research strategy should give a special focus to address the major problems constraining agricultural production of the smalholder.

In view of the poor research-extension-farmer linkages, there is a need is to supplement the interface activity with joint regular functions including technology verification, on farm trials, demonstration and field days, technology packaging, approval and design and development of information material.

To create the ground for effective and efficient operation of the research institutions established, capacity building in terms of facility and manpower development should be given emphasis. Manpower is perhaps single most important factor determining the proper and efficient functioning of the Research System. Human resource development and management are thus critical and be given priority for achieving the Region's desired research goal which centers around "increase in productivity" of the resources (land, labour and capital) employed in the agriculture business.

To promote growth and development in the Region, commercial agriculture should be stimulated. The present systems and limited technology packages inevitably impede the development of commercial agriculture. In addition to improvements in policies on land tenure, mechanization, irrigation and fertilizer usage should be increased. This should be done through adequate research emphasis for the sub sector.

Annex 1 Zonal distribution, extent (sq. km) and % coverage of major and subagro-ecolgies in the Amhara Region.

AG_ZONE	ZONE	Sum Of AREA(sq Km)
Summary for 'AG_ZONE' = (1 detail record)		
Sum		
Percent		
A1-1		
	South Wello	111
	North Wello	3131
Summary for 'AG_ZONE' = A1-1 (2 detail records)		
Sum		3242
Percent		1.84%
Lake		
	Lake Tana	2999
Summary for 'AG_ZONE' = Lake (1 detail record)		
Sum		2999
Percent		1.70%
M1-1		
	North Gonder	6663
Summary for 'AG_ZONE' = M1-1 (1 detail record)		
Sum		6663
Percent		3.79%
M1-3		
	Oromia	2702
	South Wello	1085
Summary for 'AG_ZONE' = M1-3 (2 detail records)		
Sum		3787
Percent		2.15%
M1-4		
	South Wello	2117
	South Gonder	988
	North Shoa	1208
	North Gonder	1507
	West gojjam	2882

AG_ZONE	ZONE	Sum Of AREA(sq Km)
	East Gojjam	3147
	Awi	1064
Summary for 'AG_ZONE' = M1-4 (7 detail records)		
Sum		12913
Percent		7.34%
M1-7		
	North Wello	1206
	North Gonder	1201
	South Wello	1549
Summary for 'AG_ZONE' = M1-7 (3 detail records)		
Sum		3956
Percent		2.25%
M2-1		
	South Gonder	795
	North Gonder	5108
	West Gojjam	1981
Summary for 'AG_ZONE' = M2-1 (3 detail records)		
Sum		7884
Percent		4.48%
M2-5		
	South Wello	5649
	North Gonder	15326
	South Gonder	11040
	North Shoa	1673
	East Gojjam	7471
	West Gojjam	11830
	Oromia	2206
	North Wello	3254
Summary for 'AG_ZONE' = M2-5 (8 detail records)		
Sum		58449
Percent		33.21%
M2-6		
	North Gonder	188
Summary for 'AG_ZONE' = M2-6 (1 detail record)		
Sum		188
Percent		0.11%

AG_ZONE	ZONE	Sum Of AREA(sq Km)
M3-7		
	East Gojjam	1964
	South Gonder	754
	North Gonder	871
	North Shoa	1543
	Oromia	589
	South Wello	976
	West Gojjam	344
Summary for 'AG_ZONE' = M3-7 (7 detail records)		
Sum		7041
Percent		4.00%
SA1-1		
	North Gonder	77
Summary for 'AG_ZONE' = SA1-1 (1 detail record)		
Sum		77
Percent		0.04%
SH1-7		
	Awi	2217
	East Gojjam	1945
Summary for 'AG_ZONE' = SH1-7 (2 detail records)		
Sum		4162
Percent		2.36%
SH2-7		
	Awi	5316
Summary for 'AG_ZONE' = SH2-7 (1 detail record)		
Sum		5316
Percent		3.02%
SM1-1		
	North Gonder	11130
Summary for 'AG_ZONE' = SM1-1 (1 detail record)		
Sum		11130
Percent		6.32%
SM1-3		
	Kobo	742
Summary for 'AG_ZONE' = SM1-3 (1 detail record)		
Sum		742
Percent		0.42%

