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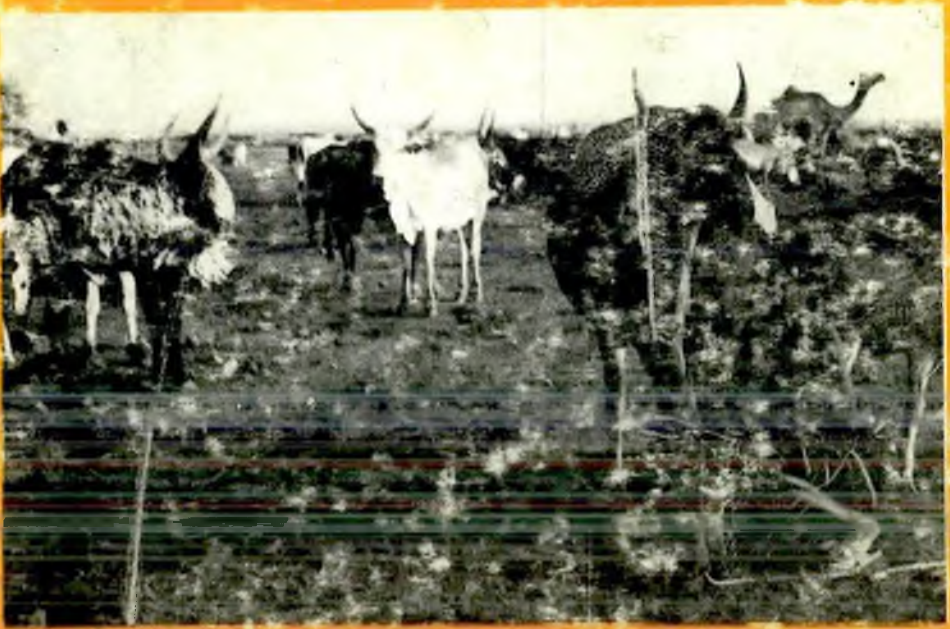

14-15 May 1998
Addis Abeba, Ethiopia

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To Dr Seifu Ketema

PROCEEDINGS

Sixth Annual Conference of Ethiopian Society of Animal Production

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Ethiopia Agricultural Research
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14-15 May 1998
Addis Abeba, Ethiopia

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PREFACE

Annual Conference on key livestock-related issues of the nation has become one of the most important features that have regularly been convened ever since the Ethiopian Society of Animal Production (ESAP) is legally established in August 1990. Ultimately aimed at promoting animal production through sustained scientific research and development initiatives, such conferences played significant roles towards meeting ESAP's profound objectives by nurturing interest in the scientific development of animal production and maintaining the professional quality and academic standards. ESAP's annual conferences are the ideal fora at which research findings and associated development efforts are exchanged, critically discussed and disseminated amongst a range of scientists, both at national and international levels.

The proceedings of all the preceding five conferences have been published. Needless to say, all members of ESAP, contributors and national and international partners feel proud that these proceedings have become one of the most significant information sources of animal production, a sector that constitutes the large portion of the population and the national economy. The fact that these proceedings are in use as regular reference documents by students of higher learning institutes, researchers, academicians, development practitioners within and outside the country confirms the increasingly growing interest in the scientific development of animal production. Whenever we think of the future, however, we always believe that we can contribute and achieve more.

We are pleased to release the proceedings of the Sixth Annual Conference of ESAP, which was held in May 1998. The theme of the Conference was 'Women and Livestock Production'. It is for the first time that such a theme pertaining to women and agriculture is addressed at a national continence. Accordingly, the conference has attracted professionals outside the livestock discipline but related to gender issues. All the nine papers presented on the theme, we believe, have addressed the dynamic role of both men and women, in particular women, in improving animal productivity. Ways and means of enhancing the productivity and contribution of women in animal production were identified. Specific recommendations that were made at the end of the first session of the conference have indeed attracted the attention of researchers, development practitioners, and policy makers. The second day focused on technical issues related to animal science such as breeding, feeds and nutrition and animal health. A total of 24 papers were presented in two concurrent sessions. We hope, the papers presented in this proceedings will contribute towards a better understanding of the roles of gender in research, extension and development issues in Ethiopia and trigger a useful debate at every level.

The Conference and publication of this proceedings would have not reached at this stage has it not been for the dedicated and strenuous efforts of executive committee members. The society is indebted to the different organizations in sponsoring the Conference and covering the costs of publication of this proceedings. All participants are thanked for their contributions to the various aspects of the program and the general success of the conference. I would also like to acknowledge Ato Amare Molla for copyediting and page layout of the book.

The Sixth Conference was also special in that for the first time it laid a foundation to establish national livestock networks under the auspices of ESAP. We would like to take this opportunity to express our appreciation to all who paid their efforts towards forming the two networks, 'the Ethiopian Network for Animal Power' and 'the Ethiopian Network for Feed Resources and Animal Nutrition'. These networks are initiated in order to strengthen the capabilities of national research and development efforts through collaborative work and dissemination and exchange of information.

It is also our pleasure to inform ESAP members, our general audience, partners and all interested that we are in the final stage of organizing the Seventh Annual Conference under the theme 'Livestock and Environment: Implications Towards Sustainable Livelihoods'. Three interwoven aspects are associated with sustainability; a growth component, a distribution component and an environment component. The relationship between livestock and environment, whenever optimally managed, are advantageous in terms of food security through diversification, energy and nutrient cycling and subsistence; hence, resulting in improved human support capacity of the land. The challenge, therefore, becomes devising a mechanism of making the best uses of livestock and other scarce agricultural resources safeguarding the environment and restoring the already degraded environment as well.

Choosing the above mentioned theme for the Conference has meant putting lots of efforts towards identifying and approaching experts from different institutions with relevant academic and professional experiences and willing to present invited papers. May we, thus, extend our sincere appreciation and heartfelt thanks to all who have shown their interest in sharing their expertise to our audience.

We eagerly look forward to everyone's active participation in the forthcoming Conference to be hold in May 1999 and the cumulative output thereon.

December 1998.

Zinash Sileshi (PhD)
President, ESAP

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WELCOME ADDRESS

Zinash Sileshi (Dr.)
President, Ethiopian Society of Animal Production

Your Excellency, W/zo Tadelech Haile Michael,
With the Rank of Minister, Head of Women Affairs, Prime Minster's
Office of Federal Democratic Republic of Ethiopia,
Distinguished Guests, and
Conference Participants

On behalf of the Executive Committee of the Ethiopian Society of Animal Production, it is a distinct honor and pleasure for me to welcome each and ever one of you to this Sixth Annual Conference of ESAP. Agriculture has a crucial role to play in the social and economic development of Ethiopia. The sector, however, has not satisfied the nation's requirement. The problem of food shortage in Ethiopia is multifaceted, and an equally multifaceted approach is required to resolve it. This calls for immediate reappraisal of rural education programs and agricultural research and development efforts to achieve the national goal of self-sufficiency.

Livestock production is a complex system that needs the integration of social, economic and technical issues. The expected increase in the flow of technologies to the needs and the improvement of production conditions of resource-poor farmers in Ethiopia has not been attained occurred in spite of considerable investments in research and technology transfer. The major problems result from not only the inability to identify appropriate technologies but also lack of adequate knowledge on how the different livestock production systems function. An understanding of the production factors (livestock, capital, feed, land and labour) is a prerequisite for livestock development. The experience of other countries suggest that livestock development can only be achieved through the involvement of small-scale farmers in the process of technology generation and transfer. The challenge is therefore how best to involve small-scale farmers in the process of technology generation and transfer.

In Ethiopia, women are the major and important force in animal production. Almost all the strenuous operations of feeding and caring of livestock, collection and processing of dairy products are performed by women. However, the contributions of women to the national development have not been fully recognized and adequately enumerated. Research has given little attention to solving the problem of female farmers, and designing of new technology often disregards the important question of women's influence on decision making and labour allocation. The system of rural education and training has also failed to consider women's roles as agricultural producers but mainly focused on their roles as housewives and mothers.

Development of animal production would only be enhanced if the role of women is recognized, in order to make rural women more productive as farmers and integrate them in the context of development projects. It is, therefore, high time that we recognize the dynamic role of women in improving the life of the rural community. The theme of this Conference devoted to women and agriculture is thus a gesture of our recognition of the importance of the issue. It is for the first time that such a theme pertaining to women and agriculture is addressed at a national continence. Accordingly, the conference has attracted even professionals outside livestock disciplines but related to women's issues. Nine papers that are directly related to the theme will be presented.

We hope the first day of this conference will adequately address the dynamic role of in improving animal productivity and identifications ways and means that enhance the productivity and contribution of women in animal production. We believe there will be active participation of members on issues related to the theme through the plenary and discussion fora. We trust that each of you will strive to make specific recommendations that attract the attention of researchers, academicians, development practitioners and policy makers.

The second day of the workshop will focus on technical issues related to animal science such as breeding, feeds and nutrition and animal health. Twenty-four papers will be presented in two concurrent sessions.

Our sixth conference is also special in that for the first time it will lay a foundation to establish networks under the auspices of ESAP. The last session of the workshop will work on the formation of two networks: Ethiopian Network for Animal Power and Ethiopian Network for Feed Resources and Animal Nutrition. These networks will provide a structure to enhance collaboration and provide a forum for communication between professionals working on research and extension for the benefit of rural communities in Ethiopia. The Executive Committee is kindly requesting each member of the society to actively participate in the development of the Network constitutions. ESAP looks foreward to work with the networks and our concerted effort and unity will bring an impact.

As stated in our previous annual conferences, our Society's financial constraint is still persisting and the Executive Committee would like to bring this issue to the attention of the general assembly. Finally, I would like to take this opportunity to thank the different sponsoring organizations for enabling us to hold this conference. I wish to thank you, the conference participants, for sacrifying your time to attend this conference; your presence indicates a professional commitment to scientific excellence and development.

May I now respectfully invite her excellency W/zo Tadelech Haile Micheal, with the rank of Minster, Head of Women's Affairs, Prime Minister's Office, to officially open this Sixth Conference of ESAP.

I thank you all.

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OPENING ADDRESS

W/ro Tadelech HalleMichael
With the Rank of Minister, Head of Women's Affairs, Prime Minister's Office of the Federal Democratic Republic of Ethiopia

Chairlady,
Distinguished participants of the Sixth Conference of the
Ethiopian Society of Animal Production,
Ladies and Gentlemen

It is a great honor and pleasure for me to have this opportunity to address the opening session of this conference. You are gathered there representing various research, teaching and development institutions to discuss an important subject, the issue of the role of women in livestock development which to my knowledge has not been staged for this kind of high level deliberations by an assortment of professionals like this one. The theme of your conference is a very challenging and important one. The government of the Federal Democratic Republic of Ethiopia attaches very high importance to the role of women in agriculture, who are the major actors. Conferences of this nature, particularly at this time, when Ethiopia is struggling to attain sustainable food security at the farm level and at the national level, are undoubtedly very useful for the attainment of these goals.

In Ethiopia, animal production is an important component of the agriculture sector as evidenced by the large herds and flocks. Most of the people in our country continue to depend on agriculture for their livelihood. It is unfortunate that our livestock subsector has remained traditional and largely undeveloped. Management is poor, reproduction and growth rates are low and there is a high incidence of diseases. In recent years, the productivity of the livestock sub-sector is showing negative trends in some products such as milk. A part from the factors I have already mentioned, this has mainly been caused by adverse climatic conditions such as poor erratic rainfall and by increasing population that have aggravated the overpopulation of natural resources, especially land. The uncontrolled population increase has resulted in serious competition for land, and so less land is available for agricultural purposes. This has increased the problems of oversocking and hence overgrazing of rangelands in most parts of the country.

As a consequence of this, we are still net importers of many animal products. With the current status of our economic development, we cannot afford to import enough quantities of these important commodities and so our people are faced with unbalanced diets and, in some cases, not enough food. We all know, of course, that inadequate diets and poor nutrition, especially of children, will eventually lead to problems in the development of our manpower resources.

One of the shortcomings of agricultural development in general and livestock development in particular is lack of recognition of the roles of family members, especially women, in the development process. It is the women that do a major portion of the animal production activities of rural farms. It is therefore important to actively involve women in the process of improving animal production. We need not to be reminded that it is our responsibility to feed ourselves. We cannot blame others for our plight, and neither can we depend forever on the goodwill of the international community to donate food to feed people. Instead, we must strive harder to seek solutions that will reverse the current trend and indeed improve food security in our country. We hope, therefore, that your participants of this conference from various development research and higher learning institutions will work hard towards the realization of this goal. One way of achieving this is through the promotion of interaction among research, extension workers, trainers and others involved in livestock development, which will ensure the exchange of ideas and information.

Finally, I wish to take this opportunity to commend the sponsors and organizers of this conference for their efforts to organize this conference and for selecting the theme. I wish you maximum possible success in your deliberations. Ladies and gentlemen, it is now my pleasure to declare this conference officially open.

Thank you.

session I-plenary

WOMEN
and
ANIMAL PRODUCTION

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WOMEN, FOOD SECURITY AND AGRICULTURE

Bogalech Alemu
Women's Affairs Department, Ministry of Agriculture, Addis Ababa

Introduction

The challenges to food security and environmental sustainability are so complex that solutions must involve all human resources including women. Evidence shows that food security and agricultural productivity, once considered gender neutral, affect men and women differently. Food security and economic reform work through people, new opportunities open up for those with access to land, credit, education and market outlet—more likely to be men—while the costs of change fall on those without access, often women.

A number of studies indicate that female farmers are responsible for a large part of the domestically consumed produce in Africa and they play critical roles in natural resource management. Despite these facts women have little representation among professional decision makers whose policies, programs and practices so dramatically affect them. A study in Africa (FAO 1984) indicated that only 4% of the professional agricultural position in 46 Sub-Sahara African counties were held by women and only 7% of the extension service was devoted to helping women farmers in Sub-Sahara Africa.

According to the British Council gender guideline (1991), a plant breeding project aimed to produce a faster growing and more pest resistant strain of the local bean in order to increase food security for a particular community. A team of expatriate and Indian plant breeders worked hard over a period of three years to develop a new variety. When the team offered the bean to the community they were surprised to find that the bean was not welcomed as warmly as they had expected—women were simply not using the new strain of bean. On further investigation, the team found that the new been required longer cooking time which required more fuelwood to cook. Hence, the project was extended and the team worked more closely with the women users of the new variety and the team succeeded in producing a series of new strains which fulfilled the women's criteria and were taken up by the community.

Wudenesh (1997) in her women and development study for southern nations and nationalities verified the fact that women in the study areas actually participated in crop and livestock production as they share 33-37% of the crop production. Similarly they perform 70% of the livestock production activities caring for animals around homestead, cutting grass, hay processing, getting water, in born cleaning, processing dairy products, poultry keeping and marketing of animal products were indicated as major activities of women. On the other hand, it was noted that women contributed 15–25% of the labor needed in afforestation and soil conservation programs.

Similar studies undertaken by the above researcher in selected weredas of Tigray and Amhara regions has confirmed the fact that women actively participate in agricultural production. Their participation in crop production is mainly in seed cleaning, land preparation, weeding, harvesting, winnowing, manuring, transport and storage of harvest crop, watering, hoeing, threshing ground preparation and food preparation for people working in the field. In animal production women play major roles by feeding and caring for animals and in the processing of animal products and in poultry keeping. On the other hand they actively participate in afforestation and soil conservation programs. Women's role in life stalk production was significant in the studied weredas of both Amhara and Tigray regions. The study indicated that they spend major time caring for animals, fetching water, barn cleaning dairy processing, poultry keeping, trekking animals to water points and to vaccination centers.

Findings of a similar study undertaken in Afar Region by ECA (1997) also indicated that all members of the household (men, women and youth) play important roles in animal husbandry. Camels are mainly looked by men; cattle sheep and goats are herded by women, men and youth. Milking camel is exclusively done by men while milking cattle is done by women and men. Milk processing and marketing is done by women while selling and buying livestock is exclusively men's responsibility.

In a women's workload study of two regions in Ethiopia, Barbara and Zewdie (1990) stated that women in the study area work for over fifteen hours daily performing activities mainly to feed and care for their families. The study indicated that women make an important contribution to food production through the long hours women spend on the farm in caring for household animals, selling farm product and in processing food at home.

Women's Indigenous knowledge in Food Production, Processing and Management

Women around the world manage to produce, process and market food with limited external assistance individually or collectively utilizing thousands of years of experience and trial and error problem solving methods, in order to meet the difficulties and opportunities presented by their local environments. Women's indigenous technical knowledge and innovative solutions are evidence across the whole range of food cycle activities.

In many part of the world providing food for their families is a women's job. Indigenous technical knowledge enables women to continue to feed the population despite deteriorating agro-ecological conditions and their lack of access to improved technologies.

Women's indigenous technical knowledge can and should form a solid basis for technology development activities, and yet it continues to be ignored by people working in these areas. One reason for this is that what women do is often labeled "domestic". Women's knowledge of production process remains largely invisible and yet women constantly use their knowledge to make rational economic and technical choices and changes appropriate to their environment. Women's knowledge and skill in food production, processing and marketing plays a crucial role in household livelihood and food security. Their indigenous knowledge and skills are not static. Women modify, adopt or change production processes in response to various factors such as environmental change, market demands, etc.

Factors Contributing to Gender Difference in Food Security and Agriculture

Limited number of women are involved in extension services, or in decision making, technical development or formal food and agricultural research. Men working in these areas usually do not discuss with women to identify their specific development needs.

The technological invisibility of women has been supported by lack of acknowledgment both at national and international levels of women's economic contribution. National and international statistics, which form the basis for resource allocation and major policy decisions, do not estimate the value of unpaid work. This means that most subsistence activities on which the lives of rural people depend are not reflected in development plans and statistics. Most development plans treat the rural household as a single economic unit rather than develop the plan to address the specific needs of women, men and youth in a household.

There are several distinct and interrelated areas of gender based differentiation within the household. The following are the major areas:

- Access to productive resources.
- Control over family labor.
- Inequalities and rigidities in gender division of labor,
- particularly with regard to reproductive responsibilities.
- Inequality in consumption.
- Gender difference in responsibility of household expenditure.

The above factors interact with gender conditions of access to market and public institutions, which may reinforce gender biases within the household. Socio-cultural and ideological norms about appropriate roles and behavior for women and men constrain women's scope for independent activity and decision making.

Food security is a crucial determinant of human well-being. Studies analyzed in several countries by IFPRI indicated that women direct more resources to food and to children when they have their own income or are in charge of household income. A nutrition survey done in Kenya and Rwanda indicated that the share of income controlled by women had a significant, positive effect on household calories consumption and nutritional well-being. Women's workload, nutrition information and their access and control over household resource have influence over family nutrition. Women are traditional food handlers; when they have enough time, energy and adequate nutrition knowledge they would be in a better position to improve their family nutritional status.

Agriculture is the main source of livelihood for most households in Sub-Sahara Africa where 25% of the female labor force is engaged in agriculture and in Southern Asia 55% (CUN 1995). A large proportion of women work in agriculture in these regions as unpaid family workers. Much of women's agricultural work is in subsistence rather than cash crops. Both women and men turn to the informal sector when opportunities in wage employment are scarce. Women's employment status has a direct impact on the food security status of their families. Female jobs are often related to perceived female characteristics. In most developing countries of the world in general female jobs tend to be lower paid, less skilled, less secured and less in opportunities for upward mobility compared to male jobs. Many of the world poor women are self employed in micro-enterprises and small business. It has been found that low income women entrepreneurs repay their loan and use the benefits and increase their income and asset. Once their income increases they use this new earning to improve health, education and nutrition of their families.

Therefore, targeting women for nutrition education, raising women's awareness of food quality and safety, and the participation of women in community level decision making on matters related to food and nutrition issues will help to promote food security among households. Studies in India and other developing countries showed that the poorer the family, the greater is its dependence on women's economic productivity. Thus enhancing women's economic productivity is an important strategy for improving food security and welfare of households below the poverty line.

The Impact of drought and Famine on Women

Poorly nourished, poorly cared for mothers give birth to low birth weight and high risk infants. In addition to reducing women's productivity as a worker, poor health also reduces her ability to perform her reproductive roles and affects the productivity and the very survival of the next generation. In time of drought, adult males have less work to do on farm field. They may look for off farm employment often by moving out to far places if crop fails completely, leaving additional responsibility to women who remain behind with children and the elderly. The women have to fetch water for domestic uses including for animals in some cases and they should travel long distances to water points which creates stress since other household activities would still wait for them. When food is scarce young children get malnourished and become more susceptible to diseases demanding more caring time from their mother. The depletion of pasture reduces livestock productivity and increases mortality. This affects household income in general and women's access to resources since animal by-products are usually at the discretion of women. Women supplement their income by selling forest products. Thus, as a result of increased deforestation and increased restrictions on public use of forest this supplementary source of income decreases overtime further constraining women's economic opportunities.

The heavy workload women have requires additional calories requirement and this could not be maintained during food shortage. In principle women who exert more energy should get more food, as care takers of their families they tend to eat last and least. The resulting protein energy deficiency exposes women to nutritional and infectious diseases.

If food crisis becomes severe and during food aid they are obliged to work for it. Women's special needs while working in relief program needs special consideration. Women's workload reaches its peak during planting, weeding and during certain pre and post harvest periods. When such periods coincide with illness and food scarcity the health of women and their family may be seriously impaired—many studies have shown that pregnant women loss weight and birth weight of infants vary by season. Lactation ability and breast milk volume is also affected by season according to net intake of energy. Women's productivity in agriculture is highly dependent on their opportunity to having access to productive resources such as land, credit fertilizer and other agricultural technologies.

Access to Land

Because of the traditional patrimonial transmission of property women have usually limited access to the ownership of land which is the most important productive assets. Increasing women's economic productivity is a necessity. Whatever the complex socio-cultural cause for the observed patterns of gender-based differential access, affective interventions are those that help increase women's ability to earn and control a secure livelihood that guaranties food security to themselves and their families.

When women do not have access to necessary credit, input supplies or technical services, and lack of legal access to inherit own and transfer agricultural land can be a problem for females, as membership to peasant association is registered by household head (the husband) except in cases of divorced or widowed household heads.

Rural women are responsible for raising small livestock and handling large livestock, gathering food, fodder and fuelwood and for drawing water and managing domestic water supply. They perform a large portion of the post harvest activities including storage, handling and marketing and in and off from food processing activities either in micro-enterprises or as wage workers in agro-industries. Many rural women lack access to land or have insecure land tenure. Usually their husbands, fathers and brothers are those who hold land title and this limits their access to credit or membership to peasant or farmers associations and to having access to agricultural extension services and inputs.

Unlike other constraints faced by women which may be deeply embedded in social custom discrimination outside the household is something that policies and programs can help change land ownership. The national constitution has given women and men equal access and control right over land ownership. Some regions have put this legal right into practice and others have yet to inmate laws and implement the constitutional right. Land ownership, being a major agricultural productive resource, its absence is a major constraint to having access to agricultural technology and extension service.

Access to Credit

To expand their economic activities and earn more money to support their families women need access to more resources. Women usually have less income than men and it will be harder for them to save enough for a bigger and more profitable investment. Even when credit is available access requires either collateral assets or land. Most women have control of fewer marketable assets and thus may lack the opportunity to build independent business or investment.

Entry into activities that provide higher return depends on dissemination of information about such opportunities and on well functioning labor and capital markets. One of the main sources of information is formal education. There is evidence that better educated farmers are more likely to enter better agricultural practice as some of the structural factors affecting women's participation in food production are macro level factors such as price policies for different crops, the availability of credit, the stage of family life cycle, the ages and needs of children, ownership and inheritance of land which have a lot of effect on women's capacity to food production. The socioeconomic status, competing demands on women time and hence their opportunity costs and the amount of land and other productive resources available within the social structure, all affect their opportunity to participate in and benefit from agricultural development.

In most parts of Ethiopia, women have traditionally been responsible for producing food for the family. Their fundamental role in securing food for the family and national food security must be recognized and technologically extension supported in addition to improving their access to cashable skill, credit, and business management training and information which is important to enhance their productivity and status.

Better information about women's situation and their multiple roles, as well as the increased involvement of women in development planning and monitoring is needed urgently. This would help agricultural programs and projects to achieve greater agricultural productivity and national food self-reliance while also supporting socioeconomic goals and sustainable development.

Women's Access to and Management of Natural Resources

Women's relationship with the environment is centered around their concern for household food security and family welfare and with the provision of water and fuel. Changes in land tenure and uses in technology and input are seen by women according to the availability and the supply of water for domestic use, on the possibility for gathering food, fuelwood, fodder, medicinal plants and row materials for small-scale industries. Women are custodians for biodiversity, they are care-takers of agricultural and livestock genetic resources, wildlife is a major component in household food security for women as is the identification, preservation and use of wide diversity of domestic plants, and animal species which women have carefully selected, bred and exchanged throughout history.

In addition to having access to resources, rural women must cope with poor availability and quality of means of production, degrading environmental condition. Thus increasing demands are made to the already overburdened assignment of domestic, farm and community responsibilities in their effort to satisfy their family food needs.

Rural women's technical knowledge of sustainable resource use in soil and water conservation and management, forest use and conservation of plant and animal genetic resource management need to be recognized understanding the impact of environment on women and girls livelihood and the well-being of their families is an important step in establishing a more sustainable development framework. In highly deforested areas it takes women longer time to collect fuelwood, thus reducing the time available for other activities.

Women spend much of their time cooking with biomass fuel such as wood straw or dung in poorly ventilated rooms and are thus exposed to high levels of indoor air pollution resulting in acute respiratory infections and bronchitis.

Integrating gender in food and agricultural project and programs

Gender concerns should be appropriately addressed at all stages of a food and agriculture project/programs cycle in designing, planning implementation, monitoring and evaluation. Gender must be the concern of all the staff involved in food and agriculture programs.

Main actions to ensure the participation and benefit of women in food and agricultural programs and projects to ensure that gender concerns are properly addressed while designing and planning should be able to:

- Undertake gender analysis of current situation
- Involve women in problem identification and program design
- Identify ways and means of female participation and benefit from the project/program
- Enable women's participation
- Undertake measures to strengthen women's participation even further
- Ensure project benefit reach women and men
- Follow up and monitor to check and review that the project or program has met women's practical and strategic gender needs

To enhance the status of women and to increase their productivity in agriculture, to strengthen their decision making power and leadership roles in agriculture and food security the following principal courses of action should be included in all agricultural and rural development programs.

- Gather statistical data and undertake research on all issues related to women in agricultural development.
- Advise policy makers on women in agricultural development at both national and international levels using research finding and other information
- Assist women in implementing agricultural development projects and programs, and in mobilizing the necessary resource. All development programs should give greater recognition to women's special needs such as income generating activities and control of income, education and training opportunities and promoting technologies that reduce women's workload.
- Recognition of women's role and contribution to social and economic development in general and that of agricultural development in particular by planners and policy makers would help to enhance the status of women and increase food security at household and national level.

- Undertake studies to identify obstacles preventing women's participation in decision making at all levels and. Increase availability and accuracy of gender desegregated data.
- Encourage labor and time saving technologies that can help women to participate in social, economic, educational and political activities.
- Integrate gender diminution into national policy, strategies and structures.
- Promote the role of women in resource allocations, decision and policy making process.
- Assist in the establishment of women and mixed gender organizations and associations, cooperatives credit and saving unions, etc., Education appears to increase the ability and willingness to reallocate resources efficiently.
- Assist women to benefit from agricultural extension service and develop agricultural extension menu of extension models from which individual women and men groups could choose. Even if agricultural extension service puts more emphasis on reaching women farmers, it may lack the appropriate technology to recommend. Most of the technical improvements are geared to tasks largely performed by men, such as plowing rather than weeding. When technological innovation do address women tasks, women can be encouraged to become self-reliant and productive. Areas of agriculture that women require in developing food production and processing such as butter making, weeding, hoeing, pounding and grinding grain and *kocho* processing require a great deal of women's time and energy. Thus, research should be able to reduce women workload in such areas by developing and promoting new technologies.
- Train women individually and in group on gender concerns, leadership and assertions and on business management and investment techniques in agricultural fields to increase opportunities for economic gains.
- Encourage the enrollment of girls in agriculture at higher learning institutions to increase the number of female agriculture professionals, researchers, decision makers and extensionists.
- Integrate gender concerns in government and non-government development programs and projects agricultural development should tackle the causes of women's poverty and promote equal opportunity for women's and men's development. Since most women are in a subordinate position, especial effort and resources are required to promote their involvement and active participation in development. There is a positive policy environment and legal support to enhance the status of women and to establish a more sustainable development in Ethiopia, and this can be made effective by mainstreaming gender concerns in all sub-sectoral programs of agriculture including livestock.

Population, Food Security and Women

The demand for food is directly associated with the size of the population. A rapidly increasing population requires a fast increase in agricultural production to maintain the current level of consumption. If the minimum required per capital food intake of 2100 kc is to be satisfied, 130-9 million quintals is required. Minimum erratic rainfall and unpredictable climatic change, coupled with high population growth rate, are likely to cause challenges in adequately feeding the population. Hence, a decline in the fertility rate of women and in the total number of population would reduce the demand for more food and ease the problem of food deficiency in the years to come. On the other hand, resource depletion is based on the number of people using the limited resource. Rapid population growth undermines the environmental resource base upon which sustainable agricultural development depends.

The accelerated degradation of the forest resource throughout Ethiopia represents the most profound ecological challenge for decades to come. According to NOP (1997) wood charcoal accounts for 62% of the total household energy in urban areas and 66% in rural areas. Dung and crop residuals together account for 27% and 34% in urban and rural areas, respectively. The impoverishment of the biological resource base has a negative impact on agricultural productivity. Deforestation leaves the top soil exposed to rain and wind, and soil erosion leaves farmers vulnerable to crop failure.

Women and Population

The issue of women and population is critical for their advancement. Population growth and female fertility rate affects women's productive and their reproductive behavior. When young boys and girls lack basic population and family life education they tend to marry young and are exposed to unwanted pregnancy, illegal abortion and may drop out of school. Rapid population growth affects food accessibility and the nutritional status of women. Women's nutritional health would be severely affected when food resource becomes scarce. A number of studies indicate positive relationship between increased fertility rate, child mortality rate, foetal death, low birth weight and other pregnancy related problems. Rapid population leads to the migration of men to towns leaving behind women and their children. Thus women are exposed to the difficulty of heading their household with scarce resources.

When women marry young they begin to have children as early as 14 and 15. The issue of child spacing is hardly practical and this result on a level standard of living which then affects the women's health and their ability to care for their children. Having too many children born with frequent intervals affects the participation of women in development activities including agricultural production. Rapid population growth also leads to environmental degradation and the depletion of vital resources such as water and fuelwood and women have to walk long distances in search of the scarce resources. In most communities of Ethiopia women parents consider children as economic value and old age security. Furthermore, women tend to have many children because of the rate of infant and child mortality which could be prevented by proper health care including family planning practice and proper nutritional habits and practices.

The age at marriage for an average Ethiopian woman is 17 years and for developed countries 25 years. Early marriage leads to high incidence of maternal and child mortality and fertility rate. The level of education attained by women is strongly associated with decline in child death of between 5–10% particularly in poor countries with limited health care and other resources. Education combined with the availability of family planning services has the most powerful influence or family size. Educating girls is three times more likely to lower family size than educating boys. Educated women not only want fewer children but they are also likely to use contraceptive successfully and to limit their family size. Women with more schooling tend to marry and have children late which will contribute to having smaller family size and reduce their fertility rate.

When program planners accept women's contribution to food security and economic development and design programs aimed at maximizing their productive capacity women's fertility rate would be reduced naturally. Thus, to overcome population-related problems affecting food security, sustainable agricultural development and the empowerment of women the following areas of action should be given priority consideration.

- Enhance socio-economic development.
- Integrate population programs with major development sectors to harmonize population growth with socioeconomic development.
- Integrate gender issues in all development sectors to give women the opportunity to gain greater control over their reproductive lives and be able to participate in gainful economic activities.
- Provide attention to adolescent reproductive health.
- Strengthen effort to increase male involvement in reproductive health and family planning programs.
- Address harmful traditional practices to eliminate cultural practice affecting the health and well-being of the population.
- Establish high level political and public support for population programs.
- Create balance between population growth and sustainability of natural resource management.
- Integrate gender and population information in education within agricultural extension and information systems.

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GENDER DIFFERENTIALS IN SMALLHOLDER LIVESTOCK PRODUCTION IN THE CENTRAL HIGHLANDS OF ETHIOPIA

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ABSTRACT

Many studies that focused on household-level factors have not looked into gender differentials. A study was conducted in Ada, Lume and Gimbichu weredas of the central highlands of Ethiopia to assess the gender differentials in agricultural production and decision making among small holder farmers. The evidence derived from this study shows that the different classes of livestock kept and the reasons for doing so are not significantly different in both male headed and female headed (de jure) households. The average number of the different classes of livestock owned by male headed households in general was significantly different from that of the female (de jure) headed households. The right to purchase and sale any of the different classes of livestock is mainly the responsibility of the female head in female headed households. In the case of male headed households, the husband and the wife have differential control depending on the type of livestock under question. The Spearman one-tailed significant test showed a negative and weak correlation between the number of cattle owned and use of manure as soil maintenance in both female- and male-headed households.

Introduction

Gender differentials in the decision making processes of the farm household chores play significant role in the economic performance of the household. A great deal of empirical research has shown that gender is important in defining the economic role of rural peoples in Africa (Dey 1980 and McSweeney 1979). There is thus a growing recognition that men and women often have different rights and responsibilities in resource use and decision making in agricultural production process.

In gender analysis, the roles of women and men are largely determined by social than biological factors (Rosaldo and Lamphere 1974). This recognition has resulted in several studies documenting the different roles of women and men in farm, non-farm, food preparation, household maintenance and child care activities (McSweeney 1979, Dey 1980, Whitehead 1985, Adepoju and Oppong 1994 and Bryceson 1995). Some studies have also shown that women and men are faced by differential access to new technology, education, health care and other resources (Ahmed 1985, Abu and Oppong 1987 and Stamp 1989). Besides, both gender- and household-based approaches have been realized as useful frameworks for targeting policy and interventions in rural areas (Warner et al. 1997).

This study attempts to add to the growing empirical evidence on the role of gender in agricultural production in general and livestock production in particular. It assesses the role of gender in resource ownership and decision-making process in livestock production in the mixed farming systems of Ada, Lume and Gimbichu weredas in the central highlands of Ethiopia. The specific objectives were to determine the differential access to and control of resources of male- and female-headed (de jure) households and compare differences in decision-making processes in livestock production.