AG_ZONE	ZONE	Sum Of AREA(sq Km)
SM1-4		
	Waghemera	2676
	North Gonder	3282
Summary for 'AG_ZONE' = SM1-4 (2 detail records)		
Sum		5958
Percent		3.39%
SM2-5		
	South Wello	5575
	Waghemera	6287
	North Shoa	12320
	North Wello	9949
	South Gonder	2742
	North Gonder	2008
Summary for 'AG_ZONE' = SM2-5 (6 detail records)		
Sum		38881
Percent		22.09%
SM2-7		
	North Gonder	471
Summary for 'AG_ZONE' = SM2-7 (1 detail record)		
Sum		471
Percent		0.27%
SM3-7		
	South Wello	1309
	North Shoa	113
	North Wello	610
	South Gonder	111
Summary for 'AG_ZONE' = SM3-7 (4 detail records)		
Sum		2143
Percent		1.22%
Grand Total		176002

Annex 3. Existing and Phase Establishment of Main Research Center, Sub-center and Trial Sites in the Amhara Region (2000-2020)

Existing			2000-2005			2006-2010			2011-2020		
Main Center	Sub-Center	Trial Site	Main Center	Sub-Center	Trial Site	Main Center	Sub-Center	Trial Site	Main Center	Sub-Center	Trial Site
Adet	Kobo	Achefer	***Adet***	Kobo	Dabat	***Adet***	***Andasa***	Ankober	***Adet***	***Bichena***	***Ankober***
Sirinka		Fogera	***Sirinka***	Andasa	D. Tabor	***Sirinka***	***Bichena***	Chagni	***Sirinka***	***Kosober***	***Chagni***
Sheno		Dabat	***Sheno***	Bichena	Tseda	***Sheno***	***Debark***	Enewari	***Sheno***	***Wereilu***	***Enewari***
		Bichena	Sekota (F)	Debark	Ankober	***Sekota (F)***	***S. Robit***	Achefer	***Sekota (F)***	***D. Brehan***	Achefer
		Finoteselam	B.D/Mech.	S. Robit	Chagni	***B.D/Mech.***	***Kosober***	Fogera	***B.D/Mech.***	***Amedguya***	Fogera
		Mota	B.D/Fisher	Kosober	Chilga	***B.D/Fisher***	***Shehedi***	Finoteselam	***B.D/Fisher***	***Arerti***	Finoteselam
		Merawi		Shedi	Chefa	Andassa	***Wereilu***	Mota	***Andassa***	***Anjeni***	Mota
		Debark		Wereilu	Lalibela	Shehedi	***D. Brehan***	Merawi	***Shehedi***	***Maybar***	Merawi
		Stayish		D. Brehan	Enewari	Andit Ted	***Amedguya***	Stayish	***Andit Ted***	Woreta	Stayish
		Geregera		Amedguya	Achefer		***Arerti***	Geregera	Debark	Dabat	Geregera
		Gimba		Arertu	Fogera		***Anjeni***	Gimba	S. Robit	D. Tabor	Gimba
		Kutaber		Anjeni	Finoteselam		***Maybar***	Kutaber	Kobo	Tseda	Habru
		Habru		Maybar	Mota		***Anditted***	Habru		Chilga	Hara
		Hara		Anditted	Merawi		**Kobo**	Hara		Chefa	Chacha
		Ankober			Stayish		Woreta	Chacha		Lalibela	Mehalmeda
		Andit Tid			Geregera		Dabat	Mehalmeda			Molale
		Koso Ber			Gimba		D. Tabor	Molale			Faji
		Chefa			Kutaber		Tseda	Faji			
		Chacha			Habru		Chilga				
		Mehalmeda			Hara		Chieffa				
		Molale			Chacha		Lalibela				
		Enewari			Mehalmeda						
		Faji			Molale						
					Faji						
3	1	23	6	14	24	9	21	18	12	15	17

Annex 2. Administrative Staff Minimum Requirement for MRC and SC

Position	Level of Education					
	MSc	BSc	Dip	Cert.	Other	Total
1) Main Center						
Secretary (Grade 1)			2	1		3
Head of Admin and Fin.	1					1
Personnel Officer		1		1		1
Auditor						1
Cashier			1			1
General service head				1		1
Head Store keeper			2	2		2
Senior Mechanic			1			1
Mechanic			1			1
driver/Mechanic					6	6
A/Librarian			1			1
Library Assistant				1		1
Tractor Operator				2		2
Accountant		1				1
Junior Accountant			1			1
Assistant Tractor Operator					1	1
Guard					5	5
Janitors					3	3
Sub Total	1	2	9	6	15	33
2) Sub-center						
Accountant			1			1
Cashier				1		1
Stove keeper				1		1
Driver				2		1
Sub Total			1	4		5
Grand Total	1	2	11	10	15	38