Study Area and Data Collection

Study Area

Ada, Lume and Gimbichu weredas that were covered in this study are found in the central highlands of Ethiopia where mixed crop–livestock production is predominant. Ada Wereda, 40 km southeast of Addis Abeba, covers 1750 km^2. The largest part of Ada (66%) lies above 1800 m (Gryseels and Anderson 1983). Much of the land in Ada is eroded and poorly drained. July and August are the wettest months while April and May are the hottest. Lume Wereda lies northeast of Debre Zeit at altitudes ranging from 1700 to 2100 m. July and August are the wettest months while April, May and June are the hottest. Gimbichu Wereda, lying at an average altitude of 2450 m, borders Ada on the northern side of Debre Zeit. July and August are, on average, the wettest months. The major soil type in all weredas is Vertisol. The major crops grown are tef, wheat, chickpea, lentil, faba bean, maize, barley and haricot bean. The major classes of livestock kept include cattle, small ruminants, poultry and equines (Workeneh 1989).

Data Collection

The gender-disaggregated data used for the analysis were collected in 1996–1997. Multi-stage random sampling was used to select peasant associations in each wereda. On average, 90% of the households were found to be male-headed, while only 10% were female-headed. Female-headed households were those that were managed by widow, divorced or single women without the mediation of a husband, father or male relative in the routine day to day activities of that household. Male-headed households were those in which a husband was present and was the final decision maker in the important issues pertaining to the household (Starkey et al. 1994). The male and female (de jure) households were purposively sampled in order to include enough female-headed households. This resulted in a sample of 180 household heads (60 in each wereda). Of the sampled households, 99 (55%) were male-headed, while 81 (45%) were female-headed. The households were more or less homogenous in types of crops they grew and their farming practice. Descriptive statistics such as cross tabulations and one-way t-test were used.

Results and Discussion

Socioeconomics of Female- and Male-Headed Households

A summary of the socioeconomic characteristics of male- and female-headed households is shown in Table 1. There was significant difference in the average size of male-headed (7.9 persons) and female-headed (5.8 persons) households (t = 5.9; sig. = 0.00). However, except for daughters (t = 4.0, sig. = 0.00), there was no significant difference between male- and female-headed households in the number of other members of the family. In general, female-headed households were found to be smaller in size than other households in developing countries (Buvinic and Gupta 1997). This implies that the male-headed households might have more labor available than female-headed ones.

Furthermore, it has been observed elsewhere in Africa that female farmers also tend to limit their labor time in farm activities due to heavy commitment to domestic chores (Chipande 1987). Thus, male-headed households are able to undertake their farm operations in a more timely fashion, which leads to higher productivity, than female-headed households. This is because in ox-plow culture, women do not usually plow and depend on share-croppers (other farmers of the nearby area who are willing to do the job) which delays the farm operation. Since labor is one of the critical resources needed to effectively carry out farm operations and to adopt improved technologies, male-headed households, according to this study, will have better chance of benefiting from the opportunities that could be derived from readily available

Table 1. Socioeconomic characteristics of female- and male-headed households in Ada, Lume and Gimbichu weredas, 1996/97

Particulars	*Female (N = 81)*	*Male (N = 99)*	*T-value*
House size (no.)	5.8	7.9	5.9*
No. of sons	2.4	2.7	1.4 (NS)
No. of daughters	1.9	2.8	4.0*
No. of relatives	1.8	1.7	-0.16 (NS)
No. Of non-relatives	1.6	1.6	-0.13 (NS)
Age of household head	47.2	47.5	0.13 (NS)
Access to education(%)	14.4	37.2	
Farming as main occupation (%)	100	97	
Farm size (ha)	2.4	2.9	2.36 (NS)

NS = not significant; * = significant at one percent

Table 2. Average number of livestock classes owned by male- and female-headed households in Ada, Lume and Gimbichu weredas, 1996/97

Livestock class	*Female (N = 81)*	*Male (N = 99)*	*T-value*
Cattle	4.9	6.4	2.92*
Equine (donkey and mules)	0.6	0.9	3.1*
Sheep	1.8	1.8	-0.17 (NS)
Goat	0.8	1.2	1.3 (NS)
Poultry	2.5	3.4	1.67 (NS)

NS = non-significant; * = significant at one of percent

Table 3. Responsibilities for livestock activities in male- and female-headed households in Ada, Lume and Gimbichu Weredas, 1996/97

Activity	*% family member responsible*				
	Female (N = 81)		Male (N = 99)		
	Head	Other	Husband	Wife	Other
Animal feeding (%)	38.2	61.8	58.9	20.5	20.1
Animal treatment (%)	31.1	68.9	31.1	6.8	62.1
Animal slaughtering (%)	35.6	64.4	35.6	1.1	63.3
Animal transport (%)	41.1	58.9	41.1	2.6	56.3
Animal product processing (%)	3.3	96.7	3.3	60.9	35.8

family labor. Similarly, elsewhere in Africa, it has been shown that labor constraint in female-headed households limits adoption of innovations (Chipande 1987).

There was no significant difference in average age of male (47.5 years) and female (47.2 years) household heads (Table 1). Nearly 86% of female household heads were illiterate, 12% attended literacy classes while 1% had primary and secondary education. In contrast, 63% of male household heads were illiterate, 25% had attended literacy classes while 10% and 2% had primary and secondary education, respectively. In general, there was a difference in access to education between male and female household heads. Other studies have found similar results. For instance, in Uganda more than half of the women household heads received no schooling compared to less than a quarter of their male counterparts (Appleton 1996). In Tanzania, 96% of male-headed households had some formal education while 82% of female-headed households had none (Bisanda and Mwangi 1996). Hence, due to their higher education, male-headed households tend to have higher productivity as they are better able to decode new production technology than female-headed households. All female-headed households had farming as their main occupation since the poor educational level of female household heads did not give opportunities for employment in the off-farm labor market. Hence, policies that expand education will open better access to economic opportunities for female-headed households.

Livestock Ownership

The types of livestock owned by female- and male-headed households is shown in Table 2. There was a significant difference in ownership of cattle between the two grow. This could be attributed to the prevailing culture where women are not allowed to plow land as a result of which the number of oxen they own could be fewer than that men own. Furthermore, as starkey and colleagues (1994) report, the extra labor involved in managing animals has discouraged female-headed households from owning oxen. As a result, the relatively large number of cattle owned by male-headed households enables them accomplish farm operations ithout delay since it ensures a relatively adequate supply of draft power. The number of ivestock owned also affects the adoption of technologies positively (Chilot et al. 1996).

Keeping sheep and goats is not common for both female- and male-headed households and there was no significant difference in ownership of small ruminants between the two groups (Table 2). There was a significant difference in the ownership of equines (donkeys and mules) between female- and male-headed households (Table 2). This is because, even though both male- and female headed households use equines, predominantly donkeys, for transporting their produce to the market, male heads often ride mules which is quite uncommon among female heads. There was no significant difference between female- and male-headed households in the ownership of poultry (Table 2).

Gender Division of Labor for Livestock Production Tasks

Members of a farm household are responsible for differnt livestock keeping activities. In male-headed households, the husband is mainly responsible for animal feeding, treatment, slaughtering and transporting; while the wife is mainly responsible for processing animal products. The other members of the family mainly assist in animal treatment, slaughtering and transporting. In female-headed houeholds, on the contrary, other members of the family have the main responsibilities for all livestock activities (Table 3.)

But it is important to note that in Ethiopia, even the sexual division of labor, and gender roles in general, vary from one cultural setting to another depending on whether the plow or the hoe is the main means of cultivation. For instance, in some areas women do not sell or buy bulls, oxen, heifers or cows (Dessalegn 1991).

Control Over Livestock Output

As in most areas in Africa or Ethiopia, women in the study area, whether in female- or male-headed households, make central decisions in consumption and selling of livestock and livestock products and in keeping of the proceeds, in an attempt to optimize family welfare

(Chipande 1987 and Dessalegn 1991).

The decision to sell livestock was made 90% of the time by the husband in the male-headed households, while it was made by the head 95% of the time in female-headed households. In female-headed households decisions to keep proceeds from sale, look after the produce and consumption of the produce were mainly made by the head. But in male-headed households these decisions were jointly made (Table 4).

Livestock are not commonly sold live in the study area except poultry. It should be kept in mind that livestock are traditionally not raised to be sold, but to be used within the framework of the subsistence farming system as draft and transport animals and as producers of milk, meat, hides, etc. They also provide financial security and are even wealth for many people, and they are not likely to be sold. These attitudes have to be understood and seen in their context (Brannang and Person 1990). However, selling of livestock products (milk and egg) and by-products (manure and skins and hides) was common. During the survey year there was no significant difference in the slae of livestock between male- and female-headed households. Although poultry is commonly sold (Tadelle and Oegle 1996), even that did not happen often during the survey year. Both male- and female-headed households had similar reasons for keeping different classes of livestock besides the proceeds from sale of live animals and animal products. The main reasons were consumption of by-products, draft power, consumption of main products and transport.

Similar to other areas in Ethiopia, farmers in the study area are aware of the advantages of using animal manure as fertilizer. However, only 8% of female- and 12% male-headed households used manure to maintain soil fertility. This is, firstly, because the number of livestock kept by farmers is limited by the scarcity of grazing land. Secondly, wood is scarce so farmers use animal dung as fuel. A study conducted by Teklu and Teklu (1995) shows that selling animal dung cakes, made from a mixture of manure and straw, has become a major source of cash income. Thirdly, land holdings are distributed widely making it difficult to transport the dung to every field (Behailu 1996). Moreover, there was a negative correlation between the number of cattle owned and the use of animal manure. The Spearman one tailed

Table 4. Decision making over livestock output in male- and female-headed households in Ada, Lume and Gimbichu Weredas, 1996/97

Crop/livestock output	*% family member making decision*					
	Male (N = 99)			Female (N = 81)		
	Husband	Wife	Both	Head	Son	Both
Decision to sell livestock	89.8	-	10.2	95.1	4.9	-
Decision to keep proceeds from sale	55.1	8.2	36.7	96.1	1.3	2.6
Decision to look after produce	49	4.1	45.9	84.6	1.3	12.8
Decision how much to consume from produce	27.6	-	72.4	94.9	-	5.1

significant test showed a negative correlation between the number of cattle owned and the use of manure in both male-headed (-0.23) and female-headed (-0.5) households. The decision to use manure in male-headed households was made by the head in most cases (60%) while in female-headed households the head made decision all the times.

Conclusion

The study revealed that male and female heads had different rights and responsibilities with respect to resource ownership and decision making in the process of livestock prodection. However, there was no significant different between male- and female-heded households in ownership of different classes of livestock and the reasons for keeping them. The average number of the different classes of livestock owned by male-headed households in general was significantly higher than that owned by female headed (de jure) households.

Gender division of labor by tasks of livestock production showed that in female-headed households much of the responsibility in livestock production was the responsibility of other members of the household like sons, daughters, relatives and non-relatives although female heads were also involved to a certain proportion. The scenario was the same in male-headed households except for animal feeding which was but the responsibility, to a large extent, of the head and animal product processing the responsibility of the wife.

As regards control over livestock output, both the heads in male- and female-headed households assumed the greatest responsibility. However, in male-headed households the joint decision between the head and wife accounted for significant proportion as opposed to the female head in which over 90% of the decision was made by the head alone.

Gender is culture neutral and interest in gender relations derives from its explanatory power as a primary organizing priniciple of society including agricultural production. Hence, the significance of gender should not only be seen as a means of categorizing household headship. It is also a key to understanding structures and actions including production relationships within and across households, setting goals and priorities, mobilizing resources, willingnes to take risk, and decision making vis-a- vis the rights to be derived from increased farm production. Given this, it is crucial for policy makers, technology generators and extension agents to recognise the importance of gender in the development of Ethiopian agriculture. It is particularly important to note that in their present status female-headed households are and will be disadvantaged if the technologies being developed and extended are knowledge and labor intensive.

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IMPACT OF MARKET-ORIENTED DAIRY PRODUCTION ON WOMEN AND CHILDREN: EVIDENCE FROM THE ETHIOPIAN HIGHLANDS

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ABSTRACT

This study investigates the intra-household consequences of market-oriented dairy production (MODP) based on the introduction of crossbred cows and complementary feed and management technologies. These technologies are being tested on-farm in a collaborative dairy technology project involving the Ethiopian Agricultural Research Organisation (EARO) (previously IAR), and the International Livestock Research Institute (ILRI). One major objective of the project is to develop technologies to enable resource–poor smallholder mixed crop-livestock farmers to participate in market-oriented dairying. The study reported here sought to identify the intra-household impacts of market-oriented dairy production and policy options to ensure that the technology benefits of MODP are realized and equitably shared within households. These and related issues were addressed in a collaborative study involving the Ethiopian Health and Nutrition Research Institute (EHNRI), EARO, and ILRI. Members of households with crossbred cows on average consumed 17% more calories, 24% more fat and 13% more protein than members of dairy households with no improved cows. The households with crossbred cows spent about 7% more on food purchases, and, in addition, they allocated more land to growing high-protein pulses and consumed about 30% as much pulses. The hypothesis that increased marketing activity would lead to less milk available for home consumption is rejected. Milk consumption in households with crossbred cows was found to be more than double that in households with local cows, especially benefiting children. Other studies in other areas have reported that as cash crops are introduced in smallholder production systems, with greater integration into the market women may lose control over cash income to men, who tend to spend less on food for the household. These results indicate that women in households with improved crossbred cows maintain control over income allocated for food purchases and make over 80% of household expenditures on food. Furthermore, the men in these households spend some 28% more on food than men in households with no crossbred cows. The anthropometric data collected by EHNRI point to the fact that the introduction of crossbred cows could significantly improve human nutrition and health. By the end of the study, stunting of children (height for age) was found to be less than half as prevalent in households with crossbred cows (20%) as in those households with local cows (43%). Results of this study show that food-based intervention can have a significant positive impact on human nutrition and health status.

The Problem

The introduction of crossbred cows and complementary feed and management technologies for increased dairy production results in commercialisation of smallholder farms. The milk is treated as a cash crop and integration into the market occurs. Such intensified, market-oriented dairying has the potential to make smallholder systems more viable and sustainable. The introduction of these technologies has been shown to substantially raise milk production and incomes where development efforts are market-oriented and demand-driven.

The introduction of these market-oriented technologies also results in substantial changes in terms of allocation of labor and other resources. The consequences for individual family members, however, are not clear. There has also been conflicting evidence regarding the consequences of the new technologies on intra-household decision making, including control of the benefits of dairying, thus effecting individual the household member's incomes and expenditures and consumption. The impacts on nutrition and health, especially as they effect the more vulnerable household members, women and children, are also not clear.

When market-oriented dairying is introduced, the milk is treated as a cash crop and the increased income may not be spent on more or better food or result in improved nutrition and health. It has been well established by nutritionists that if more dairy products are available and consumed there will be a positive effect on human nutrition and health (Neumann et al.1993). However, the nutrition and health impacts of increased milk production on individual members depend on intra-household resource allocation, income distribution, and the expenditures made with the increased income. The interactions between these intra-household decisions and individual outcomes need to be considered to ensure that all household members are reaping the potential benefits.

The problem, then, is that the links between the new dairy technologies, the increased production, the increased income, and improved human nutrition and health have not been established. Furthermore, the factors that explain varying outcomes and the policies or other interventions that would ensure positive impacts on all households members are not known.

Previous farm-level studies have shown that adopting crossbred cows and improved feeding and management strategies increases milk production and household income. What they did not show is how those changes affect intra-household decision making, including the control of new income by women, and the resulting impacts on the nutrition and health status of household members, especially those most vulnerable, mothers and children.

Background and Justification

Improving human nutrition, including micro-nutrition, are critical elements of achieving food security and are compelling and priority concerns of development efforts in Sub-Saharan Africa. Interest is mounting in the donor and nutrition communities in food-based approaches (dietary change) to combating nutrient- and micro-nutrient deficiencies. The essential role of livestock, and more particularly the potential for dairy to combat these problems, may have been overlooked or understated.

Food-based approaches (dietary change) to combating nutrient- and micro-nutrient deficiencies are more sustainable than chemical supplementation (such as vitamin A tablets) (Neumann et al, 1993). There is a need to document that the food-based approaches do indeed make an impact and are sustainable. Not only the nutrition community, but also agriculturalists, have an interest in showing that food-based approaches can improve the wellbeing of the members of poor rural households. This includes establishing that positive nutrition and health impacts can occur when the incomes of household members are raised through market integration, making food more accessible through markets.

Livestock products, and especially dairy products, can make unique contributions to nutrition, and especially the micronurient and health status of smallholder household members. Contrary to the developed world where many people eat too much animal products, most people throughout Sub-Saharan Africa eat too little animal products for good nutrition. Under these circumstances, increased milk consumption has a significant positive effect on the nutritional status of household members, especially children.

Besides containing important nutrients, especially carbohydrates, protein, and calcium, dairy products contain micronutrients in bioavailable form such as vitamin A (retinol), the B-complexes and zinc, essential for growth and proper physical and mental development. Evidence is mounting that the bioavailability of Vitamin A in carotene-rich leafy-green vegetables is much lower than previously believed (de Pee et al., 1995 and Gillespie and Mason 1994). Studies done by the Human Nutrition CRSP in Kenya have shown that children deprived of vitamin B12, which comes only from animal products, suffer impaired learning abilities and do not develop their full human potential (Neumann et al., 1993).

The introduction of these market-oriented technologies results in substantial changes in terms of allocation of labour and other resources. The consequences on individual family members, however, are not clear. A study conducted in the early 1980s by International Livestock Center for Africa (ILCA) indicated that the introduction of crossbred dairy cattle to the Debra Berhan area of the Ethiopian highlands provided a number of advantages to the household as a whole (e.g., higher milk output and incomes) (Wagenaar-Brouwer 1986). At the same time, however, the new technologies increased the labor demands placed on women (Whalen 1983, 1984). To the contrary, meanwhile, later studies by MoA/FINNIDA (1991) in the Selale region showed that while women's labor time was increased, it was the overall labor time of men that increased the most (MoA/FINNIDA 1991).

There has also been conflicting evidence regarding the consequences of new crossbred cow technologies on intra-household decision making and control of the benefits of dairying, thus effecting individual household member's incomes and expenditures, and consumption. In the Debra Berhan area, women were reported to process most of the milk from local cattle breeds into butter before the introduction of crossbred cows and to spend most of this income on food for household consumption. Introduction of these higher productivity animals resulted in more direct sales of fresh milk by men. Men were reported to control this income from fresh milk sales, but it is not known what became of this income (Whalen 1983, 1984). Two years after the end of a development project at

Selale in Ethiopia, the International Livestock Research Institute(ILRI) began evaluating the effects of these technologies on farm households. The results there showed that although the income from fresh milk sales was more likely to be controlled by men, it went to food items and agricultural inputs, and per capita food consumption increased. The men did not spend the additional income on other non-food consumption items such as drinking.

In the Debre Berhan study, average daily energy intake was slightly higher for the non-adopting households (Wagenaar-Brouwer 1986). There were large seasonal differences in the intake of livestock products. However, 8% of calories of the adopting households on average were provided by livestock products and only 4% for non-adopting households. Per capita milk consumption (whole milk plus buttermilk) was twice as high among adopting households as compared with non-adopting households. No analysis was undertaken of differences in micro-nutrient intakes between adopting and non-adopting households or between seasons. Furthermore, the nutritional analysis was not done at the individual household member level. Thus, the impacts of market-oriented dairy production on nutrition and health, especially as they effect the more vulnerable household members, women and children, are not clear. Most studies have evaluated the impacts of new technologies only at the household, rather than at the intra-household level, and have not included explicit indicators of the consequences for human nutrition and health. The intra-household consequences of crossbred cow technologies need to be assessed to ensure that all household members are reaping the potential benefits.

Objectives

This study investigates the intra-household resource allocation, income, expenditures, food consumption, nutrition and health consequences of intensive dairying. The objective is to document the impacts on household members and identify policy options that could help ensure that the benefits of the new technologies are shared equitably by all household members. To fully understand the impacts of the technologies, intra-household decision making must be understood, and the complex intra-household relationships and consequences have to be investigated. A number of sub-issues thus need to be addressed that together provide a picture of the impacts on all household members.

Conceptual Framework

The conceptual framework depicted in Figure 1 visualizes the linkages to be investigated in this study. It provides an understanding of the effects on intra-household decision making and outcomes brought about by the introduction of market-oriented dairy production (MODP) with crossbred cows. These effects are those occurring in the short run.

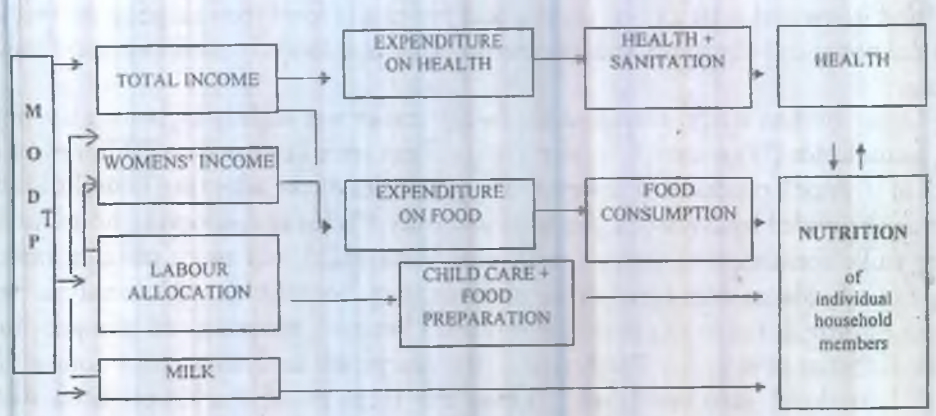

Figure 1. Flow-chart conceptualizing the linkages between the introduction of MODP and intra-household impacts expressed in the hypotheses

There are other factors related to the introduction of MODP influencing resource allocation, incomes, expenditures, consumption and nutrition that could also be expressed as variables and need to be investigated to provide a full picture of the impacts of market-oriented dairying. Very important ones are the prices for food and non-food items, the education of parents, especially mothers, mother's nutritional knowledge and the overall health environment. Most of these factors not addressed in the Figure 1 are not specific, however, to whether MODP technologies are adopted or not.

The Farming System

The study area is located in the Ethiopian highlands, about 40 km west of Addis Abeba in the vicinity of a small town called Holetta. The altitude of the research area is about 2600 m. Average annual rainfall is 1100 mm with mean daily temperature of less than 20 0C. The main rainy period starts in mid June and continues up to September and is called the meher season. The short rains season or bulg is from February to April and is mainly used to break the soil. Farmers in Holetta mainly depend on the meher rains to plant crops.

The farming system in the study area is classified as a mixed crop–livestock system. The group of technology adapter (CBC) farmers have larger landholdings of 2.8 ha compared to 2.1 ha for control (LBC) farmers and keep less livestock per hectare. The average land area cultivated by all households comprises 1.5–2.0 ha and livestock holdings are equivalent to 8.1 TLUs[1]. Main crops grown are tef, barley, wheat, and various types of pulses.

CBC farmers keep fewer, but more productive animals (the cross bred cows). TLU/ha for MODP households is 3.2, for non-adopters it is 3.5. This difference is not significant at the 0.1% level indicating the wide variation in livestock holdings. The average animal herd consists of 2 cows, 2 oxen, a horse or a donkey, and a number of sheep and chicken. While the LBC farmers exclusively own indigenous cows, the CBC group own indigenous and crossbred cows.

Households at Holetta comprise a family unit of husband, wife and children. Often they live together with other relatives and accommodate a farm employee, who usually is related to the family, as well. The average household size of the sample farmers is about 6.2 people. Households have an average of 4 children. This equals an agricultural labor force of 3.5 adult male equivalents with a very small and insignificant difference between the two groups under study.

To obtain more meaningful labor, food consumption, expenditure, and nutrition assessment, household size can be converted into respective adult male equivalents. For agricultural labor, man equivalents were used (Norman et al. 1981). There are 3.1 man equivalents in CBC households and 3.2 in LBC households. For food consumption, expenditure, and nutrition assessment, adult consumption equivalents were used. There are 4.7 adult equivalents in CBC households and 4.9 in LBC households. Adult consumption equivalents were calculated using WHO/FAO conversion factors (Michael 1985).

Data

The data for this study were provided by a collaborative dairy technology project involving the Ethiopian Agricultural Research Organization (EARO), and ILRI. One major objective of the project is to develop technologies to enable resource-poor smallholder mixed crop–livestock farmers to participate in market-oriented dairying. Another major objective is testing the use of crossbred dairy cows for traction, as well as milk production.

Pairs of crossbred dairy cows were introduced on 14 farms in Holetta in 1993, half for milk production only, and half for traction as well as milk production. On-farm mean milk yield and average lactation days were not effected very much by traction. Thus, the use of the crossbred cows for traction by households, in addition to dairy production, is not considered of relevance for the purposes of this study.

In 1995 and early 1996, 120 more crossbred cows were introduced into an additional 60 households that were all using the cows for traction, in addition to milk production and reproduction. About 60 control households using traditional practices of local zebu cows for milk production and oxen for traction are also being followed since mid-1996.

There were then 134 households who were surveyed for one year from October 1996 through September 1997. The 134 households, in two groups of 74 with crossbred cows and 60 without, were further stratified into three resource-endowment groups, relatively rich, middle income and poor.

Intensive farm-level data collection was carried out daily for this aspect of the study on 84 farm households during 1997. Special attention was given to the nutrition and health effects on children and women since they are at most risk. The target population of the study thus included all members of households with pre-school children 6 months to 6 years old. These households include both those that were using the new technologies and those following traditional practices. Data collection included land use, labor allocation and activity times, draft power use and source, input use, output use and price data to enable a whole-farm analysis to evaluate the potential of dairy–draught, intra-household data on resource allocation, income distribution, and expenditure by household member. Food availability and food intake by household member were also collected.

Anthropometric measurements (weight for height, weight for age and height for age) were taken by the Ethiopian Health and Nutrition Research Institute (EHNRI) on women and pre-school children in all the households. Anthropometric measurements were focused on pre-school children 6 months to 6 years old since they have relatively high risks of developing nutrient-deficiency related health problems. Furthermore, due to their key position in ensuring food availability for all household members, child health care measures and the nutritional knowledge of mothers was assessed. Environmental health factors, child care and health care measures, child morbidity, and mothers' nutritional knowledge were also assessed.

Analytical Methods

Whether the introduction of MODP affects resource allocation, especially the farm and other labor patterns of women, farm production, and income distribution and expenditure patterns was tested through statistical comparison of households with (CBC) and without (LBC) crossbred cows and the intensified dairy production technologies. Comparison of income distribution and expenditure patterns of adult male and female household members was also carried out. The comparisons aimed to provide the basis for a more comprehensive assessment of the impact that market-oriented dairying with crossbred cows has on food consumption and child nutrition of participating households. Descriptive statistics, including analysis of variance, were used to describe and compare households with and without the crossbred cows and complimentary dairy technologies.

Results

Production and Labor Allocation

Milk yields of crossbred cows in intensified smallholder production systems can exceed those of local cows by up to 6, even 8 times. In a conducive peri-urban marketing environment this leads to doubling, even tripling of farm cash income (Gryseels and Whalen 1984 and Mengistu Buta 1997). In the study region, milk production per crossbred cow is about 5 times higher than for local cows.

Table 1. Weekly average family and hired labor for all dairy activities (in agricultural adult labor man equivalents)

	Family labor (hr)			*Hired labor (hr)*	
Group	Men	Women	Children	Men	Children
CBC	10.9	2.7	24.7	5.4	10.4
LBC	4.8	1.8	25.1	0.5	0.5

*CBC, The group of farmer households with crossbred cows
LBC, the group without crossbred cows (control)

Members of adopting and non-adopting households spend slightly more time in animal husbandry, but CBC households hire more labor, both men and children, than do LBC households (Table 1). There was not much seasonal variation in time spent in animal husbandry, although there is considerable seasonal variation in labor devoted to crop production. Children (as herders), and, to a lesser extent men were found to be primarily responsible for animal husbandry.

The introduction of peri-urban dairy technologies (MODP) does not increase the time women spend on animal husbandry and would not be expected to change women's time allocation patterns (labor supply) the other activities. Thus, the minimal impact on time spent on household activities such as child care and food preparation would not be expected to negatively impact on child nutrition and health.

Income Impacts

To what extent do the MODP increase farm household incomes at the study site? And especially the incomes of women? Previous studies at various sites in the Ethiopian highlands, as well as in Kenya, Uganda and India, have shown that cash incomes of CBC households increase significantly as a consequence of higher milk production and increased commercialization of dairy products (Gryseels and Whalen 1984, Kennedy 1987, Walshe et al. 1991, Ehui et al. 1995, Sanders et al. 1996 and Mengistu Buta 1997).

As indicated in Table 2a, cash income from dairying at the study site was found to be significantly higher in households that keep crossbred cows (25 Ethiopian Birr per adult equivalent (4.7 adult equivalents per CBC household) per month) than in households that keep local cows (3.6 Birr per month) (4.9 adult equivalents per CBC household). Moreover, both men and women were observed to benefit, with men making an average income of 15.2 Birr per month and women 9.6 Birr.

Cash incomes of farmers with intensified dairy production are more about 75% higher than that of those farmers using traditional production methods. CBC owners earn almost 7 times more income from the sale of dairy products than control farmers. This difference is attributable mainly to liquid milk marketing. CBC owners have slightly more income (about 20%) from animal sales, primarily cattle and particularly crossbred cattle.

Table 2b documents that CBC owners also have more off-farm income. This is mainly due to wage labor and farm-related businesses, primarily production of tej, a local beer, and renting out of draft animals. Perhaps due to the ability to hire labor, CBC households can allocate more time to off-farm income earning activities. The share of off-farm to total cash income is about 39% of the total cash income for CBC households and 17% for LBC households.

An important issue is whether the introduction of intensified, market-oriented dairying with crossbred cows makes women better or worse off and who controls the income from the new commercialized activity. It has been reported that under traditional dairy production practices, almost the entire milk yield is usually processed into butter, an activity exclusively undertaken by women, who also sell the butter at the local market and retain the money for the purchase of household consumption items (Whalen 1983).

Table 2a. Monthly cash income from farm production sales

Cash income source	*CBC*		*LBC*	
	Average	Coef. of variance[a]	Average	Coef. Of variance[a]
	(Birr/adult equivalent/month)			
DAIRY SALES				
Total	24.9**	0.9	3.6**	3.6
Milk	20.3*	1.0	1.0**	6.5
Butter	3.0	1.7	1.7	2.8
Cheese	1.6	1.7	0.8	2.6
ANIMAL SALES				
Total	10.4**	1.6	7.9**	2.2
CBC sales	6.0*	3.2	0.0	6.3
LBC sales	3.2	2.1	5.6+	3.6
Other animals	1.2	2.9	2.3	2.2
Livestock products	0.3		0.4	
Farm-related business	3.7		3.0	
Sales	17.6	1.1	17.7	0.7
Total farm cash income	57.0**	0.7		

+Significant at the 0.1 level; *Significant at the 0.05 level; **Significant at the 0.01 level
[a]Coef. of variance = standard deviation/mean

Table 2b. Monthly cash income from farm production sales and off-farm sources

Cash income source	CBC		LBC	
	Average	Coef. of variance	Average	Coef. of variance
	(Birr/household equivalent/month)			
Total cash farm income	57.0**	0.7	32.6**	0.6
Dairy sales	24.9**	0.9	3.6**	3.6
Animal sales	10.4**	1.6	7.9**	2.2
Crop sales	17.6	1.1	17.7	0.7
Livestock products	0.3		0.4	
Farm related business	3.7		3.0	
Total cash off-farm income	36.2	1.4	6.7	2.9
Total cash income	93.2**	0.7	39.2**	0.6

+Significant at the 0.1 level; *Significant at the 0.05 level; **Significant at the 0.01 level;
Coef. of variance = standard deviation/mean

As indicated in Table 3, husbands apparently gain more of the additional income through milk sales. Their cash income from fresh milk sales is about 13 times that of LBC owners. However, the anticipated negative effect on female income does not take place. The incomes of women in CBC households are almost 4 times that for women in LBC households. In addition to increases mainly from the marketing of fresh milk by husbands, wives gain additional cash income through more sales of butter and cheese, products traditionally produced by women. Whereas women in LBC households realize more income in relative terms, in absolute terms it is the women in CBC households who gain most. Women in CBC households still realize about 63% of total dairy income. It can be observed thus that the distinction between male and female responsibilities in marketing of dairy products is not as rigid as expected. Wives of adopting households market large quantities of fresh milk under the changed production system. Income from milk sales by wives is twice the increased cash income from cheese and butter sales combined.

The hypothesis that women lose control over dairy income is rejected. The effect on food expenditure, needs also to be considered and is discussed in the next section.

Expenditure Impacts

Expenditures documented in this section are cash expenditures on farm inputs, food, and other nonfood commodities. Expenditure levels and patterns can be expected to change as a result of higher and more readily available cash income from the dairy operations. This has been documented for other examples of agricultural commercialization (Kennedy 1987, von Braun 1995).

Table 3. Dairy income from milk, butter and cheese sales of wife and husband by technology group

		CBC		*LBC*	
Income source	***Responsibility***	Average	Coef. of variance	Average	Coef. of variance
		(Birr/adult equivalent/month)			
Milk	Husband	15.1**	1.2	1.0**	6.4
	Wife	5.2**	2.4	0.0**	5.0
Butter	Husband	0.1	4.6	0.0	6.0
	Wife	2.8	1.6	1.6	2.8
Cheese	Husband	0.0	4.8	0.1	6.2
	Wife	1.6	1.8	0.8	2.5
Total	Husband	15.2**	1.2	1.1**	6.3
	Wife	9.6**	1.8	2.4**	2.7

**Significant at the 0.01 level

For the surveyed households differences in levels and patterns of cash expenditures between CBC and LBC owners exist, although not to the extent experienced at other sites under commercialization of production. These differences mainly occur within the non-food categories of commodities. CBC households have higher cash expenditures for farm inputs, transportation, tax and debt repayment, milling and clothing, which add up to higher but not significantly different total cash expenditures. CBC households purchase significantly more animal feed and animal health and AI services (Table 4). CBC households exclusively purchase seeds for pulses and vegetables, however, protein and vitamin-rich crops that can significantly effect consumption and nutrition.

Research elsewhere has shown that wife and husband have different responsibilities to provide for family needs utilizing the respective income they control. Expenditure patterns usually depend upon the amount of money they have at their disposal and on social and cultural norms. It is widely believed that women spend more income on food (Quisumbing et al.1995). A comprehensive analysis therefore has to carefully investigate if changes in income control occur between husband and wife and if these changes adversely affect food consumption and nutrition.

As shown in Table 5, women in both CBC and LBC households spend more income on food items than men, over 80% more in both groups. However, with the introduction of the MODP technologies, the men in CBC households increase their purchases of food by about 28%. Women in CBC households, meanwhile, only increase their expenditures on food by about 4%. Thus, women in CBC households do not lose control of cash income, and expenditures on food do not decline with the introduction of the MODP technologies.

Table 4. **Cash expenditure per household on farm inputs by technology group**

	CBC		*LBC*	
Expenditure type	Average	Coef. of variance	Average	Coef. of variance
	(Birr/month)			
Seed	1.9	2.0	1.82	3.2
Fertilizer and hertbicide	12.59	1.7	11.9	1.0
Animal feed	10.55*	2.0	3.33	3.6
Land rent	2.64	2.0	1.30	
Animal health and AI	13.69**	0.9	9.73**	4.4
Total	41.40	1.3	28.08	1.0

*Significant at the 0.05 level
**Significant at the 0.01 level

Table 5. **Monthly average expenditure per household on food and non-food items**

	Men		*Women*	
Group	Food	Non-food	Food	Non-food
CBC	10.04	99.99	55.83	29.59
LBC	07.85	45.32	53.75	22.43

Husbands, meanwhile, expend more on farm inputs, taxes and debt repayments and durable household goods. Wives of CBC households increase their expenditures on non-food items, using some additional income on purchases of cloth and transportation. Tax, trade and debt repayments, on the other hand, which are almost double for CBC households, remain the responsibility of husbands.

Consumption Impacts

It has been documented in several studies that technological change and commercialization of smallholder agricultural production improves the level of food consumption of participating households (von Braun and Kennedy 1994). Changes in food consumption are generally associated with more readily available cash income, but increased commercialization can lead to increased self-sufficiency through increased land and labor inputs into subsistence food production and changes in cropping patterns (von Braun et al. 1989). With higher incomes, a substitution of cheap calories for more expensive calories often takes place and diets gain in quality and diversity. Consumption and nutrition effected by technological change and commercialization have been attributed to income increases rather than higher milk availability (Binswanger and von Braun 1991 and Alderman 1987). Increased household calorie consumption associated with cash crop production schemes has been identified as one of the important determinants for improved child nutrition, although the scope of improvements often falls short of expectations (Kennedy et al.1994).

The calorie and nutrient calculations in this study were derived from a monthly 24-hr recall of foods consumed by the surveyed households. The different food components presented in Table 6 are calculated on the basis of the Ethiopian food composition tables (ENI 1984 and EHNRI 1997) and were converted to adult consumption equivalents (FAO/WHO 1985). The United States Department of Agriculture(USDA) has fixed the minimum calorie requirement for Ethiopia at 2088 cal per day per adult equivalent (USDA 1996). This is a very rough generalization, but a useful reference, although it does not take into account individual activity levels and energy needs. Out of all surveyed households, 30% do not meet this requirement, the majority belonging to the LBC household group.

As indicated in Table 6, intensified dairy production and commercialization is associated with significant increases in energy intake. CBC households consume almost 17% more calories than LBC households. This difference in energy intake corresponds to more fat and protein in the diet. CBC households consume 24% more fat and 13% more protein per adult equivalent. These results show significant differences in food consumption levels as well as diet composition between the two groups. CBC households eat more calories and derive more nutrients from dairy products.

Table 7 illustrates the diet composition of CBC and LBC households, which is expressed by their respective share of calories obtained from different food groups. Calories consumed in the form of dairy products is 2.5 times higher in CBC households. Significant increases are also recorded for pulses, but not for staples or meat. Vegetable consumption is not very common, primarily potatoes and onions are used.

Table 6. Energy and nutrient consumption per day by technology group in adult equivalents

	Food components						
	Calories (cal)	Fat (g)	Protein (g)	Carbohydrates (g)	Retinal (ug)	Iron (ug)	B-carotene (iu)
Technology group	(Per day/adult equivalent)						
CBC	2005.1**	19.6**	70.3*	458.6	38.8*	74.2	1809.3
	(0.2)	(0.5)	(0.2)	(0.2)	(2.0)	(0.3)	(0.8)
LBC	1716.6**	15.8**	62.1*	438.8	27.1*	65.6	1871.3
	(0.2)	(0.4)	(0.2)	(1.1)	(2.0)	(0.5)	(1.1)

The numbers in parentheses are the coefficients of variance.
**Significant at the 0.01 level; *Significant at the 0.05 level

Table 7. Diet composition by technologygroup expressed in share of calories in selected food groups

	CBC		*LBC*		*All*	
Food group	cal	%	cal	%	cal	%
	(Calories/food group/adult equivalent/day)					
Staples	1260	64	1066.7	68	1163.3	66
Mixed[a]	253	15	282.7	17	267.6	16
Pulses	321**	11	245.5**	8	283.2	10
Meat	15.0	0	8.2	0	11.6	0
Vegetables	63.7	3	59.5	3	61.6	3
Sugar and oil	39.5	3	21.7	2	30.6	3
Dairy	44.5*	3	17.5*	2	31.0	2
Total	1996.7**	100	1701.3**	100	1848.9	100

*Significant at the 0.05 level; **Significant at the 0.01 level

[a] Mostly kollo, a local snack which is a mixture of whole grains, often pulses

Calorie sources and in particular the positive change in retinal intake due to more dairy product consumption lead to the conclusion that CBC owning households keep enough of their dairy production for home consumption, to have a significant effect on nutrition. This is further emphasized by the assessment of per capita average weekly milk consumption (Table 8). All family members of CBC households profit from the higher milk yields. While priority in domestic milk consumption is clearly given to children, women and men gain as well. (Although these households increase their milk consumption to such an extent, they still market a far higher share of the produce.)

Nutrition Impacts

Does introduction of the peri-urban dairy technologies (MODP) improve macro- and micro-nutrient status of specific household members, measured by anthropometric measures and clinical signs? Children at the study side suffer exceptionally from eye problems closely related to vitamin A deficiency. In pre-study eye examinations undertaken by the Ethiopian Health and Nutrition Research Institute (EHNI) a high incidence of bitot spots and conjunctival xerosis, a pre-cursor of bitot spots, were found in a representative sample of 122 preschool children (EHNRI 1996). The World Health Organization has set a critical value for the prevalence rates of bitot spots, above which vitamin A deficiency should be considered a public health problem (West 1994). This value is exceeded by a multiple of twenty times in the children at the study site.

Table 8. **Average weekly milk consumption in liters by technology group disaggregated for family members**

	Average milk consumed (L)				
Technology group	Children	Women	Men	Household (L/adult equivalent/week)	Milk consumed/ milk produced (%/household)
	(L/capita/week)				
CBC	0.57'	0.04*	0.14*	0.55*	13.5**
	(1.5)	(2.1)	(2.5)	(1.3)	(1.3)
LBC	0.22'	0.004*	0.01*	0.13*	38.9**
	(2.2)	(3.0)	(2.8)	(2.0)	(0.7)

The number in parentheses are the coefficients of variance

**Significant at the 0.01 level; *Significant at the 0.05 level; 'Significant at the 0.1 level

Table 9. **Prevalence of chronic malnutrition among preschool children of CBC and LBC households in quarter IV**

	CBC		LBC		Total	
Prevalence	No. of children	% of CBC	No. of children	% of LBC	No. of children	% of total
Normal (≤ 2 SD)	54*	80	48*	57	102	67
Stunted (≥ 2 SD)	14*	20	36*	43	50	33
	68	100	84	100	152	100

*Significant at the 0.05 level

Most of these eye problems, however, are usually reversible when sufficient vitamin A is supplied. So long as children do not suffer from certain health problems, especially intestinal parasites, any increase of the micronutrient vitamin A in the diet will enhance their nutritional wellbeing appreciably. It is therefore promising to observe that the retinal content of foods consumed by CBC households is increased significantly. Retinal is a precursor of vitamin A exclusively derived from animal products.

In clinical assessment during the study, a higher number of eye problems were identified in LBC children. These eye problems are directly related to vitamin A deficiency. It is therefore encouraging to observe that children of CBC households, who have a comparably higher share of dairy products in their diets, suffer less from eye problems. It is possible that these children directly benefit from a high dietary content of retinal, a precursor of vitamin A, which animal products provide in a high bioavailability.

Ethiopia is one of the countries with the highest prevalence of stunting2 among preschool children in the world (UNICEF 1993). The immediate factors attributed to this high incidence of chronic malnutrition are insufficient food consumption in terms of quantity and quality, as well as poor health. The underlying factors are poverty-related and encompass a wide spectrum from inadequate income, lack of education, prevalence of infectious diseases, harmful infant feeding practices, to inadequate sanitation and hygiene (ENI 1993). Linkages between improvements in income and changes in the farming system related to intensification and commercialization of dairy production are complex and can alter immediate and underlying factors of child nutrition in a number of ways.

The assessment of changes in the nutritional status of 152 preschool children of the surveyed households aged 6 months to 6 years was conducted by means of anthropometric measurements. By the end of the one year study period, stunting[2], a parameter used to indicate chronic malnutrition, was found in 33% of all children (Table 9). This is far lower than the average of 64% for all children of this age group in rural Ethiopia (ENI 1993). There was a significantly lower prevalence of stunting in children of CBC households compared to LBC households; 20% compared to 43%, respectively. Wasting[3], a measure to indicate acute food deficit, was found in only 2 of the children in 2 of the CBC and 2 LBC households in the sample survey. Furthermore, there were no significant differences in morbidity between children of CBC and LBC households. The next stage in the research will be to determine which factors are related to lower stunting in CBC and LBC households.

Conclusions

Higher milk yields from market-oriented dairy production with crossbred cows result in higher milk consumption of individual household members, and accompanied improvements in nutrition, especially for children. Moreover, all household members, especially women, benefit from the new technologies, in terms of increased incomes and higher consumption.

Members of households with crossbred cows on average consumed 17% more calories, 24% more fat and 13% more protein than members of dairy households with no improved cows. The households with crossbred cows spent about 7% more on food purchases, and in addition, they allocated more land to growing high-protein pulses and consumed about 30% more pulses.

The hypothesis that increased marketing activity would lead to less milk available for home consumption is rejected. Milk consumption in households with crossbred cows was found to be more than double that in households with unimproved cows, even immediately after the crop harvest, when food availability is greatest. Children consumed most of the milk, men the next most and then women, but all family members benefited significantly.

Other studies in other areas have reported that as cash crops are introduced in smallholder production systems, with greater integration into the market women may lose control over cash income to men, who tend to spend less on food for the household. A key concern is that milk may be seen as a "cash crop" as milk yields increase. When this happens, men may take over marketing the milk and women, who typically spend their income on food and household essentials, may lose control of the income. Contrary to the findings of other studies, these results indicate that women in households adopting improved crossbred cows maintain control over income allocated for food purchases and make over 80% of household expenditures on food. Furthermore, the men in these households spend some 28% more on food than men in households with no crossbred cows.

The anthropometric data collected by EHNRI point to the fact that the introduction of crossbred cows could significantly improve human nutrition and health. By the end of the study, stunting of children (height for age) was found to be less than half as prevalent in households with crossbred cows (20%) as in those households with local cows (43%). Stunting, a measure of chronic malnutrition, is related to poverty and chronic illness as well as inadequate food. Chronic illness did not vary between households keeping crossbred animals and those not, but income was greater and more and better food was available from both food purchases and production, leading to the reduction in stunting.

The increased production and incomes from improved dairying make important contributions to three dimensions of food security–availability, access, and stability. Beyond increasing availability of and access to nutritious food directly through both increased production of dairy products and higher income, the large increases in both dairy products and income made possible by improved dairying can make vital contributions to the stability of smallholder household consumption. The far higher production response to improved feeding of dairy cattle made possible by the use of exotic breeds rather than local animals results in a more steady flow of milk production and income.

Results from this study of the human nutrition and health impacts of market-oriented dairy production with crossbred cows show that this food-based intervention can have a significant positive impact on human nutrition and health status. The roles and importance of the different factors involved in this dramatic change in production practices will be investigated in the next stage of the analysis.

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ENDNOTE

1.Tropical livestock unit, taking an animal of 250 kg liveweight as the basis for conversion factors for different sizes and species (H.J. Jahnke 1988 and Gryseels 1988)

2.Stunting isa height for age measurement indicating the prevalenceof chronic malnutrition by standard deviations from the median of the referencepopulation; standard deviation ≥ 2indicates stunting (WHO 1993)

3. Wasting is a weight for height measurement indicating the prevalence of acute malnutrition by standard deviations from the median of the reference population; standard deviation ≥ 2 indicates wasting (WHO 1993)

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EXPERIENCE OF COMMUNITY-BASED AND WOMEN-ORIENTED GOAT IMPROVEMENT PROGRAM

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Introduction

Livestock is an important component of nearly all farming systems. Cattle and small stock (sheep, goats and poultry) are often the integral part of the mixed farming system supplementing the nutrition and income of the smallholders. Goats are widely distributed throughout Ethiopia and are kept by the poorer segment of society. They are the source of meat, milk and other products. Apart from this, they are sources of ready cash, means of investment and saving. They are also used by the community to fulfil many other social obligations. As most goats are owned by marginal communities their products do not enter the formal economy and their contribution to the national economy is grossly under-estimated. Traditionally small stock are looked after by women and children. However, the role women play in agricultural production, particularly as small-farm producers, though implicitly recognized, has not attracted sufficient attention from national development planners and agricultural policy makers.

FARM Africa's Dairy Goat Development Project (DGDP) in Ethiopia has tried to address poor rural women. The project had been operating in the arid highlands of Ethiopia where drought is a common phenomenon, food shortage a frequent occurrence and land under an immense pressure. The seasons are characterized by dry and wet seasons where the wet season exhibits bimodal pattern of long and short rainy period. The short rain is often unreliable and sometimes amounts to only occasional showers.

In these rural highland areas of Ethiopia, FARM Africa was engaged for the past nine years in Dairy Goat Development Program (DGDP) with the poorest, most deprived, economically weak and not-easy-to-reach farmers of the communities. The farmers that the project has been working with were often women-headed households (widows) too poor to own livestock but appreciating the value and benefit that comes from keeping small livestock.

Project Objective

The aim of the project was to increase the incomes and improve the nutrition of families in the highlands by improving the productivity of goats managed by women. Women were chosen as the focus of the program because, with their children, they look after goats and they traditionally milk livestock. Hence, they were considered the appropriate target group for the extension effort.

Project Components

The project had its own development path and was implemented in collaboration with both GO and NGO partners. The key elements were:

- The ownership of native goats by women
- The distribution of cross breed goats to women
- The establishment of buck stations at community level for cross breeding program at community level
- The establishment and making operational of community -based veterinary services using women and men 'bare foot' vets (paravets)
- The establishment of women goat groups
- The establishment and making operational of two cross breeding stations and contract cross breeding stations
- The training of farmers extension staff, undergraduate students, postgraduate students and professional staff in aspect of goat production
- The production of extension material and public awareness campaign
- The surveying of Ethiopia and Eritrea to identify goat types, management systems and production of survey results
- The monitoring and epidemiology study of goat diseases, producing new information and their control.

After nine years of implementation the project has had a significant impact on the lives of 1,500 families through: improved food security, increased milk production by 300 – 400%, increased household income by 25 – 50% and empowerment of women.

Gross Observation of Project Components

Role of Women's Goat Groups

Group formation was perceived early in the project life to be a necessary means by which project intervention should be made. Each group constituted of an elected committee to work under a framework of agreed bylaw, and each group having 20–30 members. The committees managed the credit operation of members and collected repayments according to an agreed schedule. Groups were responsible for the management of bucks and organizing how improved bucks should be cared and paid for service provided. Two members from each group were trained to provide basic health care to the group's goats and to alert the Ministry of Agriculture (MoA) veterinary departments when any major health problem occurs. In addition, members were receiving continuous training in the basic minimum goat management and improvement courses. Other training included numeracy and literacy. These trainings have enabled the women to take over the group's account with very minimum assistance from outsiders. Generally the group, organization and ownership of property has enabled the women to assert their place in the community and create self-confidence in themselves (Peacock 1994). Most of these groups have now reached a stage where they negotiate and demand services from other agencies such as MoA, DGDP and Development Bank.

Today, there are 122 groups with a saving capital close to birr 35,000 (7000 USD). This may not be a striking figure for banks and funding agencies, but for the poor women who were with nothing of their own at the start to reach this level of saving is a long way from utterly desperate situation.

Credit Scheme

Each poor woman identified by the community and interested to participate in the project is provided with two local goats on credit. The goats are bought from the local market where the women themselves select their own goats and bargain for the price. The credit repayment schedule depended on the group's decision and financial strength of their savings. The group manages the credit repayment and selects new families who they think need to receive goats. Participants can pay in kind or cash and decide on to whom, in the group, should the weaned kid be passed. Thus the women themselves decide who should be provided first and those that follow. Groups have proved themselves in shouldering their responsibilities in credit disbursement to appropriate families, maintenance of accurate records and the collection of repayments. Some women are able to own a heifer or an ox for traction in addition to cash earned from sales of goats and milk.

Supplying goats on credit to women was a new scheme in Ethiopia. Funds for credit to purchase the initial local goats and later on for crossbreed goats were supplied by FARM Africa. Credit term was formulated to suit each area (Yilma et al. 1997. In the eastern Harerge dairy goat program area where there is a relatively extensive cash economy payment in cash was adopted. Whereas, in the southern Ethiopia dairy goat project area where cash is often scarce the repayment is agreed to be 'in kind'. This is passing a weaned goat to another woman in the group that awaits for its turn to receive goat on credit. The distribution of local goats during 1988 through 1997 is shown in Table 1.

Repayment in kind

There are many advantages of 'in kind' repayment. These are:

- reduction in the possibility of corruption;
- repayment in kind is virtually inflation-proof
- closer ties are formed within the community when one woman directly helps another woman obtain a goat;
- repayment in kind is easier to manage by the community itself, without having bank accounts and complicated book keeping; and
- less defaulters due to community peer pressure.

There are also constraints associated with repayment in kind. These are:

- Farmers tend to develop attachment to their animals and are reluctant or unhappy to part with animals born in their house;
- When the arrangement is to collect the second born kid reallocation often takes longer period and this discourages the recipients waiting;

Table 1. Local goats movement during 1988–1997

Year	*Distributed on credit*	*Credit repayment in kind*	*Goat born*	*Mortality*	*Sales*
1988	70	-	-	-	-
1989	340	-	-	-	-
1990	360	-	-	-	-
1991	245	-	374	40	-
1992	60	-	-	-	-
1993	230	189	505	140	156
1994	406	344	3250	753	1548
1995	156	196	1310	413	610
1996	-	154	994	434	670
1997	-	59	738	158	378
Total	1867	942	7171	1938	3364

Source: DGDP 1997

- At times there is a risk of heavy unwanted community intrusion and control over individual's decision making; and

- The repayment arrangement is not practical or it is very difficult when it involves cross breed goats, because, the repayment goat could be a higher grade animal than the dam.

Repayment in cash

Repayment in cash is still practiced in Eastern Harerge where women are given the option to repay in small installment, or in lump sum after harvest or sale of a goat. It has the following disadvantages:

- It require some level of literacy and numeracy skill with farmers to manage their own account which otherwise require the assistance of outsiders;

- There is the possibility of corruption; and

- Unless the interest rate is adjusted to the prevailing inflation rate there is a possibility of loosing the capital to inflation and lesser people benefit from the next round of disbursement;

The cash repayment model in Eastern Harerge was preferred for the following reasons.

- In Eastern Harerge fattened goats fetch better price and farmers realize a better margin from selling fattened male or female and also meet their commitment; and

- There is a lot more individual freedom in decision making;

Forage Development

In the densely populated area where the project operates, forage has to be grown without competition with food crops. It needs to have a strategic approach around the farmstead, along the edge of fields or under-sown in maize/sorghum plots giving serious regard to soil conservation work and environmental protection. Forage strategies promoted by the project are the backyard fodder cultivation, forage strips and under-sowing annual and perennial crops.

Growing forage for animal feeding is quiet a new technology and it will take time before the benefit of forage and controlling livestock are perceived to outweigh the labor and supervision costs. Though all participants understand the need for more and better feed for their goats, all are not convinced enough to allocate enough land and provide the necessary labor and provide the protection to produce reasonable amount of forage to exercise zero grazing. However, increasing number of farmers are realizing the value of planting of forage that they are either asking for planting material or raising their own seedlings in their backyards.

Breeding Strategy

The DGDP begins with distribution of local goats and with the acquirement of management capability crossbreds are distributed to farmers. The crossbreds are outcomes from local goats and Anglo-Nubians. The crossbreeding is carried at Awassa College of Agriculture and Alemaya University of Agriculture based on Somaliu does. In-kid F1 does are distributed to those members proved by the community to be outstanding in the husbandry work and credit payment with their local goats. Moreover, due to the shortfall in the supply of F1 does, more than 20 bucks were supplied and 14 stations were established in the last 9 years. Twelve are operational. The crossbreeds show superior performance in terms of growth rate and milk production. Daily milk yield of 1–1.5 liters are reported from Eastern Harerge. The distribution of the crossbreds and their source during 1992–1997 are shown in Table 2.

Buck Station Management

The buck station management started to show effect when the project stepped in to help by offering the buck handlers a reward of birr 10 for every successful crossbreed kid born. More crossbreds were obtained from buck stations after the introduction of this scheme.

Table 2. Distribution of crossbreds by source, year and sex

	Source										
	Breeding stations		Private producers		Buck stations		Repayment		***Total***		
Period	F	M	F	M	F	M	F	M	F	M	Total
1992	36	10	-	-	-	-	-	-	36	10	46
1993	68	22	-	-	10	8	-	-	78	30	108
1994	48	14	-	-	14	8	-	-	70	22	92
1995	37	16	33	15	29	40	-	-	99	71	170
1996	42	17	35	23	102	106	5	-	184	146	1230
1997	23	11	18	4	54	48	8	-	103	63	166
Total	254	90	86	42	209	210	23	-	572	342	914

Source:DGDP 1997

Table 3. Average milk off-take (ml) during lactation period of dairy goats as observed between April 1993 and September 1995

Breed	*No.*	*Minimum*	*Maximum*	*Mean*	*Standard deviation*
F1	52	306.4	1732.0	803.5	321
Local 34	34	173.1	860.4	369.1	180

Extension and Training

The project was conducting a two phase fortnightly intensive training for extension agents twice a year. The first course is an introduction to extension methods, forage development strategies, goat husbandry and health care. The second training is a more advanced version dealing with the issue of breeding, feeding and health issue of dairy goats. In both sessions an intensive sessions on group organization and issue of organizing women for development is treated to improve the awareness of extension agents the need of women. The project has supported post graduate training of goat specialists. Nine professional staff were supported for MSc and one for a PhD degree level study in association with goats.

Managing Collaborative Project

Running a project as collaborative program of activity with many different organizations has its own advantages and disadvantages. The obvious advantages are that it is relatively cheap as there is no need to employ a large number of staff and working through existing institutions a project has a much better chance of having longer term sustainability in both implementation and management. However, a collaborative project is only as strong as the commitment of its collaborators. Having no executive control over collaborators can be frustrating when they are not performing well.

Empowering Women

Women constitute 70% of the world's poor and two-thirds of the world's illiterates (UNDP 1995). Investing in women's capability and empowering them to exercise their choice is not only valuable in itself but is also the surest way to contribute to economic growth and overall development. It is also true that where women prosper countries prosper. Thus, the empowerment of women must be an integral part of sustainable human development. The project used goat group to play a strategic role in empowering women by way of making their own decision and having control over their properties. The social advancement they have gained is evidenced by their owning livestock and being able to contribute to social events and getting extra cash and milk for their households. In Eastern

Harerge it is noted that household income has increased by 25–50% in the sites where the DGDP is operating (Table 3), largely attributed to the involvement of women in the project and substantiating household income.

Lessons from DGDP

Technically the project has demonstrated goat dairying to be feasible in creating additional income, alternative source of milk and capital build up for smallholder resource poor farmers in the mid and highlands of Ethiopia. Through sales of male kids farmers were able to generate cash for food purchase and any other needs. Through owning milking local or crossbreed goats farmers were able to get some milk for their family as well as for sale. And through cash generated from goats farmers were able to acquire oxen to plow more lands or buy heifers to increase food production and wealth.

Involving women in meaningful extension work has been a successful experience and as a consequence has brought about an attitudinal change across governmental agencies, banks and partner NGOs as well. MoA now involve women in their livestock extension package. Development Bank of Ethiopia extend its loan in Eastern Harerge to women organised following the goat group model earlier on women could not offer collateral they were excluded from this development process.

Investing in rural women is a worth while development effort. Women had responded effectively to basic information and training and demonstrated a high level of goat management skill. Women who were trained as paravets and group cashiers were effective. Women goat groups efficient in administering the project as grassroot level. This involved managing credit, collecting repayment and disbursement, organising credit and savings as well as extension training.

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PRODUCER MILK GROUPS IN ETHIOPIA: IMPACTS ON WOMEN'S ROLE IN DAIRY PRODUCTION AND MARKETING

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ABSTRACT

Small-scale processing of milk by producer groups has been promoted by the Smallholder Dairy Development Project (SDDP) in selected areas on the Ethiopian highlands. These milk groups create a new market outlet for fluid milk in rural areas, which may imply a large number of changes in the production, marketing and consumption behavior of farm households. This paper examines the impacts of the establishment of milk groups on women's role in dairy production and marketing. Data on milk production and marketing were collected from a stratified random sample of 144 households in four peasant associations with and without access to a producer milk group during June to October 1997. Women play and important role in dairy production and marketing; adult women provide labor for feeding and milking of cattle and mostly for processing and marketing of butter and *ayib*—as much as 8 hours per week. The tabular analyses presented in this paper provide little evidence that the milk groups have had large or systematic impacts on who provides labor for cattle care, or on the time spent processing or marketing butter or ayib. The results provide some evidence that the groups result in additional time requirements for daily marketing of fluid milk, the re-allocation of some milk produced by the household from home processing to fluid sales, and a shift in the control of dairy income from women to men. Subsequent multivariate analyses will provide additional evidence on the magnitude of these impacts and their practical implications. Further study of the implications of the increases in time required for fluid milk marketing, and of the shift in control of dairy income, may help development projects and policy makers to improve the effectiveness and sustainability of the milk groups as a dairy development strategy.

Introduction

Intensification of dairy production has the potential to improve the welfare of smallholder producers in periurban areas of the Ethiopian highlands. The Smallholder Dairy Development Project (SDDP) [and its predecessor the Dairy Rehabilitation and Development Project (DRDP)] funded by FINNIDA and implemented by the Ministry of Agriculture, have supported the introduction of crossbred cows and complementary feeding and health strategies to increase the productivity of dairy cattle in areas of the Ethiopian highlands for the past 10 years. More recently, SDDP also recognised that development of milk and dairy product marketing will need attention as producers acquire crossbred cows. Milk production will more regularly exceed the household's desired consumption, particularly in locations away from major roads where it is difficult for producers to sell fluid milk to the parastatal Dairy Development Enterprise (DDE). Even in areas close to DDE fluid milk collection centers, the erratic collection of milk and payments to producers may be affecting milk production, marketed surplus, and milk quality.

To facilitate milk marketing by smallholders with crossbred cows, SDDP has catalysed the formation of producer 'milk groups' (also called 'milk units' or 'mini-dairies')[1] to process milk into butter, local cottage-type cheese (*ayib*), and yogurt-like sour milk (*ergo*), primarily in Shewa Region[2] north of Addis Ababa. SDDP continues working to form other producer groups in the area. Two similar producer groups were formed about three years ago south of Asela (Arsi Region) with assistance from Ministry of Agriculture, and another group was formed over ten years ago in Bakelo near Debre Birhan. This last site is in the Amhara region, whereas the other four are in the Oromiya region.

In addition to providing a structure for more cooperation among farm households in region, the milk groups create a new marketing outlet for raw milk. In the recent past, fluid milk sales in rural areas were limited to locations where the DDE actively collected milk, or where a small number of private processors have arranged purchases with producers. Thus, few producers have had access to an outlet for fluid milk sales until the formulation of the milk groups.

The creation of a new market outlet for fluid milk instead of dairy products may imply a large number of changes in the production, marketing, and consumption behavior of farm households. These changes in turn may affect the overall welfare of the household, with differential effects on individual household members. In the last two decades there has been a growing recognition of the need to assess the impacts of changes in agricultural technology and marketing options by gender (Mullins et al. 1996, Dieckmann 1994, Von Braun and Webb 1989).

Technologies and marketing options that impose additional time burdens on women, or change the balance of control over incomes earned by men and women, often have been less readily adopted that those where work and benefits are more equally distributed. This is true even when the technologies or marketing options improve the overall welfare of the household, as measured by total income. Previous work on the impacts of adoption of crossbred dairy cattle in Kenya indicated that women provided most of the additional labor required, yet experienced limited increases in control of income earned from dairying (Mullins 1996, Price Waterhouse. 1990). Because gender divisions of labor and income control are common in the developing world, consideration of gender-differentiated impacts may help researchers and development agencies to improve the effectiveness of project and policy interventions.

Most households with cows in Ethiopia's highlands currently process milk into butter and ayib to sell at local markets. Typically, it is women of the household that process milk at home, transport it for sale, and control the income from dairy product sales. The introduction of a new marketing outlet through the milk groups may change both the amount of milk produced by households and the allocation of milk produced to household consumption, home processing, sales, or calf feeding. Changes in feeding strategies are a mechanism for short-term increases in milk production; such changes may alter time spent caring for cattle by different household members. If total milk production increases as a result of the new marketing outlet, sales of fluid milk may not reduce the amount available for processing at home. However, if the household's milk production does not increase, fluid milk sales to the milk groups are likely to reduce the amount of milk processed into butter and ayib at home.

A reduction in the amount of milk allocated to home processing may reduce the amount of home-produced butter and ayib; the quantities of these products sold may decrease as well. Because women typically control income received from dairy product sales, the income received by women from dairy processing may decrease as a result of the establishment of the milk groups, even if total income from milk and dairy product sales increases[3]. Less milk allocated to home processing may also reduce the time required for home dairy processing and marketing, which is frequently done by women. Sales of fluid milk to the milk group, on the other hand, are likely to increase the time required for marketing, because milk typically is delivered to the groups every day—in contrast to the weekly or bi-weekly markets at which butter and ayib are sold.

To date, there has been no quantitative analysis of the impacts of the milk groups on gender-disaggregated outcomes. Thus, the objective of this paper is to examine the impacts of the establishment of the milk groups on women's role in dairy production and marketing. The focus of the study is on the extent and sources of labor for cattle care, the amount of time spent processing and marketing dairy products and fluid milk, and the control of income received from dairy product and milk sales. An assessment of these outcomes will inform future efforts to establish milk groups as a dairy development strategy.

Materials and Methods

With the collaboration and assistance of SDDP, ILRI and IFPRI initiated a study in October 1996 to examine the impacts of the four milk groups in Oromiya Region formed prior to 1997. Assessment of household level (and gender-disaggregated) impacts of milk group formation was undertaken in four peasant association (Pas) near two of the four milk groups in Oromiya region. Preliminary surveys to ascertain the extent of crossbred cow ownership by households were carried out in December 1996 and January 1997. On the basis of the preliminary surveys, the Mirti and Ashebaka Pas in the area of the Lemu Ariya milk group were selected from Arsi Region, and the Ilu-Kura and Archo Pas were selected near the Edoro milk group in Shewa Region. One PA in each region was close enough to the group that farmers resident in the PA sold milk to the milk group, and the other was nearby but distant enough from the group to effectively prevent farmers from selling fluid milk there. Thus, the households in the Ashebaka and Archo PAs served as 'controls' to compare with the households in Mirti and Ilu-Kura Pas with households participating in a milk group.

A random sample of 36 households was selected in each of the four Pas. This sample was stratified by whether the households owned crossbred cows, participated in the group (by selling milk in the month prior to the census), and distance to the group or other local market where dairy products could be sold. During June 1997, baseline surveys of household characteristics and current cattle management practices were administered to the 144 households in the sample. From June 1997 to October 1997, data on milk allocation and marketing, 'significant event' occurring in the cattle herd[4], and cow feeding practices were collected every two to three weeks for the 144 households. In addition to the household surveys, market surveys were conducted in local markets at which households in the sample PA sold dairy products processed at home. These market surveys were used to determine current dairy product prices and the nature of containers used for dairy product sales[5]. The market surveys allowed us to calibrate information collected from the households on quantities of dairy products sold.

Results

For the variables of interest, the results are presented by PA and by milk group participation status. For the purposes of the study, milk group 'participation' can be interpreted in at least two ways. The samples were stratified to include nearly equal numbers of 'participating' and 'non-participating' households, based on whether the households sold fluid milk to the group during the month prior to the census of households in the four Pas during March–April 1997. This definition of group participation is probably more appropriate for consideration of longer-term outcomes such as acquisition of (additional) crossbred animals. An alternative definition of 'participation' is whether a household is currently selling milk to the group. For an examination of milk allocation to various uses, time spent processing and marketing, and income from milk and dairy product sales, this latter definition is more appropriate. Unfortunately, fewer households near the milk group sites were classified as 'participating' based on this second definition (9 of 36 households in Ilu-Kura PA, and 3 of 36 households in Mirti PA). The small numbers of 'participating' households imply that the results presented herein should be treated as indicative, rather that definitive, indicators of the impacts of the milk groups on womens' role in dairy production and marketing in The Ethiopian highlands[6].

A further qualification of the results is that they do not account for the underlying factors associated with the group participation decision. For example, ownership of crossbred animals is associated with milk group participation, but that is ignored in tabular summaries of household means by PA and participation status. Tabular results provide evidence to assess preliminary hypotheses, and thus complement multivariate approaches (such as regression analysis) that can account for many underlying factors simultaneously. Because multiple factors are associated with milk group participation and impacts, subsequent analyses with use multivariate techniques to refine the insights provided by tabular analysis in this paper.

Characteristics of Households and Household Heads

The characteristics of the household and of the head of the household may influence the likelihood that the household sells milk to the milk group. Household size, the number and ages of children, land resources, access to transportation equipment, physical barriers between the household and the group and access to information are likely to influence milk production and marketing behavior. Relatively small differences in household size and age composition exist between PA and participation status (Table 1). There appear to be no systematic differences in land allocation and use between participating and non-participating households, and the magnitudes of difference in land resources are generally small. Differences in ownership of transportation equipment and physical barriers between the survey PA in Shewa (no ownership, more physical barriers) and Arsi regions (high ownership, few barriers) appear more important than differences between participating and non-participating households. Participating households do appear to have received more information about dairy production and processing than their non-participating counterparts in the same regions.