Annex 4. Preliminary cost estimates of capacity building by research category and expenditure classification (2000-2005)

('000 birr)

Research Category	Capacity Building in the Short-term							
					Sup. and	Training		
	Salary	Buld.	Equpt.	Furn.	Expend	Long	Short	Misc
Natural Resource Management	3837	16,418	2250	1200	500	1800	4800	2000
Soil and Water Management	5428	27,797	4800	355	2446	6339	2010	344
Field Crops and Dryland Agriculture	2428	9665	2633		565	5576	4800	100
Crop Protection	441	10,316	4100	2007	750	6880	2400	3513
Horticulture Crops Improvement	2867	4,252	2387	395	500	2860		100
Animal Production Improvement	5149	12013	5500	750	208	12960	2400	180
Animal Feeds and Nutrition	1970	9588	4155	1170	334	1800	242	100
Agricultural Mechanization	1834	1980	1683	100	250	720	-	656
Agri. Econ. Research and Extension	1472	5112	1800	150	390	2160	8060	1420
Total (+15% Contingency)	**29,723**	**111,712**	**33,704**	**7,046**	**6,834**	**47,259**	**28,419**	**9,675**

Annex 5. Preliminary cost estimates of capacity building by research category and expenditure classification (2006-2010)

('000 birr)

Research Category	Capacity Building in the Medium-term							
					Sup. and	Training		
	Salary	Build.	Equipt.	Furn.	Expend	Long	Short	Misc
Natural Resource Management	9764	23146	2600	1600	750	2400	12000	3000
Soil and Water Management	8553	23080	4021	535	3420	6090	2820	172
Field Crops and Dryland Agriculture	4889	11004	14948	817	2281	6960	6400	100
Crop Protection	635	2675	2535	759	450	5160	2400	4099
Horticulture Crops Improvement	4329	5686	3925	519	500	7560		100
Animal Production Improvement	7984	6363	3380	800	538	21600	46000	220
Animal Feeds and Nutrition	3540	5763	3575	795	327	1560	242	100
Agricultural Mechanization	1783		1242	50	500	1680	8401	1366
Agric. Econ. Research and Extension	2209	7632	3051	224	495	2400	16105	2527
Total (+15% Contingency)	**50,239**	**98,428**	**45,169**	**7,014**	**1,065**	**63,722**	**108,523**	**13,437**

Annex 6. Preliminary cost estimates of capacity building by research category and expenditure classification (20011-2020)

('000 birr)

Research Category	Capacity Building in the Long-term							
	Salary	Build.	Equipt.	Furn.	Sup. and Expend	Training		Misc
						Long	Short	
Natural Resource Management	29681	18403	3650	1300	1400	2000	18000	5000
Soil and Water Management	12923	4042	35	24	7092	2520	4020	-
Field Crops and Dryland Agriculture	141178	5744	7765	841	2508	5280	6400	150
Crop Protection	924	2194	2535	1201	450	3000	2400	5950
Horticulture Crops Improvement	13832	7848	3204	283	1000	8260		200
Animal Production Improvement	19746	8006	2700	400	1000	12960	56000	400
Animal Feeds and Nutrition	9900	150	3649	895	317	480	242	150
Agricultural Mechanization	5306		5000		1000	2120	1440	2783
Agric. Econ. Research and Extension	5535	10224	8652	300	1680	2640	40300	7330
Total (+15% Contingency)	**140,213**	**65,02**	**42,768**	**6,030**	**18,904**	**45,149**	**148,122**	**25,275**

Year	Rural population	Ratio Of Professional Agricultural Researchers to Rural Population				
		PhD	MSc	DVM	BSc	DiP
2005	16,52,758	1:751,307	1:170,399	1:4,132,189	1:706,36	1:58,200
2010	18,547,152	1:268,799	1:97,617	1:2,318,394	1:53,450	1:46,484
2020	22,777,107	1:177,946	1:85,308	1:3,796,184	1:507,29	1:44,836

Annex 7. Envisaged Human Resource Development for Technical Staff by Level of Education and Research Category

Research Category	Short-term (2000 – 2005)					Medium-term (2006 – 2010)					Long-term (2011- 2020)				
	PhD	MSc	DVM	BSC	DVD	PhD	MSc	DVM	BSC	DVD	PhD	MSc	DVM	BSC	DVD
Natural Resource Management	3	15		29	50	11	45		82	94	18	79		126	117
Soil and Water Management	8	16		38	50	10	20		52	70	9	18		58	85
Field Crops and Dryland Agriculture	6	9		23	30	13	18		39	42	19	29		55	55
Crop Protection	2	12		17	21	11	16		18	22	20	17		21	42
Horticulture Crops Improvement	3	13		28	23	9	22		37	1	16	37		49	45
Animal Production Improvement		12	4	53	66	12	37	8	54	72	26	51	10	57	73
Animal Feeds and Nutrition		4		21	23	2	8		32	47	4	12		41	71
Agricultural Mechanization		4		7	21	1	6		6	21	4	12		6	22
Agri. Econ. Research and Extension		12		18			18		27		12	12		36	
Total	**22**	**97**	**4**	**234**	**284**	**69**	**190**	**8**	**347**	**399**	**128**	**267**	**10**	**449**	**508**

Annex 8. Preliminary Estimates of Capital and Operational Expenditures

Research Category	2000-2005			2006 - 2010			2011-2020		
	Capital	Operational	Total	Capital	Operational	Total	Capital	Operational	Total
Natural Resource Management	26.5	6.3	32.8	41.7	13.5	55.3	43.3	36.1	79.4
Soil and Water Management	33.8	15.7	49.5	34.1	14.6	48.7	24.6	6.1	30.7
Field Crops and Dryland Agriculture	22.7	3.5	26.2	40.1	7.3	47.4	26.0	16.9	42.9
Crop Protection	25.7	4.7	30.4	13.5	5.1	18.6	11.3	7.3	18.6
Horticulture Crops Improvement	9.2	3.5	12.7	17.7	4.9	22.6	18.8	15.0	33.8
Animal Production Improvement	18.3	20.9	39.2	10.5	75.8	86.3	11.1	90.1	101.2
Animal Feeds and Nutrition	16.9	2.4	19.3	11.9	4.0	15.9	5.4	10.4	15.8
Agricultural Mechanization	4.5	2.7	7.2	11.4	3.6	15.0	21.5	9.1	30.6
Agri. Econ. Research and Extension	17.3	3.3	20.6	29.4	5.2	34.6	62.1	14.6	76.7
Total	**174.9**	**63**	**237.9**	**210.4**	**134**	**344.4**	**224.1**	**205.6**	**429.7**

Annex 9. Preliminary Cost Estimates by Source of Finance (Million Birr)

Research Category	Short-term (2000-2005)			Medium-term (2006 – 2010)			Long-term (2011-2020)		
	Region	Foreign	Total	Region	Foreign	Total	Region	Foreign	Total
Natural Resource Management	22.7	10.1	32.8	37.2	18.1	55.3	57.2	22.2	79.4
Soil and Water Management	41.3	8.2	49.5	36.5	12.2	48.7	10.6	20.1	30.7
Field Crops and Dryland Agriculture	14.1	12.1	26.2	24.0	23.4	47.4	26.9	16.0	42.9
Crop Protection	18.1	12.3	30.4	10.3	8.3	18.6	12.1	6.5	18.6
Horticulture Crops Improvement	8.4	4.3	12.7	12.7	10.1	22.6	25.2	8.5	33.8
Animal Production Improvement	20.6	18.6	39.2	29.0	57.3	86.3	37.7?	63.5?	101.2
Animal Feeds and Nutrition	12.9	6.4	19.3	10.8	5.1	15.9	12.6	3.2	15.8
Agricultural Mechanization	5.1	2.1	7.2	6.14	8.9	15.0	13.9	16.7	30.6
Agri. Econ. Research and Extension	10.1	10.5	20.6	14.3	20.3	34.6	21.6	55.1	76.7
Total	**153.3**	**84.6**	**237.9**	**180.9**	**163.7**	**344.4**	**217.8**	**21.8**	**429.7**