The characteristics of household heads may also affect milk production and marketing. Differences in mean age of the household head by participation status were small except in the case of Mirti (Table 2). Participating households have slightly higher years of formal education, but the differences between Shewa and Arsi regions were again larger than the differences between participating and non-participating households. With the exception of participating households in Ilu-Kura, 22% of whose heads were Amhara, nearly all household heads belonged to the Oromo ethnic group. The number of female-headed households differed among Pas and by participation status, but the impact of the household head's gender on participation status was not consistent. In Ilu-Kura, all participating households had male household heads. In Mirti, the proportion of male-headed households was slightly lower for participating households that for non-participating households. Religion was often thought to influence milk marketing behavior—a number of Muslin respondents indicated during the interviews that they would prefer to consume, rather than sell, increases in milk production. Consistent with those sentiments, no households with Muslim heads participated in the production. Consistent with those sentiments, no households with Muslim heads participated in the milk groups.

Labor for Cattle Care

Mullins et al. (1996) highlighted the importance of assessing who provides the labor, and who receives the income after the introduction of more intensive dairy production systems in Kenya. Similarly, an assessment of who performs the major tasks associated with caring for cattle, and whether this is affected by participation in the milk groups, provides information for future refinements of dairy development efforts in Ethiopia. Households in the four Pas reported that they devote substantial time to cattle care, between about

1,000 and 1,600 minutes—16 to 26 hours—per day (Table 3). Much of this time (between 85 and 95%) is devoted to herding animals in systems where grazing pasture land is a dominant source of nutrients, and most of this labor is provided by male members of the household, especially those under 12 years of age. In no PA is the contribution of female labor to cattle herding greater than one-third of the total time devoted to the activity; where female labor is used, it is typically provided by children under 12 years of age.

Table 1. Selected cahracteristics of households, by peasant association and milk group participation

Household characteristic	*Peasant association, Household milk group participation*					
	Arch	Ilu-Kura		Ashebaka	Mirti	
	No[1]	Yes	No	No[1]	Yes	No
Household size (no. persons)	7.1	6.8	6.1	6.8	6.3	4.2
Age distribution (% of household members):						
0–5 years	16	17	15	17	11	19
6–12 years	27	27	27	26	21	22
13–18 years	19	20	19	19	32	19
>18 years	40	37	40	39	37	41
Land resources (ha[2]):						
Crop land, PA	1.0	1.5	1.3	1.5	1.3	1.8
Crop land, total	1.3	2.1	1.5	1.8	0.8	2.1
Pasture land, PA	0.8	2.5	1.8	0.7	0.8	0.9
Pasture land, total	1.1	3.2	2.1	1.3	1.3	1.1
% owning transport equipment[3]	0	0	0	88	67	58
% reporting physical barrier to group participation[4] (%)	44	67	52	28	0	9
% receiving information about...[5]						
Dairy production	17	56	19	10	33	27
Dairy processing or marketing	16	56	15	5	0	18

[1] No households participate in milk groups in Archo and Ashebaka PAs.
[2] 'PA' land is that allocated by the Peasant Association. 'Total land' includes adjustments for land rented, shared or by the household.
[3] Transportation equipment includes wheeled and sled-type equipment.
[4] Physical barriers include rivers, mud, mountains, or heavy rainfall.
[5] Information received from MoA extension or other sources.

Table 2. Selected characteristics of household heads, by peasant association and milk group participation status

Household head characteristic	*Peasant association, Household milk group participation*					
	Archo	Ilu-Kura		Ashebaka	Mirti	
	No	Yes	No	No[1]	Yes	No
No. of households	36	9	27	36	3	33
Age (years)	50.6	46.9	49.3	50.1	57.3	47.0
Education (year)	0.5	0.6	0.3	1.7	4.0	3.5
Ethnic group (%):						
Oromo	100	78	100	95	100	100
Amhara	0	22	0	5	0	0
Sex (%):						
Male	81	100	74	90	67	74
Female	19	0	26	10	33	26
Religion (%):						
Orthodox	100	100	100	82	94	67
Muslim	0	0	0	18	0	0
Other	0	0	0	0	5	33

[1] No households participated in milk groups in Archo and Ashebaka PAs.

Other tasks consume much less time than herding, and tend to be more delineated according to age and gender categories. Watering consumes between 5 and 36 minutes per day; the amount of time for this activity varies with the necessity of bringing water to the animals rather than as a part of grazing activities. With the exception of Archo, watering (like herding) is a task mostly performed by males. Feeding is performed mostly by males older than 12 years, whereas labor for milking cows is provided by females over the age of 12—often the wife of the household head or the household head if female. On average, males provide 75% of the time devoted to cattle care. Participating households spend somewhat more time than non-participating households in cattle care, perhaps due to ownership of more crossbred animals. Few consistent patterns of differences in age and gender distribution of labor for cattle care are evident (Table 3).

Table 3. Age and sex of labor for care of cattle, by peasant association and milk group participation

Task, age and sex of labor	*Peasant association, Household milk group participation*					
	Archo	Ilu-Kura		Ashebaka	Mirti	
	No[1]	Yes	No	No[1]	Yes	No
Herding (min/day)	1,018	1,119	1,103	937	1,541	872
Female, ≤ 12 years	14	30	19	9	0	13
Male, ≤ 12 years	47	36	45	44	57	28
Female, > 12 years	5	2	13	4	12	10
Male, > 12 years	34	33	23	42	31	49
Watering (min/day)	5	16	37	32	21	36
Female, ≤ 12 years	0	0	31	14	0	29
Male, ≤ years	0	58	51	35	24	15
Female, > 12 years	100	6	7	12	0	10
Male, > 12 years	0	36	11	40	76	46
Feeding (min/day)	33	82	110	69	23	48
Female, ≤ 12 years	5	3	2	0	0	0
Male, ≤ 12 years	3	3	13	7	0	2
Female, > 12 years	16	29	24	6	0	20
Male, > 12 years	75	65	61	87	100	78
Milking (min/day)	32	113	52	67	31	32
Female, ≤ 12 years	5	0	6	0	0	0
Male, ≤ 12 years	0	0	1	0	0	1
Female, > 12 years	89	100	88	100	100	99
Male, > 12 years	6	0	5	0	0	0
Total (min/day)	1,088	1,330	1,302	1,105	1,616	988
Female, ≤ 12 years	13	25	17	8	0	13
Male, ≤ 12 years	44	31	41	39	55	25
Female, > 12 years	8	12	17	10	13	13
Male, > 12 years	34	32	25	42	32	49

[1] No households participated in milk groups in Archo and Ashebaka PAs.

Butter and Ayib Processing

The milk groups may change the allocation of milk produced by the household, and thus may decrease the amount of butter and ayib processed at home. This change, if it occurs, might be reflected in the frequency of butter churning and ayib production by the household; the amount of time spent processing dairy products could also be affected. Because the amount churned can be varied depending on sour milk available, and the churning time depends on numerous factors (e.g., temperature)these potential differences may not be evident in a relatively small sample. This explains in part why few differences existed in the number of times participating and non-participating households process butter and ayib (Table 4). The time spent processing butter was somewhat lower for participating households than non-participating households in the same PA, gut in Shewa the mean for the PA without participating households was lower than that for the participating households in the nearby PA with the milk group. (A similar pattern existed for total processing time). The lower value for the households in Mirti should be treated with caution due to the small sample size. The time households spent processing ayib showed no consistent pattern with participation status. Thus, milk group participation, although it may affect milk allocation, did not have a large or consistent impact on the time spent processing butter and ayib.

The results confirmed the conventional wisdom that dairy processing in the Ethiopian highlands is primarily the domain of women, especially the wife of the household head or the household head if female. More than 70% of the time spent processing dairy products was provided by the wife or female household head. Females under the age of 12, other household members over the age of 12 (usually female) and sometimes hired labor (also usually female) provided nearly all the rest of the labor. Male participation in dairy processing was markedly limited (Table 4). As for total time spent processing, participation in the milk groups had no consistent impact on who provided the labor for home-processing of butter and ayib.

Marketing of Home-processed Dairy Products and Fluid Milk

A household's labor often is one of its most important resources. Thus, the time allocated to various tasks represents a 'resource allocation' decision made by the household. In general, the time spent marketing dairy products and fluid milk potentially could be used for other tasks (or leisure). Changes in the time allocated to marketing dairy products represent changes in time available for other household activities. Households surveyed spend between 34 and 104 minutes per week transporting dairy products to a local market for sale; most of the differences reflected the distance from the households to the nearest local market (Table 5). In all markets except Rob Gebaya (the market used most frequently by households in Ilu-Kura PA), the time spent selling dairy products was also an important component of the total marketing time. For Ashebaka households, selling time was nearly

Table 4. Processing of butter and ayib by peasant association and milk group participation status

	Peasant association, Household milk group participation					
	Archo	Ilu-Kura		Ashebaka	Mirti	
Processing characteristic	No[1]	Yes	No	No[1]	Yes	No
Times butter made in the past week	1.2	1.5	1.3	1.1	0.8	1.1
Times ayib made in the past week	0.8	1.1	0.6	0.4	0.2	0.4
Time spent processing butter (min/week) *% of total by:*	168	202	233	174	81	141
Wife or female household head	70	86	66	71	68	60
Female, ≤ 12 years	6	14	9	1	0	8
Male, ≤ 12 years	0	0	0	0	0	1
Other member > 12 years	17	0	14	27	32	16
Other[2]	8	0	11	2	0	15
Time spent processing ayib (min/week) *% of total by:*	33	39	29	19	11	26
Wife or female household head	77	97	74	61	40	69
Female, ≤ 12 years	4	3	9	0	0	1
Male, ≤ 12 years	0	0	0	0	0	0
Other member > 12 years	15	0	13	39	60	24
Other[2]	4	0	5	0	0	5
Total time spent processing (min/week) *% of total by:*	201	241	262	193	92	167
Wife of female household head	71	88	67	70	65	61
Female, ≤ 12 years	6	12	9	1	0	7
Male, ≤ 12 years	0	0	0	0	0	1
Other member > 12 years	17	0	14	28	35	17
Other[2]	7	0	3	2	0	13

[1] No households participated in milk groups in Archo and Ashebaka PAs.

[2] 'Other' includes other relatives, hired labour, and 'all family' responses.

as large as the time required for transporting dairy products to market. The total time spent marketing dairy products per week was less than two hours for most households, and thus probable did not constitute an unreasonable burden on household time.

Consistent with the predominance of women in butter and ayib processing, about two-thirds of the time spent in marketing dairy products was provided by the wife or female household head. Other female household members, household labor and relatives provided most of the remaining time for butter and ayib marketing. Male participation in dairy marketing, as in processing was extremely limited.

Table 5. Marketing of home-processed dairy products by peasant association and milk group participation status

Marketing characteristic	Peasant association, Household milk group					
	Archo	Ilu-Kura		Ashebaka	Mirti	
	No[1]	Yes	No	No[1]	Yes	N
Distance to nearest local market (min[2])	68	59	60	60	18	20
Time spent transporting dairy products						
Wife or female household head	77	81	78	62	40	58
Female, ≤ 12 years	3	11	13	3	0	3
Male, ≤ 12 years	0	0	3	0	0	0
Other member > 12 years	14	0	3	34	60	18
Other[3]	6	8	3	0	0	22
Time spent selling dairy products						
Wife of female household head	70	88	80	65	50	65
Female, ≤ 12 years	4	5	8	3	0	8
Male, ≤ 12 years	0	0	2	0	0	0
Other member > 12 years	20	0	2	32	50	22
Other[3]	6	7	7	0	0	5
Total time spent marketing dairy products						
Wife or female household head	75	82	78	64	44	62
Female, ≤ 12 years	3	10	12	3	0	6
Male, ≤ 12 years	0	0	3	0	0	0
Other member > 12 years	16	0	3	33	56	20
Other[3]	6	8	3	0	0	13

[1] No households participated in milk groups in Archo and Ashebaka PAs.

[2] Walking time one-way to local market as reported by households.

[3] 'Other' includes other relatives, hired labor, and neighbors.

Participation in the milk groups had little impact on the amount of time spent in marketing home-processed dairy products (Table 5). Times spent transporting and selling butter and ayib were similar for participating and non-participating households in Ilu-Kura and Mirti PAs. Similarly, who provides the labor for transporting and selling dairy products appears not to have been influenced a great deal by participation in the groups. Women in participating households appeared to visit local markets just as often as their non-participating counterparts. These limited changes in time allocation for dairy marketing with participation status might reflect the fact that the time required was similar regardless of the amount of butter or ayib available for sale. Thus, the quantity of butter and ayib sold, as reflected by income from dairy product sales, might be the key variable of interest in assessing the impacts of the milk groups.

With the introduction of the milk groups as a market outlet, time for marketing fluid milk should increase (few households in the survey Pas sold fluid milk prior to the establishment of the groups). This increase in the time required for fluid milk marketing may increase the total amount of time devoted to dairy marketing; the extent of the increase in time required and who provides the labor are key questions. Participating households devoted more than 300 minutes per week to transporting milk to the groups and waiting for it to be received (Table 6), more time than they spend marketing butter and ayib. Thus, it appears that participation in the milk groups increases the total time spent by households in dairy marketing.

Who provides the additional labor for fluid milk marketing to the groups? For Ilu-Kura households, children under 12 years of age provided 84% of the time for transporting and waiting at the groups. In that area children would often carry milk to the group as they walked to school in the morning (Aarre Antilla, formerly of SDDP, personal communication). In Mirti, other household members (older than 12 years) provided more than half of the time required for milk transportation, and the wife or female head of household provided 29%. The contrast between adult women's high involvement in butter and ayib marketing and low involvement in fluid milk marketing is striking.

What are the practical implications of the increase in time allocated to fluid milk marketing? First, the additional time required amounted to about 40 minutes per day, and thus was unlikely to have major impacts on the allocation of time to other household activities. Second, the time required for fluid milk sales is in not, in the main, provided by adult women of the household—fluid milk marketing did not appear to impose a great additional burden on adult women. Third, to the extent that children carried milk to the groups on their way to school, the biggest 'cost' to the household of fluid milk marketing might be a few minutes of additional walking by the household's children. Additional information on the extent to which fluid milk transportation was done by children on their way to school would help to determine the importance of the additional time required for participation in the milk groups.

Table 6. Marketing of fluid milk to the milk groups, by peasant association and milk group participation status

Marketing characteristic	*Peasant association, Household milk group participation*					
	Archo	Ilu-Kura		Ashebaka	Mirti	
	No[1]	Yes	No	No[1]	Yes	No
Distance to milk group (min[2])	3	33	60	3	35	36
Time spent selling milk to group min/week) *% of total by:*	3	262	3	3	286	3
Wife or female household head	3	3	3	3	29	3
Female, ≤ 12 years	3	28	3	3	0	3
Male, ≤ 12 years	3	56	3	3	0	3
Other member > 12 years	3	13	3	3	57	3
Other[4]	3	1	3	3	14	3
Time spent selling dairy products (min/week) *% of total by:*	3	40	3	3	76	3
Wife of female household head	3	6	3	3	9	3
Female, ≤ 12 years	3	28	3	3	0	3
Male, ≤ 12 years	3	47	3	3	0	3
Other member > 12 years	3	18	3	3	34	3
Other[3]	3	1	3	3	57	3
Total time spent marketing dairy products (min/week) *% of total by:*	3	302	3	3	362	3
Wife or female household head	3	3	3	3	25	3
Female, ≤ 12 years	3	28	3	3	0	3
Male, ≤ 12 years	3	55	3	3	0	3
Other member > 12 years	3	14	3	3	52	3
Other[3]	3	1	3	3	23	3

[1] No household participated in milk groups in Archo and Ashebaka Pas.

[2] Walking time one-way to milk group as reported by households.

[3] No households participate in milk groups in Archo and Ashebaka PA, so no information was recorded.

[4] 'Other' includes other relatives, hired labour, and neighbors.

Table 7. Income from sales of dairy products and fluid milk, by peasant association and milk group participation status

Income characteristic	*Peasant association, Household milk group participation*					
	Archo	Ilu-Kura		Ashebaka	Mirti	
	No[1]	Yes	No	No[1]	Yes	No
Income from sales of dairy products (Birr/week)	19.70	10.50	9.80	8.00	11.00	7.50
% income controlled by:						
Wife or female household head	92	100	77	100	100	99
Male household head	6	0	1	0	0	0
Jointly by both	1	0	22	0	0	0
Other[2]	2	0	0	0	0	1
Income from sales of fluid milk to milk groups (Birr/week)	0.00	29.90	0.00	0.00	21.30	0.00
% income controlled by:						
Wife or female household head	3	41	3	3	64	2
Male household head	3	4	3	3	36	2
Jointly by both	3	55	3	3	0	2
Other[2]	3	0	3	3	0	2
Total income from sales of dairy products and milk (Birr/week)	19.70	40.40	9.80	8.00	32.30	7.50
% income controlled by:						
Wife or female household head	92	56	77	100	76	99
Male household head	6	3	1	0	24	0
Jointly by both	1	41	22	0	0	0
Other[2]	2	0	0	0	0	1

[1] No households participated in milk groups in Archo and Ashebaka PAs.

[2] 'Other' includes other relatives.

[3] No households participated in milk groups in Archo and Ashebaka PA, so no information was recorded.

Control of Income from Dairy Product and Fluid Milk Sales

The control of income from dairy marketing may be affected by the groups inf two conditions are true: first, that the establishment of milk groups changes household milk allocation from home processing to fluid sales, and, second, that who controls income from dairy products sales differs from who controls income from fluid milk. The evidence for changes in milk allocation due to the establishment of the groups was rather limited, based on the time spent processing and marketing butter and ayib. On the other hand, sales of fluid milk provided more income for participating households than sales of butter and ayib (Table 7) and it is unlikely that all of the milk for fluid sales resulted from increases in milk production due to the formation of the groups. Thus, there was some evidence that a shift in milk allocation from home processing to fluid milk sales occurred for participating households.

In all PA, income from butter and ayib sales was an important component of household income, generating between 400 and 1,000 birr per year. The amount received per week from butter and ayib sales differed little by PA or participation status, with the exception status, with the exception of Archo where dairy product income was about twice as high as in other Pas. Income from dairy product sales was controlled almost entirely by the wife or female household head, although about one-quarter of dairy product income was jointly controlled by the household head and the wife for non-participating households in Ilu-Kura. In contrast, control of income from fluid milk sales was more equally shared between men and women—more than half of income from fluid milk sales was jointly controlled in Ilu-Kura, and one-third of such income was controlled exclusively by male heads of households in Mirti (Table 7). The differences in milk allocation and control of income for different types of sales provided evidence that the establishment of milk groups shifted control of dairy income somewhat from women to men. Further multivariate analyses are necessary to confirm this preliminary finding, and to assess the practical implication of this shift in income control.

Conclusion

This study has documented the important role that women play in dairy production and marketing in Ethiopia. Adult women provide important amounts of labor for care of cattle, especially for feeding and milking. The wife or female household head provides the majority of time for home processing and marketing of butter and ayib, which provide rural households with an important (and steady) source of income. Adult women are less involved in the marketing of fluid milk, which is transported to the milk groups by other household members, often children. The time commitments of adult women to dairy production and marketing are substantial, sometimes totalling more than eight hours per week. Although not a focal point of our study, the time commitments by women suggest that technologies to reduce the time required for dairy processing and marketing would benefit households in rural areas of Ethiopia. Although reduction of marketing times would appear difficult, technologies to reduce butter processing time (such as the 'internal agitator' churn developed by ILRI), deserve additional attention.

Give the importance of women in dairying, the principal objective of this paper was to examine the impacts of the establishment of the milk groups on women's role in dairy production and marketing. The tabular analyses presented in this paper provide little evidence that the groups have larger or systematic impacts on who provides labor for cattle care, or on the time spent processing or marketing butter and ayib. The results provide some evidence that the groups result in additional time requirements for daily marketing of fluid milk, the re-allocation of some milk produced by the household from home processing to fluid sales, and a shift in the control of dairy income from women to men. Subsequent analyses with multivariate techniques will provide additional evidence on the magnitude of these impacts and their practical implication. Further study of the implications of the increases in time required for fluid milk marketing, and of the shift in control of daily income, may help development projects and policy makers to improve the effectiveness and sustainability of the milk groups as a dairy development strategy.

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ENDNOTES

1.In this paper, the term 'milk group' is used, as that has been the term applied during the formation of the groups. Milk groups would be called 'dairy cooperatives' in most other countries.

2.Although new administrative boundaries have been specified since the fall of the Dergue regime in 1991, the older administrative units continue to be used to describe locations. The older regions of Shewa and Arsi are part of the more recently defined Oromiya region. This paper uses these old names to distinguish locations within the Oromiya region.

3.The impacts of a shift in the control of dairy income from women to men in a household will depend on whether men and women spend income differently, but such differences have been documented for a number of countries in Sub-Saharan Africa.

4.Significant events include births, deaths, purchases, sales, illness, etc., for all cattle in the household's herd.

5.For example, butter is often sold in small tea cup types used to serve coffee, called *sini*. The amount of butter per sini varies considerably, because the butter is stacked on top of the cup in varying heights. In order to determine the quantity of butter sold by the household, we used the market surveys to establish categories for the amount of butter sold per sini.

6.It is for this reason that statistical measures of differences in means for the PA and participation status are not reported herein. An additional issue in the interpretation of the results is the smallnumber of milk groups sites; two of five milk group sites were included in the household data collection.

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Animal Production: a Past Time Activity or Another Drudgery for the Somali Woman?

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Introduction

This paper focuses on the current socioeconomic activities of the rural Somali women, their general situation and position in society as well as their participation in agricultural production, particularly in animal production. The Somali National Regional State has nine zones and forty weredas. The survey was conducted in one wereda, Jijiga.

Rural women development is an indispensable prerequisite not only for any improvement but also for maintenance of a minimum basic living standard for a growing population. This is much true in developing nations like Ethiopia, where women consist of more than half the population and most of them live in the rural part. Rural women contribute to the well being of the society in general and the household in particular. Therefore, development of rural women directly promoted improved quality of life and more well being for the majority of the population. The 1989 UN World Survey (cited in ECA 1991) states on the role of women, " Development for women means development for society. Achieving this means identifying critical points in the economic process where intervention by policies and programs can have the greatest impact."

This being the fact, rural women development cannot be planned in the abstract. Instead, the cultural background of the different people, ecological conditions, available technology, the existing rural institutions, educational standards of women and also their position in the society and many other factors can have a limiting effect on their development. Areas of concern regarding the improvement of the welfare of women according to the African Platform for Action are to empower them politically and economically; increase their access to education, training, science and technology; enhance their vital role in family and society and protect their legal and human rights. The issue becomes more worth investigating in disadvantaged areas like the Somali Region. In this Region no attempt has been made up to now to look into the productive role that the Somali women play in society and no study has been done to identify possible ways for the betterment of life for these women in the Region. The specific objectives of this paper were to:

- assess whether Somali women take part in agricultural production over and above their

household chores;
- identify specific activities, with respect to agricultural production, performed by women;
- find out whether there is a gender bias and discrimination against women and to identify the most important factors contributing to the same; and
- point out the status of women (in terms of decision making, access to resource, etc.) in the society.

The study covered eleven localities in the wereda, namely Megarea, Biyo, Lougo, Chinkakseen, Ambarro, Ambassala, Guraze, Fardo, Mellwalle, Walli Gallahs and Qaaxa. A total of 56 randomly selected women were interviewed in May and June 1997. A multi-stage sampling procedure was used to select villages and specific respondents for the survey.

It is worth noting that this survey should be considered as an exploratory one because it helped to collect and summarize some baseline information about the areas covered in the survey. However, the results should not be taken as actual indicators for decision making. Rather, they can serve as springboard for more detailed and area specific studies.

Literature Review

Rural women development has been a source of constant concern to administrators, planners, and policy makers of developing nations. Doing away with many of the features of underdevelopment calls, among others, for probing into the socioeconomic conditions of women in society.

In Sub-Saharan Africa more than 50% of the smallholder farmers are women. They account for 75% of the labor input in food production and processing, and are generally responsible for food production (ECA 1991). Moreover, 65% of African women over the age of 15 are illiterate compared to 40% of the men (ECA 1995).

There have not been extensive studies undertaken to directly compare Ethiopian men's and women's contributions to food production, although women's contribution to agricultural output is normally underestimated (Fellows 1993). Although the participation of women in the country's economy has been very high, their subordinate role has denied them fair share in the country's resources. For example, women comprise only 23% of the total student population. While primary education enrollment includes 30% females, enrollment of women in agricultural colleges is only 5.5%, and in the forestry faculty it is only 3.2% of the total. Employment opportunities for women in the agencies providing services to rural communities are also limited. For example, there are only 500 women extension workers in the Ministry of Agriculture, in an extension services which employs over 2000 men (Tilaye Nigussie, 1995, unpubl. data). Women have less access to employment than do men because of their limited education and their restricted availability due to family and domestic responsibilities. In these circumstances, many women can find work only in the informal sector.

With regard to the participation of women in agricultural activities, they are either assisting or directly involved in all stages of agricultural production and food processing. Women's activities are focused on hand land-clearing; weeding, plant spacing and manuring; cutting and threshing; grain processing, food preparation and marketing for home consumption needs (Fellows 1993).

As with other sectors, the gender role and responsibility in the provision of water for household or livestock consumption is clearly defined. The potage of water is almost universally a female task and introduction of girls to this role is initiated at a very young age which is detrimental to the development of their musculo-skeletal system. Obtaining access to water is especially laborious in Ethiopia due to the long distances from water sources and the rugged terrain of the country. It has been estimated that 3–5 hours daily are required for the potage of water and water vessels may weight 20 kg or more when filled. Some studies have reported women carrying on average 77 to 95% of their body weight uphill and over long distances (Fellows 1993).

One other major barrier to the development of women as identified by many is the prevalent inheritance laws and customs, many of which prevent women from receiving land and other possessions from their husbands and parents. There may be provisions based on religion or law for women to inherit land and other goods, but that they may be prevented from taking their inheritance by brothers and other male relatives. These problems might be intensified if adjustment induced growth substantially increases the value of the land and therefore men's desire to retain control of it (ECA 1991).

In response to the above mentioned anomalies, in 1991 the Transitional Government of Ethiopia established a Women's Affairs Office in the Prime Minister's Office, to encourage women's participation, give them a fair share of the country's resources and promote women's voluntary organization. Subsequently, in March 1993 the National Policy on Ethiopian Women was adopted. The major objectives of this policy that must be part of all policies, plans or laws regarding women are to ensure:

- the equality of men and women; special emphasis being given to the participation of rural women;
- equal access of men and women to the country's resources, to the decision making process, and to the benefits derived from central and regional institutions; and
- women's access to development institutions, programs and projects.

The related implementation strategies include, *inter alias*, the following women's rights:

- work at any level in government;
- equal pay and equal job opportunities;
- participation in land distribution and ownership;
- education at all levels in the academic and technical fields;
- primary health care and family planning; and
- establishment of women's affairs departments which are responsible for following up women's issues and concerns in every government office and organization.

The new policy is expected to respond to the problem of women in development. In deed, formulating a policy is only half the task. The other, and probably the most important one, is its implementation. In this respect, the Federal Government in general and the Regional Governments in particular need to give immense political weight to the improvement of the conditions in which women live and work.

Demographic and Social Characteristics

All 56 respondents identified themselves ethnically as Somalis and religiously Muslims. About 86% were married, 7% widows, 5% divorcees, and 2% were singles. Among those who were married, 90% were in monogamous marriage and the rest in polygamous marriage. The mean age at which a woman marries in the study area was 17 years, the lowest age being 14 and the highest 30 years. But the majority of them (64%) married between the ages of 15 and 20. The mean age of the spouse at the first marriage, on the other hand, was 22.5 years. A typical household in this wereda had a family size of 6 persons. The average number of children per family was 4, the highest being 8 and the lowest zero. A woman in this area gave birth to a child every 2.2 years on average. The highest spacing was 4 years and the least 1 year. Only one family reported the existence of twins in the household. The dependency ratio (the number of non-working individuals, i.e., minors below 18 years old and elderly above 60 years old supported by one working person in the family) for the areas covered by the study was 2.

Male-headed households were six times as frequent as female-headed ones, i.e., 85% and 15%, respectively. Among the 8 households managed by women, 4 were headed by widows, 2 by divorcees and 2 by married women whose husbands were not in the study area. Among the sampled respondents and their spouses, the illiteracy rate was 92% for the women and 80% for their spouses. The profile of the educational status of the households is given in Table 1.

With regard to the educational status of the children of the respondents, 180 (77.6%) were of school age. A response was given regarding educational status for 177 of them. Out of the 177, 12 children (6.8%) had some exposure to education, 6 attended primary school, while the rest attended literacy campaign classes at one time or another.

Table 1. **Respondents and their spouses by educational level**

Educational Level	*Spouse*		*Respondent*	
	(no.)	(%)	(no.)	(%)
Illiterate	40	71.4	41	73.2
Literacy Campaign	7	12.5	2	3.6
Primary School	3	5.4	2	3.6
No- response	6	10.7	11	19.6
Total	**56**	**100**	**56**	**100**

The health service coverage in the region is one of the lowest in the country. The majority of the respondents pointed out that they have to walk for several hours to get health services. At the regional level there is unequal distribution of health personnel and facilities because they are concentrated in the regional capital, Jijiga. This inequality is also observed at a national level. For instance, in 1994/95 three regions, Amhara, Oromiya and Addis Abeba, had 55.3% of the hospitals, 53.4% of the hospital beds, 70.4% of the health centers, and 69.5% of the health stations in the country (CSA 1996). According to CSA (1996), in 1994/95, there were 3 hospitals (3.5% of the national value), 221 hospital beds (2.5%), 6 health centers (3.6%), and 66 health stations (2.7%) in Somali Region. There were 39 medical doctors (2.7%), 138 nurses (3.7%), 3 pharmacy attendants and pharmacists (1.7%), 20 sanitarians (3.6%), 326 health assistants (2.9%), 14 laboratory technicians (2.4%), 6 X-ray technicians (2.9%), and 11 pharmacy technicians (4.5%). The numbers of medical personnel and facilities in the region were thus too small to serve the large number of people residing in the region.

The majority of the respondents (67%) revealed that they preferred modern health care centers to traditional healers when they had to seek medical attendance. Nevertheless, the survey results indicated that people usually sought the services of traditional healers for bone setting, tonsillitis, hard cases of headaches, cutting of uvula, extraction of milk teeth, illness due to 'evil eyes', measles or what is generally referred to as children's diseases, burning certain parts of a sick person with a hot iron rod, the use of traditional medicine (local drugs) to treat some maladies, etc. It is public knowledge that most of the treatments by local medical practitioners have serious side-effects. The survey also indicated that most of the causes of mortality and morbidity could easily be dealt with at health station level.

Another point of interest in the study area was the prevalence of very archaic practices. Despite attempts at a national level to whittle down some harmful traditional practices like girl circumcision, infabulation, extraction of milk teeth, cutting the uvula, etc., these practices continued to exist in the survey area. Nearly all respondents who had female children reported that they have had their girl children circumcised. The reasons given for such practices are cultural norms. Indeed, almost all the respondents were reluctant to express their ideas about genital mutilation. Their reservation could possibly be explained by the fact that sex-related issues are taboos in traditional societies.

Role of Women in Decision Making and Their Status in the Community

One of the areas where there is a glaring gender inequality is decision making at household level. The survey results showed that the participation of women in the overall decision making processes was very low since most decisions were made by men. However, regarding specific types of decisions women's degree of participation was variable. Table 2 shows that women had a lot of input in decision making regarding food and clothing, areas with little economic importance. However, they played a significant role in decisions involving family income expenditure, sale of farm products and taking part in income generating activities. On the other hand, their role with regard to agricultural production decision making, which was still the domain of the male, was minimal. In short, women's low overall decision making power as perceived by themselves indicated that women have yet to attain equal status in household administration as social and economic unit.

Likewise, women were found relegated to second position in their status in their communities (Table 3). The women in the study area perceived themselves as being highly marginalized. Men received preferential treatments for access to resources, education, information and skill, community leadership, inheritance, and overall decision making (Table 3). Nearly all respondents pointed out that they did not receive training in home economics and/or family planning. This is one factor explaining the existence of a large number of children, genital mutilation of children, higher wastage of cooked food because of archaic storage methods, exhausting and tiresome working conditions, etc.

Table 2. Women's role in decision making at household level

Type of decision	*Decision making power (% respondents)*				
	High	Average	Low	Nil	Total
Family expenditure	16.1	44.6	37.5	1.8	100
Participation in income generating activities	18.2	76.4	3.6	1.8	100
Sale of products	39.3	58.9	0	1.8	100
What to wear	80.4	12.5	7.1	0	100
Type of meal to be cooked	55.4	41.1	1.8	1.8	100
Cropping calendar	12.5	37.5	10.7	39.3	100

Table 3. Status of women in their communities (% respondents)

Status of women	*Disadvantaged*	*Equal*	*Superior*
Public role in community	95.0	5.o	0.0
The right to inherit	87.5	8.9	3.6
Access to resource	54.6	41.8	3.6
Access to education	85.7	12.5	1.8
Access to information and skills	69.6	23.2	7.2
Overall decision making role	85.8	7.1	7.1

One interesting outcome of the survey is the number of hours that respondents worked per day. Almost all respondents pointed out that they worked all day long, beginning at sunrise (dawn) and going to bed after midnight. A woman in the study area worked on average for 12 hours. Moreover, the majority of the respondents, 39 women (69.6%), reported that they worked harder and longer hours than men. This fact is crystal clear even at a national level where rural women commonly work 15–18 hours a day and are responsible for 50% of subsistence agricultural production (TGE/UNICEF 1993).

In order of importance, household work, agriculture related tasks, and income generating activities made up most of a woman's work load in the study area. The gender- and age- based division of labor in the area is presented in Table 4.

Women took the major responsibility of child rearing as well as home and family management. In addition to taking part in major agricultural activities, women were almost solely responsible for fuel gathering, fetching water, marketing, food preparation and processing, gardening, etc. Water fetching was the primary responsibility of women. Of the respondents, 91% said they were the ones who fetched water for the family. On average these women travelled 0.5–4 km to the source of water. Women made one or two visits to the water source per day. Water is usually carried by women on their backs. In some cases they use pack animals such as donkeys and camels. For nearly half of the respondents, (54%) nearby earth dams were their sources of water, while 35% indicated that they used bore holes. Only 11% of the respondents used tap water. There was inadequate access to safe drinking water in all the surveyed areas. The majority of the sampled respondents termed the water " impure".

Table 4. **Involvement of family members in various labor categories**

Activity	*% share of:* Men	Women	Children	*No. of* non-respondents
Cultivation	98.2	0	1.8	1
Animal husbandry	19.5	32.5	48	2
Home gardening	49.3	32.9	17.8	5
Selling produce	14.1	81.3	4.6	3
Purchasing supplies	16.6	81.5	1.9	2
Income generating activities	3.6	89.3	7.1	3
Food preparation	0	98.2	1.8	0
Firewood collection	8.4	81.4	10.2	2
Fetching water	13.4	85	1.6	4
Washing clothes	0	94.7	5.3	2

In all the survey areas the main sources of household energy supply, in order of importance, were firewood, crop residues, and animal dung. Firewood collection was done principally by women who, because of the depletion of the vegetation cover in their proximity, had to walk longer distances in search of wood (up to 4 km). The frequency of firewood collection ranged from once in two days to once a week. The problem of firewood scarcity was compounded by the fact that women used inefficient stoves and open fires for cooking which obviously increase firewood requirement.

To get grain mill service, depending on their proximity, women traveled from 1 to 70 km, but on average they cover a distance of 10 km. They transported their grain/flour either on their backs, or used donkeys or camels, or for far places they used cars. The frequency of their visits ranged from weekly to fortnightly, monthly and even once in two months.

Most Respondents indicated that they went to the nearby towns for marketing purposes. They visited the bigger markets less frequently than the markets nearer to their homes. The average distance a woman had to cover to reach the market place that she frequented was 13 km. The frequency with which they went to market usually depended on their engagements in some kind of trading activity besides their agriculture-related responsibilities. Those who traded in chat and other items regularly went to the market once in two days, on average. Others did their selling and buying activities from a time period that ranged from once in a week to once in a month. But most of the respondents went once in a week or once in a fortnight. They traveled to their respective markets either on foot or by car, depending on the closeness of the market place and availability of modern transportation system. In some cases pack animals were used to transport items to and from the markets.

Women in the study area participated, more actively than men, in non-farm income generating activities. Even though most respondents considered non-farm income generating activities as financially worthwhile, a variety of factors seemed to deter them from being involved in these activities. The survey revealed that the range of income generating activities available to women was very limited. Only 27 respondents were engaged in any non-farm income-generating activities like taking part in terrace construction and afforestation through food-for-work programs (12 women) and trading activities like buying and selling chat, cereals, merchandise or livestock (14 women). These women on average traveled a distance of 2.5 km away from home to do these activities. But the distance they traveled to their work place ranged from a point `close to home' to 5 km.

The non-farm income generating activities were in one way or another related to agriculture which was a clear reflection of the non-diversified nature of the economic activities in the area that made employment in other sectors of the economy impossible. For those respondents who reported to have been involved in income generating activities, lack of initial working capital and knowledge and skill were important limiting factors. The other factors which were cited as being obstacles to fuller commitment of women in non-farm employment, in order of importance, were: much occupation by household responsibilities, reluctance of husbands to permit their spouses to work away from home, cultural constraints, and having no one to look after their small children.

WOMEN AND ANIMAL PRODUCTION

The Role of Women in Agricultural Production

In addition to their preponderant role in household chores, women participated actively in agricultural activities. In general, in all stages of agricultural production, marketing and food processing women were either assisting or directly responsible.

Women in Crop Production

On average a given household possessed 2.5 ha or 10 'qoddis' and managed 2 plots. Of all the respondents, 40% owned and run garden plots. These plots were operated mainly by women and children (90%); men had a marginal role (10%). The produce from these plots was principally (i.e., in 64% of the cases) devoted both to the market and for home consumption. Production either for consumption or sale was only reported by 18% of the respondents. The income from the sale of garden products was controlled by the woman in 77% of the cases, the man (18%) and mutually (5%).

The of crops mostly grown in this region according to the respondents were sorghum, maize, wheat and barely. In crop production, the women indicated that they lent a hand in the following activities, listed, in order of importance: weeding, harvesting, carrying harvested crop to home or site of storage, taking care of garden plots, as well as selecting and safekeeping seed materials. Nevertheless, they indicated that they had a limited role in the demanding task of cultivation. Of the 56 respondents, 36 listed their limiting factors to crop production (Table 5): draft power , lack of improved seeds, and plant diseases.

Women in Livestock Production

In the study area, children and in some cases men, had the responsibility for tending animals. Women's role in livestock production concentrated around the following activities: milking and milk processing; monitoring and feeding young, sick and lactating animals; looking after chickens, sheep and goats around the homestead; collecting fodder, cleaning stables and pens; watching over animals as they leave to and come back from their daily grazing areas. Therefore, women played a pivotal role in animal production.

Table 5. Crop production constraints and their relative importance

Problem	*No. of times cited*
Shortage of rain (drought)	28
Scarcity of draft power	15
Lack of seed	9
Stalk borer	5
Leaf rust	2
Other plant diseases	3
Lack of working capital	1

Table 6. Livestock ownership by household

Type of animal	No. of owning respondents	Total no. of animals	Average no. of animals per household
Milking cow	47	146	3.1
Non-milking cow	23	54	2.3
Calf	42	115	2.7
Heifer	33	87	2.6
Ox	37	69	1.9
Camel	2	2	1.0
Sheep	31	112	3.6
Goats	39	195	5.0
Chicken	25	161	6.4
Donkey	10	11	1.1

The livestock resource endowment per household in the area is shown in Table 6. Among the 53 respondents who owned animals, only 38 (72%) said they produced animal products. Out of these 38 respondents, 35 reported selling animal products. The major animal products produced were milk and eggs. The daily average production of milk was 4.3 Ls per family, of which 2.5 L. (58%) was for sale. The daily average production of eggs was 5 eggs per household of which 4 eggs (80%) were for sale.

The majority of the respondents reported storing crop residues such as maize and sorghum stalks and straw, and also making hay for the dry season. They also said they fed their animals green foliage from weeds and thinned plants from their fields and gardens. They used communally owned grassy areas and hill sides for grazing purposes. Animals were usually taken to nearby earth dams for watering. But the respondents indicated that sometimes it was necessary to take the animals over a long distance to water them. The distance of the watering points from the homestead ranged from 1 to 72 km, the average being 6 km.

Perceptions of the respondents regarding the problems that limited livestock production in the area are summarized in Figure 1. In fact, only 49 of the 56 respondents listed various problems affecting animal production. Animal disease was the most limiting factor in livestock production in the area followed by shortage of water and feed.

Paradoxically, lack or shortage of working capital was the least important problem both in crop and livestock productions. One possible explanation for this is that most farmers might borrow for non-productive purposes. In fact, 82% of the respondents stated that they had borrowed sometimes in the past. Their motivation for borrowing was found out to be consumption needs, i.e., for the purchase of food, clothing, and household items like salt and kerosene. The reasons for borrowing are indicated in Figure 2.

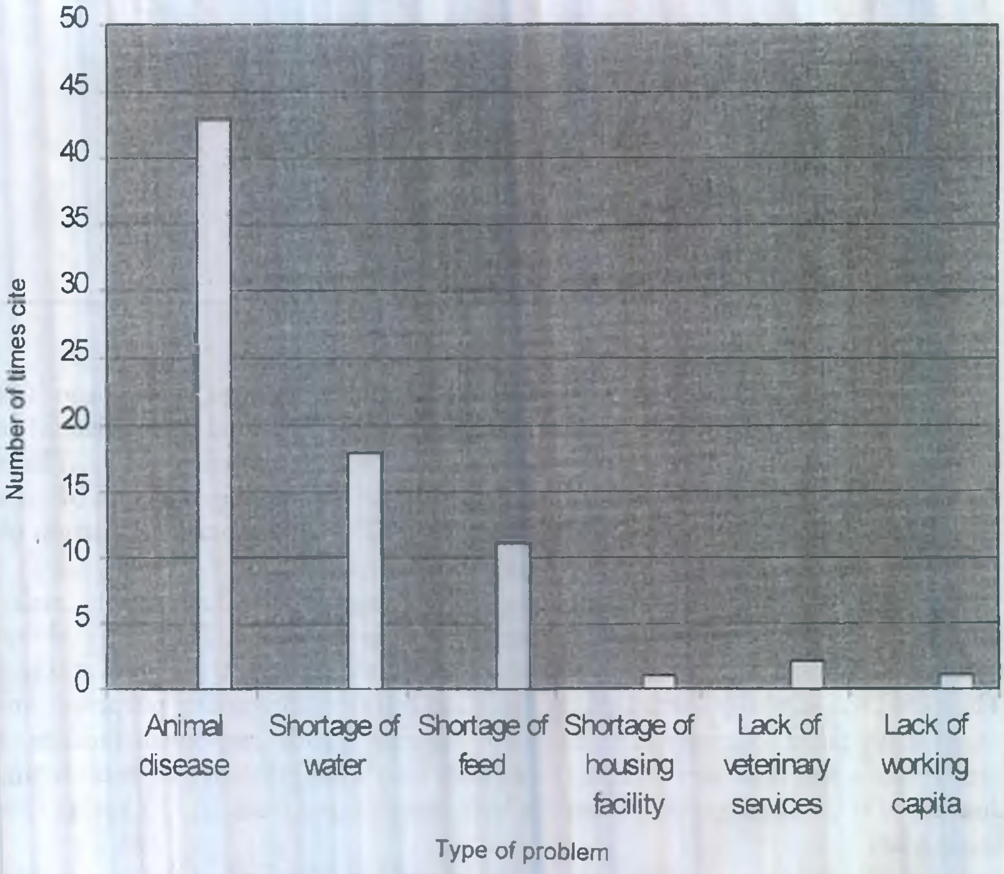

Figure 1. Perceived aimal production constraint

The sources of credit in order of importance are traders/shopkeepers, neighbors/friends, relatives, and other rich people in the area. In general, the survey showed that informal money lenders were a major source of credit. The preference to the informal sources of credit was probably because the lenders were more accessible and responsive to borrowers' needs (even for non-productive purposes) due to the social proximity of the lenders and their relationship with the borrowers. Similarly, the lack of secure collateral to obtain formal credit might have forced the rural population to resort to the informal financial sources.

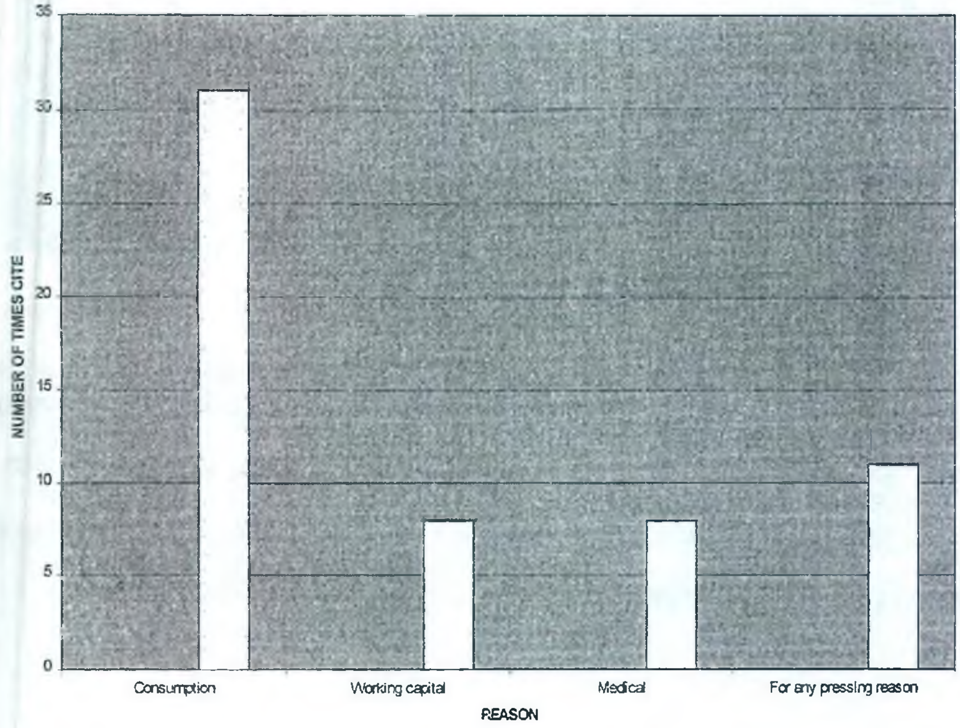

Figure 2. Resons for borrowing

CONCLUSIONS

The survey results have revealed that gender bias takes different forms, such as limited access of women to education, resources and information as well as their relegation to the second rank in making different decisions at a household level. Gender discrimination was more typically found in the allocation of family income, public role in the community, the right to inherit, and overall decision making role in which women are extremely marginalized.

Although women took part in agricultural activities, the so-called domestic tasks were reserved exclusively for them. These included transporting water; fuel gathering; processing, preparing and serving food; caring for children; home gardening; etc. In fact, cultural traditions seemed to continue to reserve these activities to women. With regard to the number of working hours per day, there was a striking difference between the sexes. Most of the sampled respondents indicated working longer and harder than their spouses.

Therefore, the government must give immense political weight to the existing level of gender discrimination. It is true that overcoming this problem in the nation in general and in the region in particular is easier said than done for there are be various obstacles (social, cultural, religious, etc.) and hard core opposition to measures aimed at curbing gender inequalities.

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Rural Women and Poultry Production in Ethiopia

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ABSTRACT

This paper describes the role of rural poultry production as an income source and nutrition in relation to rural women. A brief description of the successful rural poultry production system in Bangladesh is also presented as a model towards which we should work to improve poultry productivity and income for rural women.

Background

Ethiopia is one of the poorest countries in the world, with 60% of the population living below the official poverty line. The current level of food production (including grains, pulses, vegetables, fruits and animal products etc.) provides only 1,600 to 1,700 kcal person^{-1} day^{-1} (FAO (1993), which is below the minimum recommendation of 2 300 kcal person day^{-1}. Protein consumption by children is very low, and is a major contributing factor to the high infant mortality and abnormal growth, which is a serious problem in the country.

Women-headed, disadvantaged and resource poor families living both in towns and rural areas have very low or no incomes. They are underfed, underrated and considered as ignorant and a burden to the society. The problem is not seeing the tangible reality of poverty. The reality, however, is that they do not have the skills and working capital banks do not provide credit to the poor, who do not have collaterals. Given this, it is not surprising that women in rural areas have virtually no access to institutional credit.

More than 85% of the Ethiopian population live in rural areas, and agriculture is the primary source of income. Land in the rural areas is being redistributed time and again (e.g., to newly married couples) which results in successive reduction of land holding per household mainly in the high potential crop/livestock and high potential horticulture/livestock farming systems in the highlands of Ethiopia. Due to this rural unemployment is becoming a serious problem. A socioeconomic survey conducted in one of the villages in the central highlands shows that about 18% of the households have no land and those landless members live by selling their labor, doing off-farm activities and/or petty trade (Tadelle and Olge 1966). The above condition necessitates innovative ideas in order to create job opportunities to offset migration to cities, to increase labor productivity through training and developing an effective input delivery system.

Poultry Production Under the Ethiopian Context

According to Alemu and Tadelle (1997), poultry production systems in Ethiopia show a clear distinction between traditional low input systems, small-scale intensive system and modern production systems.

Large-Scale Commercial System

This system of production is characterized by relatively advanced feeding, health care and housing and owned by government and individuals with a relatively large number of birds from different specialized exotic chicken.

Small-Scale Intensive System

Small numbers (usually 50 to 500 birds) are produced along commercial lines. This system of production is a newly emerging system in urban and peri- urban areas in and around Addis Abeba. This activity is being taken as a source of income especially by ex-soldiers in towns like Debre Zeit.

Traditional or Rural Poultry Production System

This production system is characterized as including small flocks, nil or minimal inputs, with low outputs and periodic devastation of the flocks by disease. Birds are owned by individual households, managed mainly by women and are maintained under a scavenging system with little or no inputs for housing, feeding or health care. Chicken in this system are generally considered as a low grade animal which provide desirable products for the households. Typically the flocks are small in number with each household flock containing birds from each age group with an average of 7–10 mature birds in each household, consisting of two to four adult hens, a male bird and a number of growers of various ages (Tadelle and Ogle 1996).

Women, Income and Poultry

Poultry keeping in most of the developing countries is the responsibility of women. In a study conducted by Tadelle and Ogle (1996) to characterize poultry production systems in the highlands of Ethiopia, it is the women that look after the birds and the earnings from the sale of eggs and chickens are often their only source of cash income (tables 1 and 2). It is, therefore, important to actively involve women in the process of poultry improvement, which has actually been neglected in the past. Most of the poultry extension workers, vaccinators and key poultry farmers are men. In some parts of Ethiopia contacts between female and male extension workers are restricted by cultural and religious factors and information has to be passed indirectly through their husbands. It is important to plan poultry development projects in such a way that women participate actively as poultry advisors, extension workers, and vaccinators as well as poultry farmers. It is, therefore, important to actively involve women in the process of poultry development.

In a country like Ethiopia, chicken keeping could have a tremendous contribution to meet the animal protein requirement of the people. Particularly in poor households both poultry meat and eggs are affordable sources of protein and cash income. Rearing chicken has several advantages; it fits quite well to the condition of poor households. Due to their small feed cost, small space requirement and the low cost of the animals make poultry rearing a suitable activity for the poor. Poultry products are highly marketable and poultry rearing as a business has a high turn-over rates.

Table 1. Mean household ownership of poultry in three villages in the central high lands of Ethiopia from January to December 1995

Village	Owner in the household		
	School boys/ girls	Household women	Others
Derek Wonz (high altitude) (30)	21	72	7
Gende Gorba (medium altitudes) (30)	16	82	2
Awash (Low altitudes) (30)	10	87.5	2.5
Mean	15.2	80.5	3.8

* Number in parentheses are the number of households surveyed
Source: Tadelle and Ogle, 1996

Table 2. Mean ownership of poultry in two peasant associations in Welaita, North Omo region, Ethiopia

Village	*Owner in the household (%)*				
	Senior men	Senior women	Boys	Other adults	Girls
Kokate	30	47	10	-	13
Abele Sipa	65	11	9	12	3

Integration of Poultry Products to the Family Food Supply System

One of the major problems of poultry consumption in Ethiopia is the traditional way of consuming poultry products. Ethiopians are used to consuming poultry in the form of *Doro Wot* which is an expensive way of preparing poultry for consumption and the workload goes to the women who are responsible for food preparation in the family in the Ethiopian context. Many families can thus consume poultry only during special occasions which reduces the demand for poultry. There are, however, many less laborious and less expensive ways of preparing and consuming chicken. Eggs can be cooked in many ways, depending on how many eggs are available for use. If only a few eggs are available per family, say 1 to 3, it is probably best to incorporate them in food stuffs for the whole family, for example, pancakes or maize cakes, or adding egg in the *wot*. If families can afford more eggs and have ready access to a more adequate supply it would be sensible to feed them to small children, probably in the form of scrambled eggs, one egg per child, and also to older people and pregnant women. They can be simply boiled and added to vegetable curries as a main meal for the whole family with the addition of whatever cereals are eaten. Eggs could be incorporated into porridge made of any grain flour; it can be tef, maize, sorghum or any root crop. Similar simple means are available for preparation of chicken meat. Home economists should work hard towards the development of easy-to-use methods.

Past and Present Development Attempts

Attempts have been made to increase protein supply by improving the egg and meat production potential of local birds, and upgrading and crossbreeding with exotic germplasm has been the main focus of research and development organizations. For the last four decades scientists and the government have promoted schemes in which cockerels, pullets, fertile eggs and day-old chicks from selected strains are reared mainly on government poultry stations, and then exchanged for local cockerels owned by rural subsistence farmers or given as such. In the highlands of Ethiopia there has been an introduction of exotic breeds to the three villages at various times and in different forms, such as cockerels, pullets, and fertile eggs, but their impact in upgrading the village chickens has been minimal (Tadelle and Ogle (1996). The farmers were given advice on improved feeding and housing and were asked to remove all remaining local cockerels. In addition, improved hens were introduced to boost egg production in cooperative based intensive poultry farms in rural Ethiopia. However, these approaches led to only limited improvement, due to the high mortality rate of the modern breeds because of their lack of adaptation to the rural environment, poor management, ultimate discontinuation of the schemes and, above all, the farmers' lack of interest and awareness, because the programs were usually planned without farmer (women) participation and without parallel improvement in management and feeding. Many cross-breeding projects failed because the crosses were not accepted by local people, who feared they would be vulnerable to harsh village conditions. However, those development strategies did not pay attention to local social and cultural aspects of poultry production. For example, farmers prefer to have double-combed cocks for sacrifice purposes, in addition to their color preferences (Tadelle and Ogle 1996).

Local scavenging chickens, in addition to providing cash income, have nutritional, cultural and social functions which require consideration from planners, professionals and farmers, which is rarely given. However, planning and execution of research and development work on local birds could result in considerable improvement in egg production performance of local hens (Tadelle and Ogle 1996). As it was emphasized by Tadelle and Ogle (1996), strategic supplementation of birds according to age and production status can be a suitable solution. Generally, non-genetic factors such as poor nutrition, Newcastle disease and other management practices have equal, if not much greater, effect on production parameters than the genetic influence under scavenging systems (Sazzad 1988). The feed resource base for local birds in the villages is from scavenging and it is inadequate for the production of more than around 40 eggs /birds/year. However, supplementation of energy and protein in addition to other management changes can increase egg production by more than 100% (Tadelle and Ogle (1996). The genetic potential of indigenous poultry for egg production and feed conversion has not been achieved because of the prevailing poor management. Exotic birds need additional resources and inputs from farmers to achieve substantial improvements in productivity and profitability by changing to semi-scavenging systems. However, because of very high mortality rates, particularly due to Newcastle disease, farmers are generally reluctant to invest in improvements in feeding, health care and housing for example. The development of a new heat tolerant vaccine that can be administered via the feed opens up the possibility of significantly reducing mortality in village poultry, which should make producers more positive towards genetically improved birds and inputs to improve feeding and housing.

Main Problems in Rural Poultry Development

- A farmer will put no efforts/ investment towards poultry if he is going to lose 60–80% of his flock every second year mainly due to Newcastle disease. This is why this terribly high risk sector of the village farming considered as a low grade animal by the mail and not mentioned as a wealth in wealth ranking exercises and has been left to the women of the village.

- The system is also characterised by huge chick mortality in the first two weeks of life caused by different factors such as disease, predators, and the hostile environment for newly hatched chicks.

- Lacks of training, input delivery system and premature discontinuation of development schemes (project phase-out), generally lack of a self sustaining system.
- Lacks of attention from all of the stake-holders

Opportunities for Improvement

- Village poultry production deserves greater attention from government, research and development organizations, and above all from rural farmers.
- Preferential access to feed by the newly hatched chicks should be given through some kind of creep feeding system.
- Strategic protein and energy supplementation, providing small night enclosures, regular water and disturbing the broody bird results in over 100% egg production increase.
- Vaccination against Newcastle disease with the new heat resistant vaccine administered via the feed will substantially reduce mortality.
- It is important to focus on working with women's groups, both to use their knowledge about poultry production and to improve their incomes.

Implementation Strategies

- Exert intensive effort to change the attitudes of officials and even sometimes farmers to appreciate the great potential of poultry as income and nutrient sources
- Organize women's producer groups which may specialise as feed suppliers, chick producers, chick rearers, fertile and/or table egg producers, etc.
- Training of women in different aspects of poultry production, e.g., as para vets
- Improve input delivery system government organizations, NGOs and other development agencies, e.g., provision of vaccination kits
- Encourage women's participation in extension and other development services
- Strengthen the supply of improved genotypes
- Improve the marketing system

Innovative ideas and programs are required to promote rural poultry production for the improvement of rural household incomes and nutrition, as poultry production is an effective means of transferring wealth from the high income urban consumers to the poor rural and peri-urban members of the community. Small-scale poultry development should therefore concentrate on the rural and peri-urban areas of the country. Such a scheme has been successful in Bangladesh where an organised program that is centered around rural women has resulted in dramatic changes in the country´s poultry production system and incomes of rural women. Ethiopia can draw a good lesson from the experience of Bangladesh.

The Experience of Successful Poultry Development in Bangladesh

This project is being executed by the Bangladesh Rural Advancement Committee (BRAC) which is a local NGO in the country. This project undertakes the following activities in rural Bangladesh.

Beneficiary Training

Initial and refresher training are provided about the management of the following interlinked poultry and poultry-related enterprises.

Poultry workers or women vaccinators—one or two women from each village) trained for 19 days (10 days basic training and 9 days refresher training) in poultry vaccination and disease control measures.

Chick rearers—a number of women from each village will be selected and trained for four days (3 days basic training and 1 day refresher training). Here, 4–5 cycles of 200 day-old chicks are reared up to 8 weeks of age under confinement annually. Chicks are fed on a balanced chick starter ration. The output of this model are 8-week old pullets for sale to key and model rearers.

Key rearers—a number of women from each village, trained for 4 days (3 and 1) in groups of 20-30, one group from each village. They are trained to manage 13 birds (bought at the age of 8 to 12 weeks and soled at the age of around 80 weeks). They keep their birds under semi-scavenging system of management with some grain, oil seed cake and mill by product supplementation. The output of this model includes meat and table eggs.

Model rearers—a given number of women from each village, trained for 4 days (3 and 1) in raising 20 hens, purchased at an age of 8 to 12 weeks and sold at the age of 76 weeks. They keep the birds under confined system for the production of hatchable eggs feeding them with balanced rations. Members of this group are basically experienced key rearers who have acquired a higher level of technical capability. The primary output of this model is hatching eggs but also some table eggs and meat.

Feed producers—two women from each village, trained for three days in the preparation of balanced chicken rations based on locally available feed sources (chick starter, grower and layer rations) required by the chick rearer and model rearers in the village.

Mini-hatchery owners—trained for 21 days in Rice-Husk incubation method and other hatchery techniques.

Credit

The project also provides credit funds for the establishment of the poultry enterprise the women have been trained for. Credit is provided as follows.

Chick rearers receive credit for five cycles of 200 chicks each/year and for construction of a 9 m^2 chick shed.

Key rearers receive credit for units of 13 pullets and the construction of a 5 m^2 hen house.

Model rearers receive credit for units of 20 hens and four cocks and for the construction of a 12 m^2 poultry house.

Poultry workers or vaccinators are provided with vaccination kit consisting of a bag, syringes and needles, a measuring glass, an initial stock of vaccine, a registration book and thermos flask. The money for these start-up kits would be provided by the project but operational cost on credit basis

Feed mixers are also supported with credit for the purchase of equipment (shovels, barrels, local scales, feed bags, etc.) and working capital required for one month stock of feed ingredients.

Mini-hatchery owners are supported by credit and technically to establish the hatchery.

Repayment schedules are variable from 2 to 5 years depending on net cash flow available after financing charges. The marketing of poultry and poultry products is also supported through the establishment of "marketing groups" in the village or in the area with the maximum of three persons in an area. They are also provided with credit for the purchase of containers and local transportation equipment and some money as working capital.

Table 3. Benefit/cost ratio and average daily incomes from each enterprise in five years time

	Chick rearer	Key rearer	Model rearer	Feed mixer
Benefit/cost ratio	1.2	1.94	1.14	1.07
Average daily income/farmer (Taka)*	57.12	47.12	22.49	22.05

* 1 USD=25 Taka
Source: BRAC 1995

The benefit to cost ratio and average daily incomes over a 5-year period of each enterprise is shown in Table 3.

Credit Eligibility Criteria

- A definition of the target group, which could be a man or a women owning not more than 0.5 acres of cultivable land (most of the participants in the project are women).
- No payments overdue on credits provided through the project.
- Group membership.
- Participation in a savings program.
- Participation in awareness generation programs.
- The agreement of the individual members in the groups in group credit.
- The credit may be given either to individuals or group members without any collateral.

Conclusion

Rural poultry production is an important part of the farming systems and needs relatively small additional resources and inputs from farmers to achieve substantial improvements in productivity, profitability and incomes of rural women. However, because of very high mortality rates, particularly due to Newcastle disease, farmers are generally reluctant to invest in improvements like in feeding, health care and housing. The experience of Bangladesh in poultry development indicates that Ethiopia can improve this huge resource it has by using appropriate extension and input delivery systems.

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ROLE AND DECISION MAKING POWER OF WOMEN IN LIVESTOCK PRODUCTION AROUND ADAMI TULU

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ABSTRACT

Arsi men are the heads of households and make major decisions regarding production strategies, purchase and sales or grazing. Women do not have control over such activities. However, women are capable of selling chicken, eggs and butter as these are under their control. Two types of women's associations for supporting each other, locally called *wiijoo* and *geega'o*, have cattle and their products as major items of contribution. In the case of wiijoo women contribute butter as wedding gift while in geeja'o primally the gift of cattle dowry is provided by the family of the bride. Women in Adami Tulu area are engaged in household activities for 14–16 hours beginning from sunrise until bed time. Of this 2–3 hours/day is devoted to livestock activities. Women play the major role of milking cows and goats, churning milk to produce cheese and butter, cleaning and moving out cattle from barn, home-based forage feeding and health management of animals around the homestead. The survey results showed that the contribution of women to the development of livestock is immeasurable. As witnessed by the men respodents, the extent and magnitude of women's involvement in all areas of livestock management is much higher than men. Therefore, any livestock development intervention should consider women as the basis for the success of the program, and training has to be given to women at all levels in animal production.

Introduction

Statistics indicate that 50% of the world's population are women, yet they get only 1/10 of the total economy. This indicates the low status of women in the world (Elsa 1989). The picture would be more bleak if we look at the situation of women in the developing countries, as their lot would be made worse by under-development and poverty. In the traditional rural sector women are active forces engaged in economic activities ranging from food production, processing, preservation, marketing and handcrafts, in addition to their household chores. Home production activities, the backbone of the household economy especially in developing countries, are mainly the responsibilities of women and female children.

A study on the role of Ethiopian rural women in livestock and dairy industry (Hammer 1985) indicates that women look after the household possessions of cows, calves, sheep and poultry. Churning milk for the preparation of cheese and butter is solely a woman's job. In general, the study showed that women spend over 2 hours every day with livestock or livestock-related activities. A woman's role in marketing is no less demanding in rural

Ethiopia. Women usually supplement the family's income by selling the household produce over which they have a control. However, women's roles and responsibilities in different activities have not received sufficient attention. This study was, therefore, made to identify and assess the role and decision making power of women in livestock production around Adami Tulu.

Methodology

Data were collected from literature survey, discussion with the wereda offices of Ministry of Agriculture (MoA) and a preliminary survey carried out around Adami Tulu. Group discussions (interviews) were also carried out with farmers and elders to understand the role and decision-making power of women in livestock. In the preliminary survey, peasant associations were randomly selected and 60 farmers (30 male and 30 female) were interviewed individually using a structured questionnaire administered by a researcher and technical assistants from Adami Tulu Research Center.

Description of the Farming System

Weather Condition

The Adami Tulu area in general has a semi-arid type of climate with an erratic and unreliable rainfall. The mean annual rainfall is 735–782 mm. July-August is the only reliable period for crop production. The average annual maximum and minimum temperatures are 25–27.3 and 12–16 °c. respectively.

Human Population

The total human population of Adami Tulu-Jiddo Kombolcha is 111,926 (CSA 1996). Of this, 55,969 (50%) are males and 55,957 (50%) females. About 80,057 (39,818 males and 40,239 females) live in the rural areas while 31,869 (16,151 males and 15,718 females) dwell in the urban areas. There are 16,479 households of which 740 (4.5%) are female-headed and the remaining male-headed. The family size per household is 9.58 (4.51 females and 5.07 males).

Polygamy and early marriage are common practices around Adami Tulu. All people belong to the Oromo ethnic group of Arsi and speak Oromiffa. In terms of religion, all except few are Muslims. Many children are tied up with livestock herding and only few go to school. Especially girls are not sent to school for the reason that they assist women's work at home.

Cultivated and Pasture Area

According to a report by Ziway Wereda MoA Office, the total area of Adami Tulu-Judo Kombolcha is estimated to be 75223 ha of which, 49.06%, 22.8% and 28.14% is under crop production, grazing land and land used for other purpose.

Major Crops

Crop production is a recent experience for the farmers of Adami Tulu. Fifty or sixty years ago, crop production was not as such practiced for all crops and livestock production was the dominant farming system in the area. The major crops grown are maize, tef and haricot bean and the minor crops are wheat, barely and sorghum. Maize is the most important crop both in terms of proportion of farmers growing and area coverage. About 95% of the maize produced is consumed by the household (Aleligne et al. 1994 and SEDA 1996).

Livestock Resources

The land around Adami Tulu is suitable for livestock production. The predominant type of cattle is the Arsi type. Goats 2 are more selected for breeding next to cattle. About 70% of the smallholders own one or more donkeys, the third most important livestock species after cattle and goat. Livestock production plays an important role in the rural economy of farmers in Adami Tulu. Livestock complements crop production by supplying draft power and manure. Cattle are the most popular animals due to their long time attachment as a result of the people's pastoral habits. Cattle are also considered as indicators of wealth and prestige. In addition, the traditional women's associations for supporting each other, *wiijoo* and *geega'*o, use cattle and their product as the main contribution and dowry items. In wiijoo, women contribute butter for wedding gift, while in the case of geeja'o mainly cattle dowry is provided by the family of a bride. Goats are mainly kept to obtain cash income, for local consumption and milk production. Donkeys are very important for transport purposes. In general, livestock and their products are used as a survival strategy during periods of food shortage.

Role of Women in Rural Life

Household Structure and Education of Respodents

The average family size per household was 8 (5-22). All of the households had male heads and the men had better education than the women (Table 1).

Table 1. Educational level of respondents (%)

Education	Women respodents		Men respodents	
	Husband	Wife	Husband	Wife
Illiterate	10	30	10	70
Basic education	40	50	20	20
2nd grade	10	-	10	-
3rd grade	5	-	10	10
4th grade	10	10	10	-
5th–9th grade	25	10	40	-

Women Labor

The daily activities of women around Adami Tulu include cleaning house, fire preparation from maize stalks or fuel wood, breakfast preparation, milking of cows and goats, churning milk to produce cheese and butter, fetching water, moving out cattle from barn, fuelwood collection, weeding (during rainy season), lunch and coffee preparation, marketing to buy household goods (3 days a week), grain grinding (3–4 days a week), washing clothes, milking cows in the evening, dinner preparation, coffee preparation, cleaning babies and grinding maize grain (locally called *michigo*). Women also prepare food for social gatherings like weddings, funerals and communal farm work, *debo*.

Women also perform such seasonal activities like handcraft work, harvesting, threshing (maize) during dry season, harrowing, assistance during plowing and livestock herding.

The interviewed women reported doing a lot of duties all day long from dawn till going to bed. Their daily activities generally take 14–16 hours. The finding is similar with the patterns observed among other works (IRA/CDR 1983, Coppock 1994). Of total work hour, 2–3 hours/day is devoted to livestock related activities. Women's work days are reported long and dominated by numerous household tasks and care of livestock. Women are less busy in the afternoon than the morning.

Role of Women in Livestock Production

Livestock Management

All women mentioned the chief occupation of farmers around Adami Tulu to be crop and livestock production. All respodents (women and men) described the area as more suitable for cattle, goats, equines and poultry, and they showed continued interest in keeping these animal species. The women indicated donkeys to be very important and indispensable in their everyday lives. Donkeys are normally acceptable and the women find them friendly to work with. Donkeys are the only animals that share women's burden of work in their everyday life.

The sources of milk around Adami Tulu are cows and goats. Men responded that 90% of the milking of cows and goats was done by women and 10% by men, children and women. About 77% of the women mentioned that women were responsible for milking and the remaining 23% replied the task to be carried out by women and children. As in most parts of the country, milking of cows is carried out twice a day (morning and evening). Goats are milked once a day (67% of women respodents) or twice (33%).

Around Adami Tulu, oxen, cows and donkeys are kept in the kaarl; goats and sheep in *gurano* (an open small enclosure, and calves in the house. Barn cleaning is mainly done by women (Table 2).

Women do not give additional feed for milking cows and goats in the dry season. But in the wet season they provide them with green chopped maize after grazing. Women start to milk cows 2 weeks after calving and goats a week after kidding. The weaning age for calves is 1–1.5 years and for kids 3–4 months. Women wean calves by isolating them from their dam, smearing fresh cow dung on the dam's teats and tying of spines around the calves nose. If the dam/doe dies, women usually buy cow or goat milk from another place and feed them with artificial nipples.

Because of critical feed shortages in the dry season, women responded that they do not keep fattening animals. All women respondents agreed that animals are fattened when feeds are abundant in the wet season. Few mentioned that they keep fattening animals.

Table 2. **Participation of women, men and children in barn cleaning (% women and men respondents)**

Activity done by:	*Women*	*Men*
Women	63.4	70
Women and Men	6.7	16.7
Women and Children	26.6	3.3
Children	3.3	
Men and Children		3.3
Men, Women and Children		6.7
% share of women	80	82.15

All women mentioned that they keep poultry. Chicken and eggs are more useful for women to generate income for their daily needs. Birds are free to range and women also provide them with some grains and household debris like pieces of bread and *injera*. In the management of brooding birds, women either hang the birds, tie their wing, prickle their nose with feather and change their places.

In general, women are important actors to the husbandry of animals. They have the major role in determining milk off-take, the home-based forage feeding and health management of nursing calves.

Livestock Feeds and Feeding

The feed resource available to livestock in the Adami Tulu area are mainly grazing land and crop residues. From September to March all animals are fed on available feed resources together. During November to February all animals feed on crop stubble, remaining in the crop fields. Crop residues of different kind are fed to supplement grazing during the dry periods. From March onwards, conserved crop residues of different kinds are selectively given to oxen and milking.

Many farmers practice *godantu*; they take their animals to lake deltas of Shala, Langano and other places during the wet season at the time when each fragment of land is covered by field crops in search of feed and mineral soil, *Bole*. Usually the family heads go with the animals after they finish planting. About 67% of the respondent men mentioned that the responsibility of taking care of children, milking cows and other animals staying home during godantu is done by women; 16% by women and men; 7% by women and children. About 10% did not respond to the question because the whole family moves to godantu together. All women indicated their concern that livestock production suffers from shortage of feeds and grazing area management.

Livestock Watering

The only reliable source of water for livestock around Adami Tulu is River Bulbula. It is available throughout the year with no variation in quantity as it is an outflow of Lake Ziway. Supplementary sources of water can be obtained from rainfall run-off stored in depression around the villages during June to August.

Young calves, kids and sick animals staying at home are given water by women. Water required for this purpose is brought by women (90%) and women and children (10%). About 90% of the women travel long distances to bring water for the animals kept at home by their own back or by donkeys while for the remaining 10% of the women, the water site is near their home. In such cases, women take the animals right to the water site.

Livestock Disease and Control

Anthrax (*aba sanga*), locally called *china*, black leg (*aba gorba*), rinderpest (*desta*) and strepto-thricosis are the common diseases known by the community around Adami Tulu. All women and men mentioned that women are more concerned about the health of their animals. They are fast to inform their husband and they strongly insist their husbands to take those sick animals to the veterinary clinics or treat them locally. Women also treat sick animals with the local drugs they know. Women treat animals with local drugs such as kerosene, butter, oil and pepper in case of bloating and wounds.

Women's Position, Decision-Making Power and Property Right

Women can not decide on livestock purchase and sales or grazing as they are subordinate to men. As the case with the Borana people (Coppock 1994) major decisions concerning production strategies, sales or purchase of ruminant and equine is made by men. Most of the money from the sales of these animals goes to men. Most of the men respondents(67%) reported that they consult their wives before the sale of animals. However, the real reason for this is to avoid the nagging of their wives after they have sold the animal. Women can sell chicken, eggs and butter as these are under their control (decision to be made without the consent of their husbands). Most of the women responded that they are interested in expanding both livestock and crop production (80%) and crop production only (20%).

In case of crop production, planting decisions are taken by men, while women also do not have the right to sell and purchase crops. Although they do not have the "right", women "steal" crops like tef in small quantities to sell it on the market and buy cheaper crops like maize for household consumption or to cover household expenses such as kerosene, coffee and salt. In a study by SEDA (1996) around Adami Tulu, it was reported that caring for trees and decision of planting and cutting is up to the men. Women have no part except collecting dried branches as fuelwood. However, some women indicated that they have planted trees on the home compound on their own initiative.

Household utensils are usually bought by women by selling butter and doing some petty trade, while part of it is given as a bride gift by the girl's family.

Women are not active in community meetings. They play an important role in caring for the sick and elderly in the community. Women participate in meetings of the Wiijoo, a women's association meant for contribution of butter to be given as wedding gifts or other purposes. They work in a group for collective weeding and harrowing.

If a woman is widowed, she is given a chance of marrying to the brother of the late husband. This is a cultural obligation which subsequently help to secure the family in addition to his own. In the community divorce is very rare. Women are not entitled to inherit any family property.

Conclusion

From the results of the survey, it can be concluded that the contribution of women for the development of livestock is very high. As witnessed even by the men respodents, the extent of women's involvement in all areas of livestock management is much higher than men can do in this area. Determining milk off-take, the home-based forage feeding and health management of nursing calves are some of the major activities done by women.

Women in general have the lion share towards the development and increased productivity of livestock than men in these areas. Therefore, any livestock development intervention that is going to be implemented in this area should consider women as the base for the success of its program and training has to be given to women at all levels in animal production.

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WHO IS PUBLISHING ON WHAT SUBJECT IN ESAP?
TRENDS IN THE DIRECTION OF RESEARCH ON ANIMAL PRODUCTION IN ETHIOPIA

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ABSTRACT

Research articles published during 1987–1997 in the proceedings of two animal production fora, National Livestock Improvement Conference (NLIC) and it sequel the Ethiopian Society of Animal and Authorship Production (ESAP), were examined to identify research trends. Over the last ten years, 8 meetings were held and 4 NLIC and 4 ESAP proceedings and 2 ESAP special publications were produced. A total of 277 papers were published, with 34.6 papers on average per issue. Presentations decreased over the years. Plenary papers were totally 56 and group sessions 221, with animal production 88, feeds and nutrition 83, and animal health 50. Few papers dealt with socioeconomic aspects of animal health. Scientists from Institute of Agricultural Research (IAR), Ministry of Agriculture (MoA), higher learning institutions (HLIs) and International Livestock Centre for Africa/International Livestock Research Institute (ILCA/ILRI) were major contributors with 277 papers. Papers on ruminant production were dominant (193), while those dealing with general livestock issues were 59. The most studied species was cattle (97 papers). A total of 140 papers were on on-station research and 86 on on-farm. Papers of female animal were 65 and on male 29, while 149 were not sex specific. Studies involving both sexes were 26 while only 8 dealt with castrated animals or oxen. Women authors appeared on 34 papers, with senior authorship only in 11. A total of 86 papers were published by single and two authors each, while 104 were by three or more authors. The most researched commodity was milk (56%) followed by growth or meat production. The average number of authors per paper was 1.5.

Introduction

Professionals working on various aspects of livestock production in Ethiopia face serious problems in communication and exchange of scientific information. Shortage of national scientific journals and lack of forum for presentation of scientific data are the main ones. Moreover, absence of effective professional associations and societies have hampered the development of scientific culture. In recognition of these facts, the first National Livestock Improvement Conference (NLIC), sponsored by the Institute of Agricultural Research (IAR), was held in February, 1987. The aim was to create a forum where researchers and development workers, teachers and extension advisors in the fields of animal production, animal nutrition, animal health, poultry, fisheries, rangelands, engineering, economics, etc, could exchange ideas, assess past and on-going activities and progress, discuss priorities and formulate future strategies to develop effective national livestock research and development programs in Ethiopia. It was a great hope that through the concerted effort of professionals in various institutions, NLIC would make significant contributions to livestock policy, education and research in Ethiopia.

NLIC continued its contributions and successfully staged three conferences between 1987 and 1991. As a natural evolutionary process, based on the experiences gained in the NLIC proceedings, the Ethiopian Society of Animal Production (ESAP) was born and established on August 17, 1990 and it was immediately charged with the responsibility of organizing the fourth and the last NLIC Conference which was held in November, 1991. Subsequently, ESAP successfully organized and staged four conferences to date.

Compared to other professional societies of animal production in the rest of the world, ESAP is a very young, yet a vibrant, society with lots of challenges and opportunities ahead of it. It has continued to play a central role, under less favorable conditions, bringing together professionals, creating scientific fora communication and documentation of research results in animal production in Ethiopia. Although a life-span of 10 years for NLIC and ESAP is a short period of time, it will be worthwhile and valuable to assess and analyze the nature of research papers published in the proceedings with the objectives of examining the type and nature of research that has been undertaken, understanding the trends in the direction of research in the various aspects of animal production and helping to develop strategies for the direction of future research and development efforts to improve animal production in Ethiopia.

Materials and Methods

All articles including those which appeared in plenary sessions in NLIC proceedings published from 1987 to 1991 and ESAP proceedings published from 1993 to 1997 (Annex 1)were included in the study. Information was collected according to the following parameters: year, institutional affiliation of authors (IAR, AUA, AAU, MoA, etc.), session (plenary, animal production, animal health, feeds and nutrition), species of animal (cattle, sheep, goats, bees, fish, etc.), sex of animal, age group of animals (young, growing, mature) commodity (milk, meat, drought, etc.), location of research (on-station, on-farm, both, general), sex of senior author, number of authors, number of collaborating institutions, discipline (nutrition, breeding, health, etc.), production (milk, meat, honey, etc.), processing (milk, meat, honey, etc.) and activity (growth, milk, meat, traction, etc.). Information was coded and data entered using Dbase IV program, and descriptive statistics was run using the SAS (1987) program. However, since this is an assessment study and due to limitations in the number and distribution of publications, no attempt was made to run proper statistical analysis.

Results

General

A total of 277 papers published in NLIC and ESAP proceedings were analyzed in this study. The total number of papers published by NLIC and ESAP were 178 (64.3%) and 99 (35.7%), respectively (Table 1). The overall average number of articles published per proceeding was 34.6 papers, with an average number of 44.5 and 24.8 papers during NLIC and ESAP. Over the years, the total number of articles presented showed a declining trend both during NLIC and ESAP. NLIC started with 42 (15.2% of the total) papers and ended with 50 (18.1%), while ESAP started with 42 (15.2%) and in 1997 there were only 25 (9.0%) papers. The highest number of papers published was 50 (18.1%) in 1988 and in 1991 followed by 1987 and 1995, with 42 (15.2%) papers each (tables 1 and 2).

Plenary Session

Of the total number of papers presented, 56 (20.2%) were presented during plenary sessions, 88 (31.8%) in animal production, 50 (18.1%) in animal health and 83 (29.9%) in animal feeds and nutrition (Table 1). The ratio between papers presented in plenary and group sessions was 1:4. Of the 56 papers presented in plenary sessions, the focus was on development of animal agriculture (25%), dairy production (20%) and feed resources and nutrition (15%). Other aspects included education, socioeconomics and policy, statistics of livestock resources, etc.

Table 1. **Total number of papers presented during NLIC and ESAP proceedings by year and session**

Year	*Plenary*	*Animal production*	*Animal health*	*Feeds and nutrition*	*Total*
NLIC					
1987	7 (16.7)+	12 (13.6)	9 (18.0)	14 (16.9)	42 (15.2)
1988	6 (12.0)	13 (14.8)	19 (38.0)	12 (14.5)	50 (18.1)
1989	9 (25.0)	13 (14.8)	10 (20.0)	4 (4.8)	36 (12.9)
1991	9 (18.0)	17 (19.3)	12 (24.0)	12 (14.5)	50 (18.1)
Sub-total	31 (17.4)	55 (30.9)	50 (28.1)	42 (23.6)	178 (64.3)
ESAP					
1993	5 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (1.8)
1995	9 (21.4)	16 (18.2)*	0 (0.0)	17 (20.5)	42 (15.2)
1996	4 (14.8)	9 (10.2)	0 (0.0)	14 (16.9)	27 (9.8)
1997	7 (28.0)	8 (9.1)**	0 (0.0)	10 (12.1	25 (9.0)
Sub-total	25 (25.3)	33 (33.3)	0 (0.0)	41 (41.4)	99 (35.7)
Total	56 (20.2)	88 (31.8)	50 (18.1)	83 (29.9)	277 (100.0)

+Figures in parentheses indicate percentages
*Four papers are in animal reproduction
**Three papers are in animal health

Table 2. Total number of papers and papers published in NLIC and ESAP proceedings by session and major contributing institutions

Session	*IAR**	*MoA*	*HLIs*	*ILCA/ILRI*
Plenary	7 (12.5)**	12 (21.4)	7 (12.5)	21 (37.5)
Animal production	55 (62.5)	15 (17.1)	8 (9.1)	4 (4.6)
Animal health	7 (18.9)	12 (32.4)	17 (45.9)	1 (2.7)
Feed and nutrition	53 (55.2)	16 (16.7)	9 (9.4)	10 (10.4)
Total	122 (44.0)	55 (19.9)	41 (14.8)	36 (13.0)

*IAR — Institute of Agricultural Research
MoA — Ministry of Agriculture
HLIs — Higher Learning Institutions
ILCA/ILRI — International Livestock Center for Africa/International Livestock Research Institute
**Figures in parentheses indicate percentages

Group Sessions

A total of 221 papers were presented in various group sessions (Tables 1 and 2): animal production (88/221; 39.8%), feeds and nutrition (83/221; 37.6%) and animal health (50; 22.6%). Tables 1 and 2 show the distribution of papers presented in group sessions over the ten-year period. Of the papers presented in animal production, animal health and feeds and nutrition sessions, 62.5%, 100% and 50.6% were published in the NLIC proceedings, respectively. Even during ESAP between 1993 and 1997, the number of papers presented in animal production and in animal feeds and nutrition declined sharply by half from 48.5% to 24.2% and from 41.5% to 24.4%, respectively. It was also alarming to note that after the formation of ESAP there have been no papers presented in animal health.

Institutions

IAR was the highest published institution with 122 papers (44.0%) (tables 1 and 2). The number of publications from IAR also showed an increasing trend over the years, from 31.5% (56/178) during NLIC to 66.7% (66/99) during ESAP. MoA was the second highest contributor, with a total of 55 papers (19.9%) followed by higher learning institutions (HLIs) (41; 14.8%). ILCA/ILRI scientists contributed 36 (13.0%) papers. Of the papers presented by HLI, AAU and AUA scientists contributed 25 (61.0%) and 13 (31.7%), while the difference came from institutions under the higher education commission. Scientists from abroad contributed 8 (2.9%) papers. Among contributions by scientists from universities, AUA showed a marked and sharp decline over the years. AAU and AUA contributed 24 (13.5%) and 11 (6.2%) papers during NLIC, with a respective decline to 1 (1.0%) and 2 (2.0%) papers during ESAP. The MoA remained an active contributor and was the second highest published institution.

Species of Animals

Data on species of animals studied by various institutions are presented in Table 3. Over the ten-year period, 97 (35.0%) of the papers dealt with cattle, 43 (15.5%) sheep, 13 (4.7%) goats, 59 (21.3%) general livestock issues, 19 (6.9%) sheep and goats and 21 (7.6%) with general ruminant production. Coverage of equine (4; 1.4%), camels (2; 0.7%), fish (2; 0.7%), bees (7; 2.5%) and poultry (9; 3.3%) were very minimal. Papers which dealt with the various aspects of ruminant production dominated the presentations in all the years with an overall contribution of 193 (69.7%) papers. The percentage contributions to ruminant research increased from 57.2% in 1987 to 84.0% in 1997. Among the presentations from the four major contributing institutions, which dealt with the various aspects of ruminant production ranged from 50.9% by MoA to 97.8% by IAR. Papers which dealt with general aspects of livestock production ranged from 17.2% by IAR to 30.1% by MoA. The most researched species by all the four institutions were cattle with proportions ranging from 24.4% by HLIs to 52.8% in ILCA/ILRI. Proportion of papers on sheep production were highest in IAR (23.7%) followed by HLIs (17.1%) and ILCA/ILRI (8.3%). There were no papers presented on sheep production from MoA. However, papers which dealt with both sheep and goats production had a share of 4.1% in IAR, 9.1% MoA, 4.9% HLIs and 8.3% in ILCA/ILRI.

Table 3. Number of papers published in NLIC and ESAP proceedings on different species of animals by major contributing institutions

Species	*IAR**	*MoA*	*HLIs*	*ILCA/ILRI*	*Total*
Major species					
Cattle	42 (34.4)**	20 (36.4)	10 (24.4)	19 (52.8)	91 (36.0)
Sheep	29 (23.8)	0 (0.0)	7 (17.1)	3 (8.3)	39 (15.4)
Goats	4 (3.3)	2 (3.6)	2 (4.9)	2 (5.6)	10 (4.0)
Ruminants	17 (13.9)	1 (1.8)	1 (2.4)	2 (5.6)	21 (8.3)
Shoat	5 (4.1)	5 (9.1)	2 (4.9)	3 (8.3)	15 (5.9)
All ruminants	97 (97.8)	28 (50.9)	22 (53.7)	29 (80.6)	176 (69.6)
Minor species					
Poultry	2 (1.6)	2 (3.6)	4 (9.8)	0 (0.0)	8 (3.2)
Camels	0).0)	0 (0.0)	2 (4.9)	0 (0.0)	2 (0.8)
Bees	0 (0.0)	7 (12.7)	0 (0.0)	0 (0.0)	7 (2.8)
Fish	0 (0.0)	1 (1.8)	1 (2.4)	0 (0.0)	2 (0.8)
Equine	1 (0.8)	0 (0.0)	3 (7.3)	0 (0.0)	4 (1.6)
General	21 (1.2)	17 (30.9)	9 (21.9)	7 (19.4)	54 (21.3)

*IAR — Institute of Agricultural Research
MoA — Ministry of Agriculture
HLIs — Higher Learning Institutions
ILCA/ILRI — International Livestock Center for Africa/International Livestock Research Institute
**Figures in parentheses indicate percentages

Location of Study

A total 140 (50.5%) papers presented were based on work conducted on-station, while 86 (31.1%) were related to activities conducted on-farm (Table 4). The difference of 51 papers covered issues of general livestock production without any reference to either on-station or on-farm conditions. The proportion of papers based on on-station studies ranged from 30.9% in 1987 to 77.8% in 1996. In the NLIC proceedings, only 63 (35.4%) papers dealt with on-station work, while this increased to 67 (67.7%) in ESAP, with only 17.2% of the papers based on on-farm work. Of the 254 (91.7%) papers presented by the four major contributing institutions, 130 (51.2%) were based on studies undertaken on-station, while only 80 (31.5%) were based on studies carried out on-farm. Among the 122 papers presented by IAR scientists, most (82.0%) were results from on-station studies (Table 4). MoA presented the highest percentage (63.6%) of studies carried out on-farm followed by papers from the HLIs (53.7%). The largest proportion (55.6%) of papers from ILCA/ILRI dealt with general livestock production and livestock related issues.

Table 4. Location of research activity of published articles by major contributing institutions

Location	*IAR**	*MoA*	*HLIs*	*ILCA/ILRI*	*Total*
On-station	100 (81.9)**	10 (18.2)	11 (26.8)	9 (25.0)	130 (51.2)
On-farm	16 (13.1)	35 (63.6)	22 (53.7)	7 (19.4)	80 (31.5)
General	6 (4.9)	10 (18.2)	10 (18.2)	20 (55.6)	44 (17.30)

**IAR — Institute of Agricultural Research
MoA — Ministry of Agriculture
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*Figures in parentheses indicate percentages

Animal Sex and Age Groups

A total of 29 (10.5%) and 65 (23.5%) of the papers presented dealt with the male and female animal (Table 5). However, 149 (53.8%) papers dealt with various aspects of general livestock production and were not sex specific. On the other hand, only 8 (2.9%) of the papers dealt with castrates or oxen. Only 26 papers (9.4%) involved work on both sexes of animals. Among papers published by the four major contributing institutions, 28 (11.0%) and 59 (23.2%) dealt with the male and female animal. The highest number of papers, 137 (53.9%), dealt with issues that were not sex specific. Papers that dealt with both the male and female animal were 22 (8.7%). Only 8 papers (3.2%) dealt with castrated animal or oxen. The proportion of papers on the male animal ranged from 3.6% in MoA to 26.1% in HLIs. Similarly, the least percentage of papers on the female animal was from HLIs (14.6%) and the highest from IAR (28.7%). Only 1.6% of the papers from IAR and 8.3% from ILCA/ILRI addressed the castrated/oxen animal. There were no consistent trends over the years in the level of emphasis on any sex group of animals.

Table 5. Number of papers published in NLIC and ESAP proceedings on different sex groups of animals by major contributing institutions

Animal sex	*IAR**	*MoA*	*HLIs*	*ILCA/ILRI*	*Total*
Male	18 (14.8)**	2 (3.6)	4 (26.1)	4 (11.1)	28 (11.0)
Female	35 (28.7)	9 (16.4)	6 (14.6)	9 (25.0)	59 (23.2)
Castrate	2 (1.6)	2 (3.6)	1 (2.4)	3 (8.3)	137(53.9)
Male and female	13 (10.7)	3 (5.5)	4 (26.1)	2 (5.6)	8 (3.2)
Neutral	54 (44.3)	39 (70.9)	26 (63.4)	18 (50.0)	22 (8.7)

*IAR — Institute of Agricultural Research
MoA — Ministry of Agriculture
HLIs — Higher learning Institutions
ILCA/ILRI — International Livestock Center for Africa/International Livestock Research Institute
**Figures in parentheses indicate percentages

Discipline

Major emphasis from IAR was on animal nutrition (39; 29.5%), followed by animal breeding (28; 23.0) and animal feed resources (18.0%). MoA concentrated on animal health (14; 25.5%) followed by feed resources and production systems each with 9 papers (16.4%) and socioeconomics (7; 12.7%). Similarly, HLIs focused on animal health (19; 46.3%) followed by animal nutrition (7; 17.1%) and production systems (5; 12.2%). ILCA/ILRI's outstanding focal areas were animal nutrition (10; 27.8%) and production systems (8; 22.2%).

Gender of Authors

Women authors appeared in 34 (12.3%) papers, 22 during NLIC and 12 during ESAP. In 11 (3.9%) of all the papers, the senior author was a female. Of papers presented by female senior authors (Table 6), 6 were presented by expatriates. However, in 15% of the papers, females were co-authors. Female senior authors published 12 and 32 papers in the plenary and group sessions. Among papers presented in group sessions, 12% were in animal feeds and nutrition, 10% animal production and 5% animal health.

Female authors from IAR, MoA and Farm Africa contributed 55.9%, 20.6 and 17.7% of the papers presented by women respectively. It was also noted that 50% of the papers with female author involved was as a result of one individual only. Moreover, the same individual dominated (11/12; 91.7%) the publications presented in all ESAP proceedings so far. Over the years, the highest number of papers presented by women authors were during the third and fourth NLIC, each with 8 papers. It was, however, interesting to note that 95.1%, 100%, 92.6% and 100% of the papers presented by scientists from IAR, HLIs, MoA and ILCA/ILRI were authored by men.

Table 6. Number of senior authors by gender and major contributing institutions

Gender	*IAR**	*MoA*	*HLIs*	*ILCA/ILRI*	*Total*
Male	116 (95.1)**	50 (92.6)	41 (100.0)	36 (100.0)	243 (96.1)
Female	6 (4.9	4 (7.4	0 (0.0)	0 (0.0)	10 (3.9)

**IAR — Institute of Agricultural Research
MoA — Ministry of Agriculture
HLIs — Higher learning Institutions
ILCA/ILRI — International Livestock Center for Africa/International Livestock Research Institute
*Figures in brackets indicate percentages

Table 7. Number of authors per published paper in NLIC and ESAP proceedings by major contributing institutions

No. authors	*IAR**	*MoA*	*HLIs*	*ILCA/ILRI*	*Total*
1	24 (19.7)**	26 (48.2)	17 (41.5)	7 (19.4)	74 (29.2)
2	35 (28.7)	18 (33.3)	17 (41.5)	14 (38.9)	84 (33.2)
3	35 (28.7)	4 (7.4)	5 (12.2)	7 (19.4)	51 (20.2)
4	20 (16.4)	2 (3.7)	1 (2.4)	6 (16.7)	29 (11.5)
5	8 (6.6)	3 (5.6)	1 (2.4)	2 (5.6)	14 (5.5)
6	0 (0.0)	1 (1.9)	0 (0.0)	0 (0.0)	1 (0.4)

*IAR — Institute of Agricultural Research
MoA — Ministry of Agriculture
HLIs — Higher learning Institutions
ILCA/ILRI — International Livestock Center for Africa/International Livestock Research Institute
**Figures in parentheses indicate percentages

Number of Authors

The number of authors per published paper is shown in Table 7. A total of 86 (31.1%) papers were published by single and two authors each. Papers authored by three persons were 57 (20.6%). A total of 143 (51.6%) papers that have been published involved two and three authors. The number of multiple-authored papers showed marked increase over the years. Among papers published by scientists from IAR, HLIs, MoA and ILCA/ILRI, the number produced by single authors were 24 (19.7%), 17 (41.5%), 26 (48.2%) and 7 (19.4%), respectively. The respective number of papers published by two or three authors was 70 (57.4%), 22 (53.7%), 22 (40.7%) and 21 (58.3%).

Inter-institutional Collaborations

The number of papers published by authors from single or collaborating institutions is presented in Table 8. The number of papers published by authors from a single institution was very high (219, 79.4%) and ranged from 66.7% in year 7 to 100% in year 5. Papers published through collaboration between two and three institutions were 40 (14.5%) and

12 (4.4%), respectively. Collaboration between national institutions was while collaboration with international institutions (within the country or outside) averaged....%. Most of the papers published in collaboration were presented in group than during plenary sessions. Within institution, the number of papers presented by single institution was 98 (80.3%) for IAR, 32 (78.1%) for HLIs, 49 (90.7%) for MoA and 24 (66.7%) for ILCA/ILRI. Papers published through collaboration of two institutions was highest (11; 30.6%) followed by HLIs (8; 19.5%), IAR (15; 12.3%) and MoA (2; 3.7%). A total of 10 papers (5%) were internationally authored while 5 (2%) were internationally co-authored.

Commodity

The commodity focus of the four major contributing institutions revealed that general animal production was of the highest priority, with about 41% of the papers from IAR, MoA and ILCA/ILRI and 46.3% from the higher learning institutions covering the subject. Other major emphasis areas from IAR were meat production or growth of animals (39; 32.0%) and milk production (23; 18.9%). The MoA concentrated on milk production (11; 20.0%) and meat production or animal growth (18.2%). About 12.7% of the papers also dealt with honey production. The HLIs focused mainly on meat production (22.0%), with relatively little emphasis on milk production (9.8%). ILCA/ILRI focused on drought power (22.2%) followed by milk and meat production each with 16.7%

Table 8. **Number of papers published either by a single institution or in collaboration with other institutions by major contributing institutions**

No. institutions	*IAR**	*MoA*	*HLIs*	*ILCA/ILRI*	*Total*
1	98 (80.3)**	49 (90.7)	32 (78.1)	24 (66.7)	203 (80.2)
2	15 (12.3)	2 (3.7)	8 (19.5)	11 (30.6)	36 (14.2)
3	8 (6.6)	1 (1.9)	0 (0.0)	0 (0.0)	9 (3.6)
4	1 (0.8)	2 (3.7)	0 (0.0)	1 (2.8)	4 (1.6)
5	0 (0.0)	0 (0.0)	1 (2.4)	0 (0.0)	1 (0.4)

**IAR — Institute of Agricultural Research
MoA — Ministry of Agriculture
HLIs — Higher learning Institutions
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*Figures in parentheses indicate percentages

Discussion

The major problems encountered during this assessment study was that some papers did not clearly specify the location, animal species, sex, age group, authors affiliation, inter-institutional effort, discipline, etc. The value of these type of information is very apparent and specifications of details should be given due consideration by authors in the future. The average number of papers published per proceeding was found to be low by any standard. It is also alarming to note that the average number of papers presented during ESAP was only slightly higher than half of what had been presented during NLIC. The total number of papers presented during group sessions also went down from 147 during NLIC to 74 during ESAP.

The overall ratio between number of papers presented during plenary and group sessions was satisfactory and should be maintained for the future. Moreover, the proportion of papers presented in the various group sessions was fair, although contributions from animal health were lower. Sharp decline occurred in the number of papers presented in animal production and animal feeds and nutrition during ESAP. Besides, in animal health there were almost no presentations during ESAP. Although specialized and specific areas professional biases could be addressed on a number of different fora, any attempt to isolate or disengage issues of animal health from animal production is deemed for failure, particularly in a country like ours where the production system scenario forces us to decipher the long lasting umbilical tie of livestock production with our lives.

IAR scientists have effectively utilised the NLIC and ESAP fora as a means of disseminating their research results, and they have done so with increased presence and subsequent domination in the total number of papers presented. The second highest contributing institution, MoA, had less than half of the contribution from IAR, and all the higher learning institutions combined only produced exactly one-third of the IAR contribution. The sole Agricultural University in the country, AUA, contributed only 10% of that of IAR. It is also alarming to note that publications from both AAU and AUA were almost insignificant during the period of ESAP. Although the significant contribution of IAR should be appreciated, the low output of research from higher learning institutions should be re-examined. It is known that the School of Graduate Studies at AUA has been an important forum which provides an opportunity for graduate students to undertake theses research under the supervision of their academic supervisors. The information contained in the thesis needs to be published to allow easy reference for public use and for scientific reasons. If the University imposes such a requirement, it will allow an increased opportunity for AUA to contribute to ESAP.

Over the last ten years, research outputs indicated that studies on various aspects of ruminant production dominated with contribution of 193 (69.7%) of the papers. The percentage contribution of research on ruminant animals also increased from 57% in 1987 to 84% in 1997. It was also evident that research on ruminant production was a major preoccupation in IAR with 97.8% of the papers presented so far addressing various issues related to ruminant production. The most researched species was cattle followed by small ruminants production. Ethiopia is one of the countries in the world with a very high ruminant population and one can justify why a relatively large proportion of research effort should be going into this sector. Nevertheless, the attention given to other important species of animals in the country is very discouraging. Species like equines, camels, fish, bees and poultry have important economic role in the country. They are also potentially important in both domestic and international markets.

The dominance of research results conducted on-station was also evident from the papers presented. Presentations by the major research institution, IAR, indicate that 82.0% of the studies were undertaken on-station. The proportion of on-station papers was also increasing over the years, with almost double the number during ESAP than that of NLIC. One possible explanations for this could be that the forum created might have encouraged more number of researchers to publish their results from on-station studies. However, if the trend is as a result of a shift on the emphasis of research, then there is a serious need to re-examine the whole issue.

Both male and female animals are important to any livestock production. The balance in studies between sex groups is an important indicator of the emphasis in livestock production. A relatively large part of information published was not sex specific. This may indicate that papers dealt with general issues of livestock such as feed resources development, nutrition, marketing, policy, etc. Structured studies that utilised a specific sex group were limited. Studies on the male animal were very few with, in fact, experiments restricted only to aspects of nutrition and body growth.. Studies which involved both sexes also showed that the focus was mainly on pre-weaning nutrition and growth. Given the importance of oxen in the country, studies which addressed issues related to this group of animals were very few. Only 1.6% of the papers from IAR dealt with the castrated animal or oxen.

The analysis of publications contributed to NLIC and ESAP has afforded us the opportunity to examine the role of women in livestock research in Ethiopia. It was disappointing to note that above 92% of the publications presented from IAR, HLIs and MoA were authored by men. Although the appearance of names of few women authors in these proceedings is very pleasing, the proportion of representation is unacceptably very low. Given the role of women in livestock production in rural Ethiopia, it appears that very limited women are involved in research to join hands with their male counterparts in the effort to improve the traditional production systems. On the other hand, it was also evident that women involved in livestock production and improvement may have not yet cultivated the culture of communicating their research findings, observations, etc., on such a professional fora. The significance of one women researcher from IAR in the contribution of articles could be viewed from two different angles. First, the individual should be congratulated for taking the leadership in a consistent manner and, second, that she has demonstrated, beyond any doubt, that our women scientists have the capacity to do it and we would like to see more of them contributing to our effort in this line in the future.

The number of authors in each paper presented indicates the extent of teamwork and the inter-disciplinary nature of the work. It also reflects the nature of the development of the research program, the search for financing, sharing resources and expertise in this costly and highly competitive research environment. In this study, about 31% of the papers were published by single authors, with another 31% by two authors. It was also noted that the proportion was particularly higher for authors in MoA and HLIs. Although there is a tendency for scientists within the same institution to work together as revealed from the number of papers published by multiple authors, the proportion of papers published as a result of collaboration between two or more institutions very low. The proportion of papers authored by a single institution was 70%, ranging from 67% for ILCA/ILRI to 91% for MoA. The extent of collaboration between national and international institutions was very low and requires further examination.

Conclusions and Recommendations

Over the last decade, ESAP has made a tremendous stride forward as a professional society in creating the fora for scientific communication and documenting achievements. This can be vividly seen from the continued support and scientific contribution of its members who have solidly shown their professionalism and commitment. Members of ESAP should be proud of their consistent contributions and the scientific quality of the papers published in the proceedings. It has also been evident that members of the Executive Committee have made tremendous efforts in organizing annual conferences and publication of the proceedings. We should acknowledge their contributions and devotion to the advancement of animal production in the country. The financial support and contribution of a number of national and international organizations to enable us publish the proceedings should also be recognized and acknowledged.

A gradual decline in the total number of papers published over the last decade has been observed. Although the difficulties of producing publishable research results in animal production in a short period of time is realized, a number of data from various sources are still awaiting analysis and write-up in various institutions. Scientists should be encouraged to share these information with their colleagues. Publication of finalized information based on theses works of DVM students from the Faculty of Veterinary Medicine and graduate students from Alemaya University of Agriculture should also provide great opportunities for more and more of our scientists, particularly the young ones, to develop scientific culture through the use of this forum.

Although there has been a reasonably acceptable number of papers presented in plenary sessions, care has to be taken in selecting topics for presentation and discussion. Papers for presentation on plenary sessions should reflect issues of general concern to the improvement and development of the livestock sector.

Papers presented in groups discussions have been limited to general animal production, feeds and nutrition and animal health. Although the subject matter of papers approved by ESAP Executive Committee determines the number and types of group sessions to form, limitations to the three areas reflect or indicate the relatively narrow areas of research focus in animal production. The diversity of our livestock resources, the varied agro-ecological zones and the different production systems should have given us the opportunity to address a number of researchable issues in animal production. Unfortunately this does not seem to be the case. The absence of major inputs from other disciplines such as socioeconomics, engineering, technology, etc., needs careful examination of our research programs.

More critically, the sharp decline in the number of articles presented in animal health is alarming and may indicate lack of integrated and multi-disciplinary research programs between animal production and animal health. We cannot afford to ignore the more important interactive problems of various components of animal production and animal health that affect our livestock resources. This is particularly important to a country like ours where the problem of nutrition–health interaction is prominent and apparent. Exclusive research programs in this regard can be scientifically dangerous leading to wrong conclusions, and can only be an academic exercise with little or no impact in solving the problems of our farmers.

Scientists from IAR have effectively utilized this societal forum as an outlet to their research results. This positive contribution should be encouraged to continue in a more effective and organized manner. Looking at the contents of the papers, there appears to be lack of purpose-oriented research focus. This requires re-examining the overall research programs and not projects per se. The low level of participation and contribution from higher learning institutions, particularly AUA, needs to be carefully re-assessed.

Lack of coverage of a wider species of animals is one of the major weaknesses of the national research program. The geographical distribution, production system and the relative economic and social contributions of each species of animals have to be taken into account to ensure fair and rational coverage. Moreover, the coverage of the research program with respect to different age groups and sex of animals within a particular species and commodity focus needs careful examination.

Although the value and contribution of on-station research is realized, there is an increasing tendency for more on-station research. Results from a number of finalized studies might have been shelved until the need and opportunity for further on-farm validation comes. The danger in here is through time, due to lack of background information, we may end up wasting time and resources through repeating/ duplicating the same work. Constant reviews of achievements can be of help in this regard. We need to ensure that on-station research programs are purpose- and goal-oriented and the relative balance and linkages between on-station and on-farm research work should be re-examined.

The number and type of authors of articles could in most instances reflect upon the team effort put into a particular research program. The relatively large proportion of research articles produced by one or two authors may indicate narrow professional approach to complex research problems. Multi-disciplinary research programs need to be encouraged and the tradition of sharing the efforts, resources and finally the rewards should be cultivated. Moreover, the presentation of a very high percentage (80%) of papers from a single institution could also reflect the low level of integration of national research programs. In a country like Ethiopia where resources are very limited, we need to look both inwards and outwards and link up with scientists and institutions (both national and international) to enable us broaden our research base through multi-disciplinary and multi-institutional collaborative efforts.

The results of the above assessment in general indicate the fact that we have all the elements of undertaking sound and purpose-oriented research program to improve animal production in Ethiopia. However, putting the different bits and pieces together through appropriate leadership in the right direction, development of goal-oriented research program with adequate integration and collaboration has to be the responsibility of all researchers in the field if we are to make impact on our farming communities.

Finally, it has been well established that Ethiopian rural women play a significant role in livestock production and management. Although the contribution of women scientists and development experts to the scientific development of animal production is recognized, efforts should be made to see more and more of Ethiopian women scientists contribute to ESAP and the improvement of the livestock sector through research and development.

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The author wishes to thank all the contributors to NLIC and ESAP proceedings for their effort to share their research results. No matter how little, sharing and documentation of scientific information is the basis for the advancement of science and development of a scientific culture. I would like to thank members of the Executive Committees of NLIC and ESAP and a number of individuals who have worked behind the seen for the proper documentation of the information and production of the proceedings.

Annex 1. List of proceedings of National Livestock Improvement Conference (NLIC) and Ethiopian Society of Animal Production (ESAP) used for the study

(IAR) Institute of Agricultural Research . 1987. Proceedings of the First National Livestock Improvement Conference (NLIC), 11–13 February 1987, Addis Abeba, Ethiopia, IAR, Addis Abeba, Ethiopia

(IAR) Institute of Agricultural Research. 1989. Proceedings of the Second National Livestock Improvement Conference (NLIC), 24–26 February 1988, Addis Abeba, Ethiopia. IAR, Addis Abeba, Ethiopia.

(IAR) Institute of Agricultural Research.1991. Proceedings of the Third National Livestock Improvement Conference (NLIC), 24–26 May 1989, Addis Abeba, Ethiopia. IAR, Addis Abeba, Ethiopia.

(IAR) Institute of Agricultural Research. 1993. Proceedings of the Fourth National Livestock Improvement Conference (NLIC), 13–15 November 1991, Addis Abeba, Ethiopia. IAR, Addis Abeba , Ethiopia.

(ESAP) Ethiopian Society of Animal Production. 1995. Proceedings of the Second Conference of the Ethiopian Society of Animal Production (ESAP), 26–27 May 1993, Addis Abeba, Ethiopia. ESAP, Addis Abeba, Ethiopia.

(ESAP) Ethiopian Society of Animal Production. 1995. Proceedings of the Third Conference of the Ethiopian Society of Animal Production (ESAP), 27–29 April 1995. Addis Abeba, Ethiopia. Addos Abeba. Ethiopia.

(ESAP) Ethiopian Society of Animal Production. 1996. Proceedings of the Fourth Conference of the Ethiopian Society of Animal Production (ESAP). 18–19 April 1996, Addis Abeba, Ethiopia. ESAP, Addis Abeba, Ethiopia.

(ESAP) Ethiopian Society of Animal Production. 1998. Proceedings of the Fifth Conference of the Ethiopian Society of Animal Production (ESAP), 15–17 May 1997, Addis Abeba, Ethiopia. ESAP, Addis Abeba, Ethiopia.

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CATTLE BRANDING: ANIMAL CURATIVE OR SKIN DESTRUCTIVE? CASE STUDY AROUND BAKO

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ABSTRACT

A survey was conducted in the Sheboka, Ejaji, Anno, Sire and Jere areas, all within a radius of 35 km from Bako, to see the situation of cattle branding. A total of 12 peasant associations were identified and surveyed. Of a total of 2135 (837 male and 1298 female) cattle observed, 16.2% were branded. There was significant difference among the areas surveyed, reasons of branding and site of branding. The highest proportion of branding was around Ejaji (31.1%) while the lowest was around Sire (2.3%). Reasons for branding were black leg (76.5%), eye-related problem (13.0%), swelling and injury (8.1%) and animal identification and others (2.3%). The sites of branding were around eye, shoulder, jaw, thigh, rump, sides of the body and neck. Branding was practised in all age groups and both sexes, and most of the branding (57.1%) involved more than one part of the body. Branding was preferred to animal clinics by most of the interviewed farmers because the disease they call black leg (Bushoftu)is fatal and does not give time to take animals to clinics which are far from their vicinity, inability of the sick animal to walk a long distance to clinics and financial problems.

Introduction

Ethiopia's livestock resources are large in terms of number, species and natural resources. However, this potential has not yet been fully utilized. It only contributes 15% to the total gross domestic product (Gizaw 1987). This is because of the fact that livestock productivity is impeded by technological, socioeconomic and institutional constraints.

The hides, skin and leather industry is the second, next to coffee, major foreign exchange earner for Ethiopia. It accounts for 16% of the total foreign exchange earnings. With an estimated off-take of 7% cattle total production would be 2.1 million hides. But, owing to improper curing, inefficient collection, competition from, local tanners, and illicit contraband flow to neighboring countries, the amount that actually reaches the central market and eventually the tanneries is further reduced to an average of 1.1 million hides (Zewdu 1995). Besides, miss management at the pre- and post-slaughter operations also contributes to the low income from the hide production. Irreparable damage are done to the hide prior to slaughter. Cultural practices such as branding often exercised for either identification or curative purposes, invariably reduce the quality of the hide. Mechanical injuries such as scratches from barbed wire, thorn bushes, horn gores, yoke callouses and wounds also result in various degrees of hide damage (Williamson and Payne 1965).

Even though most of the causes of hide damage occur around Bako, branding is most commonly practised by farmers in the region. The majority of cattle population reveal branding on various parts of their body. Therefore, this paper will examine and discuss the extent, reasons and causes of cattle branding around Bako.

Materials and Methods

A survey was conducted in 1994/95 in farmers associations around Sheboka, Ejaji, Anno, Sirre and Jerre which are located within a radius of 35 km from Bako. A total of 12 peasant associations were selected purposively based on their accessibility to transport. Herds of cattle were observed for branded hide. Animals of both sexes, all age groups and of different physiological states were included in the observation. Data were collected using data collection sheet prepared for the purpose and analyzed using Chi-squared test.

Results and Discussion

Overall, 16.2% of the observed animals were branded (Table 1). There was significant ($p < 0.01$) difference between area surveyed, reasons for branding and sites of branding. Highest proportion of the cattle was branded around Ejaji and the lowest was observed around Sire (Table 1). This could be probably due to differences in climatological factors and their accessibility to health centers. Four reasons were identified: black leg (locally called *bushoftu*, 76.5%), eye related problem (13.0%), swelling and injury (8.1%) and animal identification and others (2.3%). Seven major sites of branding were also identified: shoulder, neck, thigh, around eye, mandible, sides of the body and rump (Table 2). Branding was practised in all age groups and both sexes, and most of the branding (57.1%) involved more than one part of the body while 43.2% was localized to a single part of the body. Age of the animal had significant ($p < 0.01$) effect on branding. The lowest branding was observed in heifers (7%) and bull calves (7%) than cows (43.2%) and bulls (42.9%). However, the effect of sex was not significant. Branded males (20.7%) were relatively higher than females (13.3%).

Branding was done by hot sickle or iron rod. The size and number of brands depended on the extent of the problem and the farmers good will. The size ranged from 3 to 5 cm and 1 to 2 m. The number ranged from a single brand in one part of the body to as many brands which covered different parts of the body. This also varied with the reason for branding.

Branding was preferred to taking animals to clinic by most of the interviewed farmers for the following reasons: the disease called *bushoftu*, a local name for black leg, is fatal and does not give farmers time to take their animals to clinics, inability of the sick animal to walk a long distance to the clinic, financial constraints and lack of awareness.

Table 1. Distribution of animals branded across areas surveyed

Area	*No. of cattle observed*	*No. of cattle branded*	*% branded*
Sheboka	368	56	15.2^{bc}
Ejaji	631	196	31.1^{a}
Anno	378	37	9.8^{bd}
Sire	569	13	2.3^{bd}
Jere	189	43	22.8^{ac}
Total	2135	345	16.2

Values in a column followed by different letter(s) vary significantly ($p < 0.01$)

Table 2. Distribution of animals branded across site of branding

Branding site	*No. branded*	*% branded*
Shoulder	105	30.4^{a}
Neck	81	23.5^{ac}
Thigh	63	18.3^{ace}
Around eye	40	11.6^{bce}
Jaw	32	9.3^{bde}
Sides of body	14	4.1^{bdf}
Rump	11	3.2^{bdf}
Total	345	100

Values in a column followed by different letter(s) vary significantly ($p < 0.01$).

The practice of branding animals was probably related with the incidence and distribution of the disease which in turn is related with altitude and climatological factors. Considering the above mentioned problems that farmers have, there is no alternative to abandon branding. Farmers have been practising branding since long time ago and they believe that it cures their animals. The site of the body of the animal recommended by professionals does not go with the actual problem. Farmers brand to save the life of the animal at the site which they feel need to be branded. The quality of the hide is secondary to them. In this regard the curative effect of branding needs investigation. The disease that farmers name *bushoftu* has to be clinically identified to confirm whether it is blackleg or not. Moreover, since branding is said to be effective for *bushoftu*, its effectiveness for blackleg has be studied.

Branding around the eye is done after some surgical operations are made by traditional practitioners to prevent the transmission of disease to other parts of the body. This has no practical ground since disease transmission cannot be prevented through making terraces around the eye.

Branding swellings and injured parts of the body is dangerous to the life of the animal. Identification of the type and site of swelling is important. Since, it is done by first making a circular brand around the swelling and then other brands inside the circular brand, or by branding through the tip of thick metal which farmers call *zenezena*, heavy wound could be created which the farmer cannot treat but predisposes the animal to secondary infection. Besides, the internal parts of the body of the animal can be damaged and thus lead the animal to death.

Conclusion

From this study it can be concluded that branding is a technique that has been adopted by farmers through a long time trial and error exercise. Unless, farmers are taught and provided with efficient medical services it would be difficult to stop the practice. Besides, research has to be done to disprove or support the practice in curing particularly black leg, and loss assessment study has to be done in order to quantify the amount of hides lost in the abators due to branding.

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FERTILITY OF *Bos indicus* AND *B. indicus X B. Taurus* CROSSBRED COWS AND HEIFERS AFTER OESTRUS SYNCHRONIZATION IN THE RIFT VALLEY OF ETHIOPIA

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ABSTRACT

This study examined estrus response, estrus response interval and pregnancy rate of *Bos indicus* and *B. indicus* x *B. taurus* crossbred cows and heifers after oestrus synchronization. A total of 101 non-pregnant and cycling animals, composed of 63 Boran (46 heifers and 17 cows) and 38 Boran-Simmental crossbreds (23 heifers and 15 cows) were treated with 2 ml of PGF_2 analogue (Estrumate) intramuscularly. The overall estrus response within 120 hr of treatment was 38.1% for cows and 71.1% for heifers. Crossbred heifers (78.3%) and cows (46.7%) responded better than Boran heifers (65.2%) and cows (29.4%), respectively. The mean estrus response interval was shorter in heifers (58.3 hr) than cows (75.0 hr). However, the overall pregnancy rate was basically similar, 54.3% in cows and 59.8% in heifers. The overall result achieved in the study was acceptable and the procedure used could be adopted to produce uniformly pregnant animals to farmers to allow systematic on-farm performance evaluation.

Introduction

In Ethiopia, research on dairy development have been undertaken over the past three decades by various organizations. A review of these programs indicated minimal impact on the development of the dairy industry. Besides technical and policy constraints, the main limitation has been that most research programs involving on-station activities lacked on-farm components (Kebede 1987 and Kumsa 1993). In order to bridge this gap, Adami Tulu Research Center initiated a small-scale dairy production research program with the objective of on-farm performance evaluation of crossbred cattle. However, because of the seasonal distribution of rainfall and hence available feed resources in the area designing more suitable cattle breeding and management strategy to match feed resources to animal requirements was necessary. Estrus synchronization among animals to be distributed to the farmers deemed as one of the possible strategies.

Estrus synchornization enables animals to conceive at closely similar times, proceed through pregnancy together, produce their offspring in a compact period and help to adjust the period of calving to forage availability (Hunter 1982, Chenoweth 1984, Tegegne et al. 1989). In this respect, the method should facilitate the distribution of uniformly pregnant animals to farmers, allow for smooth operation of on-farm projects, facilitate uniform data collection and managerial decisions. Oestrus response, estrus response interval and pregnancy rates of *Bos indicus* and *B. indicus* x *B. taurus* cross cows and heifers were therefore studied after synchronization with PGF_2. The ultimate goal of this study was to assess the feasibility of distributing uniformly pregnant heifers/cows to farmers and produce uniform group of calves for the next phase of the program.

Materials And Methods

Study Area

This study was carried out at Adami Tulu Research Center, located in the Mid Rift Valley, 167 km south of Addis Abeba. The center is situated at 7^0 9'N and 38^0 7'E, at an elevation of 1650 m. The area has a bimodal unevenly distributed rainfall averaging 760 mm per year. The mean minimium and maximium temperatures are 12.7 and 27.3 ^{0}C, respectively.

The conventional feeding system in the area is grazing supplemented with crop by-products such as tef, wheat and barely straws; haricot beans residue and stovers of maize and sorghum. Feed is commonly scarce from April to June, i.e, until new grasses emerge well. During the period of feed scarcity, most of the supplementary feed is given selectively to plowing oxen and pregnant and milking cows. Furthermore, some farmers are transhumants, Godantu, migrating with their livestock to distant places in search of feed during the wet season when the fields are occupied by crops. Animals are trekked back at the end of the cropping season between October and November to feed on crop stubbles and grasses.

Experimental Animals, Management and Treatment

A total of 101 non-pregnant and cycling animals composed of 63 Boran (46 herfers and 17 cows) and 38 Boran-Simmental crossbreds (23 heifers and 15 cows) were selected from a group of 134 animals after palpation per rectum to establish ovarian activity. Body weight, body condition score (Nicholson and Butterworth 1986), and the size of the left and right ovaries were recorded at the beginning of the experiment (Table 1).

The animals grazed on natural pasture during the day and were kept in an open enclosure at night and were supplemented with native grass hay. Water and mineral licks were available at all times.

Each animal was injected with 2 ml of PGF_2 analogue (Estrumate) intramuscularly. Oestrus detection was made by continuous visual observation using experienced herdsmen in Boran heifers and cows, and mounting o 2 Boran x Simmental crossbred breeding bulls in the case of the crossbred heifers and cows. The Boran cows and heifers were artificially inseminated using semen from a Jersey bull. Estrual state was checked prior to insemination. Animals that failed to respond to treatment were inseminated or served by a bull following their regular cycle. Pregnancy was determined by palpation per rectum 60 to 90 d after insemination. Data on dates and time of oestrus, dates and time of effective service, date of pregnancy diagnosis and number of services/conception were recorded.

Table 1. **Mean (± SD) of body weight, body condition score and ovarian size of experimental animals**

Breed	*Number*	*Weight (kg)*	*Body condition score*	*Ovarian size (mm^3)*
Boran				
Cows	17	312.8±56.0	5.7±1.0	3557 ± 2499
Heifers	46	267.1±42.0	5.7±0.6	2573 ± 1081
Crosses				
Cows	15	397.3±67.5	6.0 ± 0.8	3878 ± 2644
Heifers	23	342.2±64.6	5.9 ± 0.7	3889 ± 2326

Data on estrus response, estrus response interval and pregnancy rates were analyzed using the General Linear Model procedure of the SAS program. The effect of initial body weight, body condition and ovarian size on the above variables were analyzed. The effects of age, breed and breed x age interaction on estrus response interval were also assessed. Except the effect of age, breed and age x breed interaction on estrus response interval separate analyses were done on the data collected from Boran and crossbred cows and heifers.

Results

Synchrony of Oestrus

Within each group (Boran cows, Boran heifers, cross cows and heifers) the effects of weight, body condition score and ovarian size on estrus response were not significant ($p > 0.05$). Within 120 h of treatment, oestrus response was better in heifers than in cows (Table 2). The overall estrus response was 38.1% for cows and 71.7% for heifers. Crossbred heifers and cows responded to treatment better than Boran heifers and cows, respectively. Of the heats observed within 120 hr, 37%, 57%, and 27% were detected at a body condition of 6 in Boran heifers, cross heifers and cows, respectively. In Boran cows, however, the highest percentage was observed at a body condition of 5 (Table 3). A decline in percentage detected was noted as the body condition score moves from 6 to 7.

Table 2. Estrus response within 120 hr or after 120 hr following treatment with PGF2

	Cows				Heifers			
	≤ 120 hr		> 120 hr		≤ 120 hr		> 120 hr	
Breed	No.	%	No.	%	No.	%	No.	%
Overall	12	38.1	20	61.9	48	71.8	21	28.3
Boran	5	29.4	12	70.6	30	65.2	16	34.8
Boran Simmental	7	46.7	8	53.3	18	78.3	5	21.7

Table 3. Estrus response (within 120 hr) and pregnancy rate as affected by body condition score

		Cows				Heifers			
Breed	BCS	No.	Response (%)	No.	Pregnancy (%)	No.	Response (%)	No.	Pregnancy (%)
BORAN SIMMENTAL									
	4	-	-	-	-	1	4.5	-	-
	5	2	13.3	2	13.3	3	13.0	2	8.7
	6	4	26.7	6	40.0	13	56.5	8	34.8
	7	1	6.7	3	20.0	1	4.4	2	8.7
BORAN									
	4	-	-	-	-	-	-	-	-
	5	3	20	3	20	7	15.2	9	19.6
	6	-	-	2	13.3	17	37.0	17	37.0
	7	1	6.7	1	6.7	3	6.5	3	6.5

Estrus Response Interval

The effect of body weight, body condition score, ovarian size, breed, age and breed x age interaction on estrus response interval was non-significant ($p > 0.05$). The mean estrus response interval within 120 hr was shorter in heifers than cows and in crossbred animals than Boran (Table 4). Cross heifers had shorter ($P < 0.05$) mean estrus response interval than Boran cows.

Pregnancy Rate

Pregnancy rates of animals which conceived with less than or equal to 3 inseminations are presented in Table 5. The overall pregnancy rate was 54.3% in cows and 59.8% in heifers. Boran heifers had a higher pregnancy rate than Boran cows while cross cows had a higher pregnancy rate than cross heifers.

Table 4. Interval from treatment to estrus within 120 hr (Mean ± SD) in Boran and Boran x Simmental cows and heifers

		Cows		*Heifers*
Breed	No.	Response interval (hr)	No.	Response interval (hr)
Overall	12	75 ± 12.7	48	58.3 ± 6.1
Boran	5	87.5 ± 13.9	30	65 ± 5.2
Boran X Simmental	7	63.3 ± 11.4	18	51.5 ± 7

Table 5. Pregnancy rate of Boran and Boran x Simmental cows and heifers after oestrus synchronization based on ≤ insemination

	Cows			***Heifers***		
	No.	Pregnancy rate (%)	Body weight (Kg)	No.	Pregnancy rate (%)	Body weight (Kg)
Overall	17	54.3	357.8	43	59.8	301.7
Boran	6	35.3	310.33	31	67.4	268.0
Boran X Simmental	11	73.3	405.2	12	52.2	335.3

The highest pregnancy rate was obtained at a body condition score of 6 in Boran heifers (34.8%), cross cows(40%) and heifers (37%). In Boran cows, the highest value of 20% was attained at a body condition score of 5. This followed a similar pattern to that obtained in estrus response. Of pregnant cows/heifers in each group, the conception rate to first insemination/service was 50%, 35.3%, 54.5% and 50% in Boran cows, Boran heifers, cross cows and cross heifers, respectively.

Discussion

The better estrous response observed in heifers (46.9%) than in cows following the use of the prostaglandin agent was in agreement with the report of Tegegne et al. (1989). The percentage response for heifers was similar to that reported by Tegegne et al. (1989), but the present response for cows was lower than that reported by Mukasa-Mugerwa et al. (1989) and Tegegne et al. (1989). This possibly was associated with the fact that the cows in this study were not bred for a long period of time which might have affected the rate of corpus leutum regression. In this study, the single dose treatment schedule was adopted for cost considerations and practicality. It is recognized, otherwise, that the conventional regime is to use two doses of prostaglandin 12 days apart to pick up all females which were not in the right phase of the oestrus to respond to the first injection (Cooper and Rowson 1975 and Chenoweth 1984).

Crossbred heifers (16.7%) and cows (37%) had higher estrus response to treatment than Boran heifers and cows, respectively. This could be due to two reasons. First, more crossbred animals might have been in the luteal phase at the time of single injection treatment. But, second estrus in zebu tends to be subdued and is usually associated with weak external behavioral manifestations (Mukasa-Mugerwa 1989). This behavior, coupled with the short estrus duration, makes estrus detection difficult in zebu cattle which were bred by artificial insemination.

Estrus was observed 16.7 hr earlier in heifers than in cows and crossbred animals that came into heat 18.9 hr earlier than Boran animals. This followed a similar trend to that of estrus response. The estrus response intervals reported in this study were within the range of values reported in previous works (Orihuela et al. 1983, Landivar et al. 1985, Mukasa-Mugerwa et al. 1989 and Tegegne et al. 1989).

Heifers had a 9.2% higher pregnancy rate than cows. This is in line with the findings of Tegegne et al. (1989). The range of pregnancy rate reported in this study was also comparable to other reports by (Louis et al. 1975, King et al. 1983, Tegegne et al. 1989). The pregnancy rates reported for cross heifers, cows and Boran heifers were also comparable to those reported by Tegegne and Franceschini (1993) for Boran x Friesian crossbred heifers.

In conclusion, the overall result achieved in this study was regarded acceptable for the treatment regime that was adopted. The regime helped Adami Tulu Research Center to distribute uniformly pregnant animals to farmers. The ultimate goal of the study was thus achieved.

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EFFECT OF INCUBATION TEMPERATURE ON PERFORMANCE OF STRAINS OF LACTIC ACID BACTERIA FOR *GEINTO* PRODUCTION

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ABSTRACT

Three single strain [CTR3 (Lbcs-105), CTR4 (Lclld-107), CTR2 (Lcll-16)] and two mixed strain [CTR26 (Lbcs-105 + Lclld-107) and CTR 27 (Leuclc179 + Lclld107 + Lbcs-105)] cultures of lactic acid bacteria were inoculated into autoclaved whole milk (3.9% fat) to investigate the effect of incubation temperatures (21 and 30 °C) on acidity development, production of volatile aroma compounds, organic acids metabolism and sensory properties of the cultured milk after 20 hr incubation. No significant difference was observed between the cultures in the sensory properties of the products produced at the same temperature. The cultured milk produced at 30 °C incubation, however, was shown to have lower sensory scores by all judges than the 21 °C. Concentration of some volatile compounds and organic acids were also influenced by the incubation temperatures.

Key words: Incubation temperature, single strain, mixed strain, organic acid metabolism, volatile aroma compounds

Introduction

A variety of fermented dairy products are produced and consumed in southern Ethiopia. Geinto is a term that refers to cultured whole milk produced by the Sidama people, whose fermentation may be brought about by a number of different bacteria, yeast and mould species that naturally contaminate the fresh milk from various sources. The re-use of fermentation vessels and tools seems to have contributed to certain stability in the cultured milk products produced in the region. The way the milking equipment is handled allows carry-over of some microorganisms from previously fermented milk to the new batch of fresh milk. Variation has been reported in microbial quality, composition, organoleptic properties and market preference of the fermented milk products from southern Ethiopia (Fekadu et al. 1997). These fermented milk products are not only consumed as a cultured milk with cereals, but are also the starting material for processing into various dairy products such as local varieties of soft cheese, butter, and cultured butter milk. Even though several environmental, genetic and technological factors play a role in such product variability, the impact of fermenting microorganisms has the attention of the current study.

The production of shelf stable and reliable quality dairy products can be promoted through introduction of appropriate innovative intervention. Improvement in fermentation technology of traditional producers need to be based on description of the products and understanding of the starters used in production. Understanding the fermentation characteristics of the organisms involved and the metabolites responsible for the desired organoleptic property of the particular product are essential prerequisites to improve the quality of fermented milk products.

Lactic acid bacterium (LAB) is gram positive, catalase negative, non-spore forming rods, cocci or coccobacilli. It includes the genus Lactococcus, Leuconostocs, Lactobacillus and Pediococcus, and are mainly of commercial use and play an important role as essential component of starter cultures in the manufacture of fermented dairy and other food products. LAB ferments lactose and produces mainly lactic acid, acetic acid and carbon dioxide. This group of organisms is also responsible for metabolism of organic acids and concomitant production of volatile aroma compounds such as diacetyl and acetaldehyde. Lactic fermentation of foods is a widely accepted method of preservation, which may impart desirable sensory and nutritional properties to the fermented products.

The flavor of cultured milk is mainly governed by diacetyl (Pack et al. 1964, Speckman and Collins 1968, Veringa et al. 1984), but it is additionally influenced by the acetaldehyde concentration (Lindsay and Day 1965, Lindsay et al, 1965b, Lindsay et al. 1965). Lindsay et al. (1965b) reported that an average diacetyl:acetaldehyde ratio of 4:1 is found with fully flavored cultured products. Rash (1990) reported that higher acetaldehyde proportions may result in flavor defects (e.g., green).

Both the aroma intensity and the sensory impression of a cultured milk product result from a balance between various aroma compounds and CO_2, which are produced by aroma-producing streptococci (Badings and Neeter 1980). Cultures producing CO_2 (CTR27) were shown to have good flavor rating than the non producing ones irrespective of low acetaldehyde and diacetyl content. Citrate is an important precursor for aroma production (Joensson and Petterson 1977, Marshall 1987).

Environmental conditions in each country affect the properties of the predominant native microflora of the milk and this limits the use of a universal starter culture (El-Samragy et al. 1988). Moreover, reports indicate that Leuconostoc cremoris (Cogan 1975, Rysstad and Abrahamsen 1983), and Lactococcus lactis subsp. lactis biovar. diacetyl lactis (formerly known as *Streptococcus lactis* subsp. diacetyl lactis (Cogan 1975) behave differently in pure than mixed cultures. On the other hand, few published works are available about the metabolic property of lactic cultures from natural products from Ethiopia when grown as single strain culture and mixed culture.

Meanwhile, there is a growing interest in the isolation and study of lactic cultures from naturally fermented products and the possibility of making use of promising strains as a starter culture in the dairy processing. Promising strains of LAB were isolated and characterized from traditional fermented milk products in southern Ethiopia (Fekadu 1994). This study was initiated to evaluate some lactic starter cultures composed using strains isolated from geinto, in Ethiopia, for the production of cultured milk products at two incubation temperatures. Sensory properties, metabolism of organic acids and contents of aroma compounds of the fermented milk products are reported.

Materials and Methods

Strains of Lactobacillus casei, Lactococcus lactis and Leuconostoc lactis species isolated from fermented milk products, geinto, (Fekadu 1994) were used as single and mixed strain culture (Table 1). The cultured milks were evaluated following 20 hr incubation for degree of acidification, concentration of organic acids and volatile aroma compounds (acetaldehyde, diacetyl and acetoin), viscosity and coagel firmness. Sensory attributes were compared at both incubation temperatures.

The single and mixed strain cultures were evaluated at two incubation temperatures. Strains originally isolated from the same product were inoculated together in a 1:1 ratio of 1% culture, and the cultured milk was evaluated for organoleptic properties. These cultures had been selected after tests of several choices by test panels composed of four Ethiopians and four Europeans as described in previous work (Fekadu 1994).

Experimental Procedures

Preparation of the milk, inoculation, sensory evaluation on 1–5 scale with 5 points as the best, gel firmness, SMR viscosity and acidity of the cultured milk, production of volatile compounds and organic acid metabolism of the cultures were done as described earlier (Fekadu 1994).

Five starter cultures, three single, CTR3 (Lbcs-105), CTR4 (Lclld-107), CTR2 (Lcll-16), and two mixed, CTR26 (Lbcs-105 + Lclld-107) and CTR 27 (Leuclc-179 + Lclld-107 + Lbcs-105) strain cultures of lactic acid bacteria were inoculated into autoclaved (at 121 °C for 5 minutes) wholemilk (3.9% fat, determined by Gerber method). CTR2 was used as a control culture because of its high viscosity and acetaldehyde production (Fekadu 1994).

Pasteurized (72 °C/15 sec.) whole milk (3.9 % fat) was homogenized at 200 kp/cm2 (atmosphere) at 60 °C and then further heat treated at 90 °C for 15 minutes. The milk was cooled to (21 °C) and aseptically poured into sterile 1 L glass jars, inoculated with 1% starter culture and incubated at 21 °C and 30 °C for 20 hr to investigate acidity development, production of volatile aroma compounds and organic acids after 20 hrs incubation at 21 and 30 °C.

The pH of the fermented milk was determined by a digital pH–meter (Orion Research Model, 701 A/Digital Ionalyzer; Cambridge, Massachusetts, USA) with Orion Electrode (Orion RWU13, 9102 SC, Cambridge, Massachusetts, USA).

For volatile determination, Gas Chromatography with automatic head space sampler, DANI-HSS 3950, (DANI S.P.A, I-20052 Monza (MI), Italy), connected to a Carlo Erba HRGC 5300 Mega Gas Chromatograph (Carlo Erba Strumentazione, 1 20110 Milan, Italy), equipped with a flame ionization detector and capillary column [Chrompak CP SIL 5CB 25 m x 0.53 mm id with a 5 micron phase film thickness (Chrompak International B.V., 4330 Ea Middelburg, The Netherlands)] was used.

Organic acid analysis was carried by High Pressure Liquid Chromatography (HPLC).

Samples were analyzed using a Perkin-Elmer HPLC consisting of automatic sampler (ISS-100), series 4 pump system, UV detector (210 nm) (LC–95). Detector response was monitored by Maxima 820 chromatography workstation (Waters Associates, Dynamic Solutions Division of Millipore, 2355, California). Compounds were identified according to their retention time and quantified by external standard calibration.

For the analysis of the firmness of the coagulum before stirring, a Brookfield viscometer (Brookfield Synchro-Lectric Viscometer, Model RVT, Brookfield Engineering Laboratories, Stoughton, Massachusetts, USA) was used. The spindle TF, length 0.43 inches, and 6 rotations per minute was employed, and the reading was made at 30 seconds. An SMR–viscosimeter (Tip No. 5) was used to determine viscosity after stirring of the sample.

For measurement of whey separation, 30 ml of the cultured milk was poured into a test tube with 17-mm diameter and stored at 4 and 21 °C and checked every second day. The extent of whey separated after 15 days of storage was estimated by measuring the height of separated whey column compared to the total height of the curd in the tube. The experiment was replicated twice.

Table 1. Cultures used in the experiment

CTR2	*Lactococcus lactis* subsp. lactis (Lcll-16)
CTR3	*Lactobacillus casei* subsp. casei (lbcs-105)
CTR4	*Lactococcus lactis* subsp. lactis (Lclld-107)
CTR26	Lclld-107 + Lbcs-105
CTR27	Lclld-107 + Lbcs-105 + Leuclc-179

Statistical Analysis

The data were analyzed using the STATGRAPHICS program (Statgraphics User's Guide 1988). Analysis of variance method was employed in a repeated measures design and means were compared at p = 0.05, using the Tukey's HSD test (O'Mahony 1986).

Results and Discussion

Three single-strain and two mixed-strain cultures (Table 1) were used to produce cultured milk. The sensory attributes of the products evaluated following incubation at 21 °C and 30 °C for 20 hr is given in Table 2. The incubation temperature used in this study was chosen to replicate ambient temperature conditions during rainy season (21 °C) and dry season (30 °C) in Awassa area of southern Ethiopia.

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Table. 2. Sensory scores (flavor and consistency) of cultured milk produced using different cultures at 21 and 30 °C incubation temperatures

Culture	*Incubation temperature (°C)*	*Flavor[1] (1–5 scale)*	*Consistency[2] (1–5 scale)*
CTR2	21	3.62 (0.18)	3.60 (0.15)
CTR3	21	3.75 (0.19)	3.50 (0.10)
CTR4	21	3.82 (0.19)	3.75 (0.09)
CTR26	21	3.80 (0.16)	3.78 (0.10)
CTR27	21	3.82 (0.18)	3.80 (0.10)
CTR2	30	3.35 (0.13)	3.30 (0.10)
CTR3	30	3.55 (0.17)	3.32 (0.12)
CTR4	30	3.62 (0.16)	3.70 (0.13)
CTR26	30	3.58 (0.14)	3.58 (0.10)
CTR27	30	3.58 (0.14)	3.48 (0.10)
Incubation Temperature (°C)	pH	Flavor score (1–5 scale)	Consistency (1–5 scale)
21	4.57 (0.04)	3.76 (0.08)[a]	3.68 (0.05)[c]
30	4.56 (0.03)	3.54 (0.06)[b]	3.48 (0.05)[d]

Initial pH = 6.8; Temp. 1 = 21 °C; Temp. 2 = 30 °C;
Similar letters in the same column indicates absence of significant difference
[1] Average flavor scores and standard error
[2] Average score for consistency and standard error

Flavor scores showed no significant difference ($p < 0.05$) between the cultures studied at the same incubation temperature. However, temperature significantly influenced the flavor score of the cultured milk. All cultures produced product of lower flavor score at 30 °C incubation temperature than 21 °C ($p < 0.05$).

Consistency scores of the fermented milk varied significantly between the test cultures at the 30 °C. Incubation temperature also influenced the consistency score of the products. All products tested had a lower consistency score for the 30 °C incubation temperature than the 21 °C.

Comparison of the single and mixed strain cultures showed that there is no significant difference in sensory properties of the products evaluated (Table 3) at the same temperature. Gel firmness and viscosity values for the cultured milk at 21 and 30 incubation temperatures are presented in Table 4.

Table 3. Average sensory scores (flavor and consistency) of cultured milk produced using different cultures

Culture	pH	Flavor score (1–5 scale)	Consistency (1–5 scale)
Control (CTR2)	4.49 (0.03)	3.49 (0.11)	3.45 (0.09)
Single strain	4.52 (0.05)	3.68 (0.12)	3.56 (0.08)
Mixed strain	4.64 (0.04)	3.70 (0.10)	3.66)0.08)

Table 4. Gel firmness and viscosity of the fermented milk produced using the Ethiopian strains of lactic acid bacteria as starter culture at 21 and 30 °C

Culture	Incubation temperature (⁰C)	Gel firmness[1] (Pascal-seconds)	SMR viscosity[2] (Seconds)
CTR2	21	45 (5)	35.0 (1.0)
CTR2	30	46 (3)	40.0 (0.0)
CTR3	21	35 (5)	25.5 (2.5)
CTR3	30	40 (4)	40.0 (6.0)
CTR4	21	52 (3)	80.0 (18.0)
CTR4	30	48 (4)	30.0 (8.0)
CTR26	21	40 (1)	35.0 (4.0)
CTR26	30	39 (6)	37.0 (1.0)
CTR27	21	40 (0)	55.0 (1.0)
CTR27	30	41 (3)	46.0 (1.0)

[1] Measured by Brookfield viscometer

[2] spindle TC.; 2 Measured by SMR viscosimeter tip No. 5.

Significant difference was observed in SMR viscosity and gel firmness between the test cultures ($p < 0.05$). Gel firmness of cultured milk produced with CTR4 was significantly different ($p < 0.05$) from other cultures (Table 5). This culture was made of the slime producing strain of Lactococcus lactis spp. lactis and was observed producing a viscous product.

Table 5. Average gel firmness and viscosity of the fermented milk produced with single and mixed cultures

Cultures	N	Gel firmness[1] (Pascal-seconds)	SMR viscosity[2] (Seconds)
CTR2	4	45.5 (2.4)[a]	37.5 (1.5)
CTR3	4	37.5 (3.0)[b]	32.8 (5.0)
CTR26	4	39.5 (2.5)[b]	36.0 (1.8)
CTR27	4	40.5 (1.3)[a]	50.5 (2.7)
CTR4	4	50.0 (2.3)[c]	55.0 (16.5)

[1] Measured by Brookfield viscometer spindle TC;
[2] Measured by SMR
Viscosimeter tip No. 5; N = Number of observations
Similar letters in the same column indicate absence of significant difference

Table 6. Estimated volume of whey separated per 10 ml of cultured milk stored at 4 and 21 °C produced using the Ethiopian strains of lactic acid bacteria as starter culture at 21 and 30 °C incubation

Culture	Incubation temp. (°c)	Volume of whey[1] (ml)	Volume of whey[2] (ml)
CTR2	21	0	0
CTR2	30	0	0.05 (0.05)
CTR3	21	1.70 (0.10)	3.35 (0.15)
CTR3	30	2.05 (0.15)	3.60 (0.20)
CTR4	21	1.45 (0.15)	1.90 (0.10)
CTR4	30	1.40 (0.20)	2.15 (0.15)
CTR26	21	0	0.05 (0.05)
CTR26	30	0	0.05 (0.05)
CTR27	21	2.55 (0.05)	3.90 (0.80)
CTR27	30	1.90 (0.10)	3.75 (0.15)

[1] Average and standard error of volume of whey/10 ml of cultured milk stored at < 4 °C.
[2] Average and standard error of volume of whey/10 ml of cultured milk stored at 21 °C.

Although the difference between single and mixed strain cultures in textural measurements was not significant, incubation temperature influenced the viscosity of the cultured milk. Indeed, correlations ($r = 0.53$; $p < 0.05$) between the SMR viscosity and gel firmness of the products were significant. The pH of the fermented milk did not show significant difference between the test cultures. The temperature of incubation had minimal effects on pH of the fermented milk after 20 hr incubation when these cultures were used. All the cultures were able to reduce the pH to below 4.7 and 4.75 at 30 and 21 °C incubation temperatures, respectively.

The amount of whey separated from the curd varied for the different cultures at both temperatures of storage (Table 6). The cultured milk produced at both incubation temperatures exhibited a significant difference in whey separation between the test cultures. CTR27 in which strain of Leuconostoc spp. was part of the culture, maximum whey separation was observed. No separated whey was observed in cultured milk produced with cultures of CTR2 and CTR26 at both incubation temperatures when stored at $<$ 4 °C for 15 days. But storage at 21 °C caused some shrinkage of the curd even when these cultures (CTR2 and CTR26) were used.

Production of Volatile Aroma Compounds

Concentration of volatile compounds and organic acids in cultured milk at the two incubation temperatures are given in Table 7. The incubation temperatures used influenced the concentration of volatiles in cultured milk after 20 hr incubation. The 30 °C incubation temperature resulted in lower concentration of diacetyl and acetaldehyde detected. Concentration of diacetyl was greater in CTR26 than in CTR3 and CTR4 at both temperatures. At the 21 °C incubation acetoin concentration in the cultured milk produced with CTR4 was much higher than at 30 °C. CTR27, a culture in which Leuconostoc lactis strain (Leuclc-179) was a part, showed little difference in concentration of volatiles after 20 hr incubation at the two temperatures. Ethanol concentration was higher at 30 °C incubation than 21 °C. Diacetyl and acetaldehyde content in the mixed cultures was relatively lower at 30 °C incubation. CTR2 culture also showed a marked variation in the concentration of volatile compounds when incubated at the two temperatures.

Organic Acid Metabolism

Pyruvate and formate concentrations were greater in cultured milk samples incubated at 30 °C than 21 °C. Succinate concentration also followed the same trend except in the cultured milk inoculated with CTR3 and CTR26. In all the cultures studied succinate and orotic acid concentrations were much lower than the concentration in the raw milk, which were 582 and 105 ppm, respectively.

Citrate utilization was little influenced by the incubation temperatures after 20 hr incubation. Lactate concentration was much greater in the cultured milk incubated at 30 °C, while orotic acid content was lower at this temperature.

Table 7. Concentration of volatile compounds and organic acids in cultured milk incubated at 21 °C and 30 °C for 20 hr

Volatile compounds and organic acids (ppm)	Start culture (°C)									
	CTR2		CTR3		CTR4		CTR26		CTR27	
	21	30	21	30	21	30	21	30	21	30
Acetaldehyde	3.5	2	4.7	2.83	0.35	0.3	0.28	0.16	-	-
Ethanol	40.0	70	30	50	30	45	35	50.0	25	20
Diacetyl	1.8	1	-	-	7.8	3	9	5.6	1.26	1
Acetoin	80.0	25	7	5	320	150	310	290.0	180	170
Citrate	2200	2500	2660	2600	1200	1100	1600	1000.0	-	-
Lactate	7800	9000	7800	8000	8000	8200	8100	8400.0	8100	8200
Orotic acid	90	88	78	60	76	55	75	58	77	60
Pyruvate	20	35	18	30	38	100	28	70	18	28
Succinate	38	160	250	240	60	140	180	170	155	160
Formatecid	37	200	100	250	100	200	150	230	90	230

Relations Between Chemical and Sensory Parameters

The diacetyl and acetaldehyde production of the test cultures varied considerably between the two incubation temperatures, with the exception of CTR27. Diacetyl values were less than 9 ppm for most cultures at 21 °C. The single strain culture of Lactococcus lactis subsp lactis (CTR4) produced less diacetyl than the mixed cultures (CTR26), where Lactobacillus casei subsp. casei was part of the culture. Benito De Cardenas et al. (1990) reported that the addition of pyruvate to milk or other culture media causes an increase in the formation of acetoin and diacetyl by Lactobacillus spp. They suggested that acetoin production via α-acetolactate is partly inducible in Lactobacillus casei. In CTR4 the concentration of pyruvate was twice as much as detected in CTR3 at both incubation temperatures, whereas lower concentration was observed in mixed cultures. This observation supported the report by Benito De Cardenas et al. (1990), diacetyl production was not observed when the single strain culture CTR3 was used, but higher concentrations were observed in the mixed culture of CTR26.

Yoghurt organisms are known to produce acetaldehyde either from lactose via pyruvate or, as in the case of Lactobacillus delbreuckii spp. bulgaricus, from conversion of the amino acid threonine into a second amino acid glycine (Lees and Jago 1978a, 1978b). There was no significant difference in sensory ratings of products for their flavor between cultures producing either acetaldehyde (> 2.5 ppm) or Diacetyl (5 ppm) or acetoin (> 120 ppm).

In products with Leuconostocs-added culture, citrate was completely degraded (100%) during fermentation. With cultures of Lclld-107 strains (CTR4) and mixed Lbcs-105 and Lclld-107 strains (CTR26), citrate reduction at 30 °C was by 55 and 35%, but 49 and 60% at 21 °C, respectively. Starter culture CTR3 did not ferment citrate but the flavor scores were not different from product with the citrate fermenting CTR4 culture as judged by both panels. Succinate concentration was much higher in milk fermented with CTR3 than that of other cultures and would probably have influenced the flavor of the cultured milk.

As already mentioned above, CTR3, which contained only Lbcs-105, hardly ferment citrate (2662 ppm) but CTR4 (Lclld-107) which partly ferment (0.55%) citrate produced some diacetyl and acetoin. However, when the two strains were used together significant increase in these two volatile aroma compounds were observed at 30 °C incubation. The acetaldehyde level of the mixed strain cultures became lower (0.16 ppm) as compared to the single strain culture (CTR 3), which was 4.7 ppm and 2.83 ppm at 21 and 30 °C incubation temperatures, respectively. Either production or stability of volatile aroma compounds were stimulated at 21 than 30 °C incubation probably due to the slow decline in pH at lower incubation temperatures. However citrate fermentation by the mixed strain culture (CTR26) was favored at the higher incubation temperature (Table 7). The use of Leuclc-179 in addition to the two strains, culture CTR27 brought about 100% utilization of citrate and reduction of acetaldehyde and diacetyl. In CTR27 the concentration of diacetyl was much lower (1.26 ppm) than in cultured milk produced with CTR4 culture, and far lower than the concentration when the two-strain culture (CTR26) was used at both temperatures. This could be due to the activity of the diacetyl reductase after all the available citrate had been utilized. Seitz et al. (1963) reported that the final concentration of diacetyl in a cultured product is dependent on not only the efficiency and rate of conversion of available citrate but also on the relative diacetyl reductase activity of the flavor strains used.

Single and mixed cultures of the Ethiopian strains of LAB could be equally successfully used for the production of cultured milk with acceptable flavor and consistency. The temperature of incubation has been shown to have an influence on metabolic property of the strains and thus on sensory attributes of the product. Minimum whey separation and maximum concentration of diacetyl and acetoin was observed in cultured milk produced with mixed strain culture CTR26. Indeed, in this experiment the two strains were used in equal proportion. However, optimum combination of the two strains need to be determined for best sensory attributes and extended shelf life.

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EGG LAYING PERFORMANCE OF WHITE LEGHORN AND THEIR CROSSES WITH LOCAL BIRDS AT DEBRE ZEIT, ETHIOPIA

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ABSTRACT

Data collected between 1985 and 1991 on egg laying performance of local, White Leghorn (WLH) and their crossbred birds were analyzed with the primary objective of identifying the most productive breed group. Daily egg production per bird (mean = 0.08) and percent hen-housed ((mean = 6%) egg production was lowest in local birds and highest in WLH (0.43, 39%). The average mortality rate of laying hens was highest in local birds (7.1%) and lowest in WLH (2.6%) over the first 6 months of the laying period. There was no difference between breed groups in age at first laying and it ranged between 162 days (5/8 WLH–local crosses) to 172 days (pure WLH birds). Due to lack of adequate number of replicates per breed group, only the data of WLH and 5/8 WLH, 1/2 WLH and 1/4 WLH crosses were subjected to least squares analysis including breed group and year of hatching. The WLH birds were not different from their crosses in laying and survival ability. Among the crossbreeds, 1/4 WLH-local crosses were poor in their laying performance and survival ability. Based on hen-housed egg production over 12-months of laying period, a criterion that considered viability, egg laying performance and persistency of laying, the F_1 native-Leghorn crosses followed by WLH were found to be superior to all other genotypes.

Keywords: Egg laying performance, local, crosses, white Leghorn, mortality.

Introduction

Poultry production in Ethiopia shows a clear distinction between traditional, low input systems on the one hand and modern, more intensive systems using relatively improved housing, feeding, breeding, marketing and processing on the other (Alemu 1995). The major constraints that limit poultry productivity are diseases, poor feeding and management practices, low genetic potential of indigenous birds and poor extension service. In the commercial poultry production system breeding stock are usually imported from international poultry breeding companies whereas in the traditional sector indigenous birds are used. In general, the egg laying performance of indigenous birds is reported to be low (Abebe 1992, Teketel 1986, Bigbee 1965 and WADU 1980) even under 'improved' management conditions.

One avenue for improving the egg production capacity of local poultry breeds is through crossbreeding. It is hoped that exotic x indigenous crosses will be relatively more productive and well adapted to semi-intensive type of management (foraging in the backyard with supplementation by locally produced feed ingredients). With the above objective in mind a crossbreeding program between White Leghorn and local birds was started at Debre Zeit Agricultural Research Center in 1985. As a result, birds with different levels of White Leghorn inheritance were produced and data on egg production, mortality rate and age at first laying were collected. Although some of the results of the study have previously been presented in Annual Reports Debre Zeit Agricultural Research Center (1991), the data collected over the years have not been comprehensibly analysed. The objective of this paper is, therefore, to report on the laying performance and survival ability of local, White Leghorn (WLH) and their crossbred birds.

Materials and Methods

Location

The study was conducted at Debre Zeit Agricultural Research Center which is located at a latitude of 8° 44'N, longitude 38° 58'E, altitude1900 m and with a mean annual rainfall of 851 mm. The mean minimum temperature is 9 °C and the maximum 24 °C.

Breeding and Breed Groups

About 2000 day-old White Leghorn (Shaver strain) chicks used for this experiment were purchased from a state-owned commercial poultry firm in Addis Abeba in 1985. At the same time about 150 local birds were bought from Akaki, Debre Zeit and Mojo markets in Eastern Shewa Zone, Ethiopia. The exact ages of the local birds were not known but were estimated to be between 5 and 6 months.

Birds were housed in deep litter system and each house was provided with waterers and feeders. All birds were fed starter, grower and layer ration composed of noug seed cake, wheat short, corn, meat and bone meal, salt and limestone according to the standard management at the poultry farm. Both feed and water were offered *ad* lib to all birds. Vitamins and mineral premix were not provided to mimic the traditional husbandry practices. Birds were expected to obtain minerals and vitamins from fresh alfalfa leaves and from foraging outside their pen every afternoon.

Initially the breeding program was designed to produce and evaluate reciprocal crosses of native and Leghorn chicks for egg production. The reciprocally produced F_1 female crossbred birds were mated to either pure WLH or local cockerels to produce 3/4 WLH and 1/4 WLH crosses, respectively. The 5/8 WLH crosses were produced by either mating

1/4 WLH cross females to pure Leghorn males or by mating 3/4 WLH females to F_1 males. This was done based on the assumption that the suitable type of breed for the traditional poultry production system in Ethiopia is one which has 62.5% of its genes from White Leghorn and 37.5% from indigenous birds. Later, additional number of 5/8 WLH-3/8 indigenous birds were also produced by inter *se* mating them. The number of replicates (groups or batches) produced and the total number of birds of each breed group at the beginning of the laying period are shown in Table 1. Data were collected on group basis.

Data and Analysis

High level of broodiness was observed among the local birds. From time to time few broody birds among F_1 (local x WLH) and 3/4 local-1/4 WLH crosses were also observed. However, onset and duration of broodiness were not recorded. Date of hatching and date at which birds started laying were recorded for all groups of birds. Daily egg production, number of birds which started laying and death of birds of each breed group were recorded. The editorial procedure followed was to exclude performance data from analysis when the number of birds of a certain batch within breed group did not agree with the sum of the birds that started laying and that died in each month. Additionally when the birds of a certain batch were mixed with those of other batches which had different hatching date, the data of such batches were excluded from the analysis.

As a result of this editorial procedure the number of batches were substantially reduced, particularly when production and mortality over 12 months of laying was considered as a criterion for comparison. At the same time, some of the groups or batches of some genotypes had their production recorded only during the first few months of laying while others had for over 12 months. Thus, the number of observations after 6 months of laying period was much smaller. To include as many breed groups and batches within breed groups as possible in the analysis, the mortality rate and egg laying performance over the first 6 months of laying period was considered as one criterion of comparison. Generally the data collected were used to analyze the following traits:

- Age at first laying;
- Mortality rate, daily egg production per hen and per cent hen-housed egg production over the first 6 months of laying period; and
- Mortality rate, daily egg production per hen and per cent hen-housed egg production over the first 12 months of laying period.

After editing, the local and 3/4 WLH genotypes had data on only one batch (Table 1). They were, therefore, not included in the analyses . Since birds of different breed groups hatched over 5 years (1985–1989) and two seasons (months of the year divided into two, dry and rainy season), the analytical model included genotype, year and season of hatching.

The data were analyzed by the General Linear Model (GLM) procedure of SAS (SAS 1991). The justification for including year and season of hatching was to correct for any possible environmental effects. Preliminary analysis showed that season of hatching did not have statistically significant effect in the analysis of all traits considered.

Table 1. Number of birds, number of groups of each genotype, average mortality rate over the first 6 months of laying period and age at first lay

Genotype	*No. of groups**	*Total no. of birds*	*Mortality (%)*	*Age at first lay (days)*
WLH	8	1581	2.56	172
¾ WLH	1	39	4.24	165
⅝ WLH	9	444	4.66	162
½ WLH	4	127	3.28	164
¼ WLH	4	136	6.1	164
Local	1	116	7.13	-

* Groups (batches) are considered as replicates

Therefore, it was omitted from the final model used to analyze the data. Similarly the preliminary analysis of 5/8 WLH-3/8 native birds produced by the crossing program and later by inter se mating them was not found to be statistically different. Thus, in the final analysis the data of 5/8 WHL-3/8 native crosses was analyzed as one breed group.

Results and Discussion

Mortality Rate

The unadjusted mean mortality rate of birds over the first 6 months of laying was highest in the local birds and lowest in the WLH birds (Table 1). The high mortality rate in local birds could be due to several reasons. First, the local birds may not easily adapt to the indoor type of management provided at the center. It is also likely that pullets which were raised on extensive system of management might have difficulty to adapt to confinement than those hatched from eggs. Secondly, all local birds were bought from different local markets and could have been infected at the time of purchase. This was clearly seen from the high mortality rate observed in local birds between the second and fourth month of laying (result not shown) where it reached its peak at the third month of laying. Similarly, high mortality rate was observed in local birds as compared to WLH birds at Alemaya

(Abebe 1992) and Assela research farms (Brannang and Persson 1990) in Ethiopia. In a similar study in Uganda a mortality rate of growing indigenous birds was observed to be higher than that of imported (Trail 1963) genotypes. In egg laying hens, about the same level of mortality rate was observed in indigenous and crossbred (indigenous x imported) birds (Trail 1963). The second highest mortality rate per month during the laying period was observed in 1/4 WLH–3/4 native birds between the third and sixth months of laying (result not shown).

Table 2. Least squares mean age at first laying and mean mortality rate of birds

Genotype	*Age at first laying (days)*	*Mortality over 6 months of laying (%)*	*Mortality over 12 months of laying (%)*
WLH	170 ± 5	2.1 ± 5.2a*	19.5 ± 7.0
5/8 WLH	162 ± 8	40.9 ± 8.3b	45.9 ± 10.0
1/2 WLH	167 ± 10	7.1 ± 10.3a	32.9 ± 10.6
1/4 WLH	168 ± 9	46.6 ± 9.0b	54.2 ± 8.9

*Means with different letters differ significantly at $p < 0.05$.

In the least squares analysis of mortality rate, involving WLH and their crosses with local, higher mortality rate was observed in 1/4 and 5/8 WLH birds ($p < 0.05$) compared to that of F_1 and WLH birds over the first 6 months of laying period (Table 2). Results of cumulative mortality rate up to 12 months of laying period showed that it increased in all breed groups and the difference between the genotypes was marginally significant ($p < 0.08$); but still the mortality of WLH birds was relatively low. The relatively higher survival rate of the WLH birds in the present study was unexpected. Year of hatching did not have significant effect on mortality rate over both the first 6 and 12 months of laying period.

Age at First Laying

Difference between breed groups in age at first laying was small (tables 1 and 2). The WLH birds were 2 to 8 days older at first laying than their crosses; this difference, however, was not statistically significant. The difference between years of hatching was statistically significant ($p < 0.05$). However, there was no consistent trend. Age at first laying observed in the present study was higher than that reported by Abebe (1992) in Eastern Ethiopia for both local and WLH birds where it ranged between 140 and 149 days.

Egg Production

Hen-day production

The unadjusted mean daily egg production of birds of different breeds over the first 6 months of laying is presented in Table 3 and the adjusted mean over the first 6 and 12 months of laying in Table 4. The performance of the local birds was markedly lower than that of WLH and its crosses. The level of egg production of the local birds which is equivalent to 29.2 eggs/hen/year is comparable to a figure of 34 reported for local Ethiopian birds by Brannang and Persson (1990), but was lower than that reported for indigenous birds in Nigeria (Nwosu 1979). When calculated on monthly basis (result not shown), the egg production of local birds in the present study was similar to that reported by Teketel (1986) at Awassa. Similarly, the unadjusted egg production level of F_1 and 3/4 WLH crosses (Table 3) which on annual basis was equivalent to 106 and 139 eggs, respectively, was comparable to that reported by Brannang and Persson (1990). Trail (1963), working with indigenous Ugandan chickens and their crosses with imported birds, reported higher laying performance than in the present study for F_1 and indigenous birds.

Least squares analysis of the data from the four breed groups (WLH, 1/4 WLH, 1/2 WLH and 5/8 WLH) showed that genotype did not have a significant effect on hen-day production over the first 6 as well as over 12 months of laying periods (Table 4). Among the crossbreeds, 1/4 WLH birds were the lowest producers while the difference between the other breed groups was small. The difference between the 1/4 WLH crosses and the crosses increased as the age of the birds increased (Table 4).

Percentage of hen-housed production

The unadjusted mean per cent of hen-housed production over the first 6 months of laying was lowest in indigenous birds and highest in WLH (Table 3). The relationship between per cent hen-housed production and proportion of genes from WLH was somewhat linear (Table 3). The least squares mean per cent hen-housed production for the different genotype groups is presented in Table 4. Considering percent hen-housed production over 12 months of laying, breed group effect was marginally significant ($p < 0.06$) because both the survival rate and egg laying performance of 1/4 WLH crosses was lower than that of the other genotypes. When breed groups were compared on the basis of per cent hen-housed egg production over 12 months of laying period, the F_1 cross hens were superior. Due to poor persistency of laying and higher level of mortality, the performance of 1/4 and 5/8 WLH crosses dropped considerably.

The superiority of the F_1 crosses particularly when compared to WLH was perhaps underestimated. Because, among the 8 replicates or hatches of WLH which started and continued laying until 6 months of laying period, only 3 batches were included as a group when comparison was made on the basis of 12 months of laying. The data from the other 5 batches were excluded because they either died or were combined with other groups due to smaller number or were simply excluded due to some inconsistencies. One of the shortcomings of this study is that, in the calculation of per cent hen-housed egg production, mortality within groups only was considered but not within genotypes.

Table 3. Mean egg laying performance of different genotypes of birds over the first 12 months of laying period

Genotype	*Hen-day egg production*[*]	*Hen-housed egg production*
WLH	0.43	39
3/4 WLH	0.38	35
5/8 WLH	0.41	34
1/2 WLH	0.29	27
1/4 WLH	0.25	22
Local	0.08	6

[*] Hen-day egg production = total number of eggs produced divided by the product of number of birds that were alive during the laying period and the number of laying days. In the case of percentage hen-housed egg production all the birds that initially started production were considered.

Table 4. Least squares mean egg laying performance of different breeds of birds over the first 6 and 12 months of laying

Genotype	*First 6 months of laying*		*First 12 months of laying*	
	Daily prod/bird	% hen-housed prod.	Daily prod./bird	% hen-housed prod
WLH	0.40 ± 0.05	41 ± 6	0.33 ± 0.03	31 ± 4
⅝ WLH	0.41 ± 0.06	34 ± 7	0.38 ± 0.04	23 ± 6
½ WLH	0.34 ± 0.08	38 ± 10	0.35 ± 0.04	38 ± 6
¼ WLH	0.31 ± 0.07	25 ± 8	0.24 ± 0.04	12 ± 5

Variation between years of hatching was marked when per cent of hen-housed egg production of the first 6 months was considered than egg production over 12 months. Per cent hen-housed production in the range of 10–15% reported for different local ecotypes in Eastern Ethiopia by Abebe (1992) were higher than those observed in the local birds in the present study (result not shown).

General Discussion and Conclusion

The lower egg laying performance and the higher level of mortality observed in indigenous birds in the present study could partly be due to the fact that the indigenous birds are not adapted to indoor type of management. Therefore, future evaluation of indigenous birds should be carried out in a management system that they are adapted to. In addition, the higher mortality rate of the native birds in this particular study could be that the birds were bought as pullets and may have had difficulty to adapt to the new type of management (confinement). When establishing foundation stock for breeding purposes from native flocks it is advisable to start by buying eggs than adult chicks. Newly hatched chicks from eggs will have a better chance of adapting to new type of management than adult birds. The higher level of mortality observed in indigenous birds in the present study and several other studies in Ethiopia clearly demonstrates that higher survival rate and adaptability under scavenging type of management may not mean high level of adaptability in confinement. Indigenous birds that are not used to confinement may be exposed to diseases and stress that have importance in confinement.

Therefore, to have firm conclusion on disease resistance, survival ability and laying performance of indigenous, crossbred and imported birds, there is a need to carry the comparative evaluation under a type of environment that is mid-way between the intensive and extensive systems. An alternative could be to evaluate the genotypes under different management systems.

The initialobjective of this crossbreeding experiment was to evaluate and compare birds with 5/8 of their genes from WLH produced in the following three different ways:

- F_1 females produced from mating of indigenous male to WLH female were backcrossed to indigenous cockerels. The resulting 3/4 native–1/4 Leghorn cross females were then mated to Leghorn males;

- F_1 females produced from mating of male WLH cockerels to indigenous females were backcrossed to indigenous cockerels. Then the resulting 3/4 native-1/4 Leghorn cross females were then mated to Leghorn males;

- F_1 females produced from mating indigenous hens to WLH cockerels were backcrossed to Leghorn cockerels. Then, the resulting 3/4 WLH–1/4 native cross females were then mated to F_1 Leghorn–native males.

The overall breed development program was terminated before adequate number of birds of different batches were produced. If egg production was recorded for each bird, the data could have been adequate to compare the different breed groups properly. However, due to lack of trap nests egg production of birds was recorded for a group of known genotypes. Due to small numbers of batches per breed group even numerically large differences between breed groups could not be detected statistically.

Although the data in the present study are rather limited, it indicates that WLH birds had higher per cent of hen-housed egg production over the first 6 months of laying period. On the basis daily egg production over 12 months of laying period, the 5/8 WLH crosses were better than all other breed groups. However, over 12 months of laying period on the basis of hen-housed egg production, the initially assumed superiority of 5/8-WLH crosses was not maintained mainly due to their lower survival rate.

Among breed groups in the performance on the basis of per cent hen-housed egg production over 12 months of laying period, the F_1 indigenous–WLH crosses were superior followed by WLH. The superiority of F_1 crosses over the other groups in viability, egg laying performance and persistency of laying (i.e., per cent hen-housed egg production over 12 months of laying period) could be due to hybrid vigor.

The management system provided in this experiment was somewhat similar to the management condition of commercial poultry farms in Ethiopia. Some of the possible differences are that birds in this experiment were allowed to forage outside for a limited number of hours during the day and were frequently faced with feeding irregularities. Moreover, the quality of the concentrate ration was rather poor and the animals were not provided with vitamin and mineral premixes. If this was not the case, pure WLH birds when fed on a ration of adequate quality and quantity, produced up to 236 eggs per annum even under Debre Zeit conditions (DZARC 1984). This suggests that quality of feed is a major factor that limited egg laying performance of genotypes evaluated.

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UDDER DAMAGE IN COWS: CONSTRAINT IN SMALLHOLDER DAIRY PRODUCTION AROUND BAKO

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ABSTRACT

The study was carried out to determine the significance and cause of udder abnormality in cows. The study covered 4 districts around Bako Research Center and considered 237 milking cows. Data were collected in the form of interview, physical examination of udder and indirect milk test for mastitis. Using predesigned questionnaire an attempt was made to assess the management (feeding, housing, health care) of these animals. Control measure against ticks was insignificant and all animals were infested with ticks at different levels. This caused traumatic lesions that finally ended with sub-clinical and clinical mastitis and loss of teats and quarters. The level of tick burden has significantly affected ($p < 0.05$) degree of infection. Udder abnormalities were detected on 118 animals by visual examination and palpation. Of these 72% were found to be atrophy of the quarters while 14.4% were mixed type (acute inflammation, gangrenous swelling, abscess). The milk sample test showed that 122 (51.5%) animals were positive for different degrees of mastitis.

Introduction

Although microorganisms are the most obvious cause of mastitis, contributing factors affecting udder skin, the most important barrier against harmful organisms, are of equal importance. These predisposing factors cause skin wound, cut, abrasion or laceration and keratinization. Hence, the major causes of udder damage can broadly be categorized in to abiotic and biotic factors.

The abiotic factors include grass fire, thorny bushes, toxic plants, contaminated bedding, frost bite, damp or wet floor, milking machine and contaminated surgical materials. The biotic factors are virus (FMD, papillomatosis, cowpox, pseudo cowpox, bovine ulcerative mammillitis, bovine malignant catarrhea), bacteria (udder impetigo); fungus (ringworm, mycotic dermatitis), and insects (biting flies, ticks). Grass fire, thorny bush, toxic plants and contaminated bedding are the most common abiotic factors in cases of small-scale farmers. Cows burned in grass fires where most of the damage is done to the ventral part of the body may suffer very severe burns to the teats which may slough altogether or be blocked subsequently by scar tissue. Subsequently, some potentially pathogenic cocci and entero bacteria that are normally found in the faeces, bedding, on the skin and udder of cows, inflammatory exudate and lesion of diseased animals may get access to cause mastitis (Robinson 1983). The lesion can also be the starting point for myiasis due to the fly maggot chrysomya.

The most frequently encountered biotic factors are biting insects. Severe injury to udder or teats may originate from tick bites, especially those with long mouth parts (*Amblyomma* and *Hyalomma* spp). Soon after tick bite there is itching, radial pain and oedematous swelling accompanied by tissue and humeral reaction of host. In resistant host, tissue reactions are more violent and occur earlier, within 48 hr of tick attachment (CAB 1989). After detachment of the tick, the necrotic lesion remains indurated and can discharge for several months. Bacterial complications may set in with abscess formation. This is very frequent in Tropicoequatorial Africa due to Corynebactrium infection of Amblyomma bites.

Injuries to the teats or udder which penetrate to the teat cistern or milk ducts, or involve the external sphincter are commonly followed by mastitis(Blood and Radostits 1989). Once the organisms causing mastitis gain entrance to the udder their direct effect and their metabolic products might cause the milk secreting cells to loose their normal ability to synthesize the constituents of milk. Physiological or pathological alterations of the secreting cells can cause changes in milk yield and milk composition and hence udder infections can greatly influence yield, characteristics, color, odor and pH (Abdelaziz 1989).

Material and Methods

Location

The study was carried out in five districts of Western Shewa (Gedo-Goba, Gedo- Kersa, Tibe, Sheboka and Horro-Dengoro) and three districts of Eastern Welega (Ongobo, Ano and its surrounding and Sire-Moto)

Animals

A total of 237 cows managed under smallscale farm conditions were checked for udder damage, mastitis and its degree of infections. Except for three animals which are Horro x Friesian, all the other animals were pure Horro cows.

Management

Predesigned questionnaire was used to assess every aspect of the management system including feeding, housing, health care, production level and tenure of mastitic cows. The farmers were also interviewed about the hygienic practices that they normally exercise before and after milking, and in the order of milking mastitic and non-mastitic animals.

Examination

At first animals were examined visually for symmetry, abnormality, size and color of the udder. Furthermore, a thorough examination was done by palpation to see the normal consistency, to check for acutely inflamed glandular tissue, gangrenous and purulent conditions, and atrophy of the parenchyma of the quarters. Milk sample from each quarter of each cow was taken by a strip cup after washing and dressing the teats with 70% ethanol alcohol. The milk sample was immediately tested with California mastitis test solution for mastitis and its degree of infection. The degree of infection was grouped into three: trace (mild), moderate and severe.

Tick Samples Identification and Quantification

Tick sampling was done for different level of infestation: mild, moderate or heavy type. The ticks were collected from the udder region (insertion of suspensory ligament at the hind of the animal to the caudal part of the umbilicus) manually and counted immediately. Ticks were collected from 20 sampled animals and sorted to different genuses.

Data Analysis

Proc glm (SAS 1987) was used to calculate the anova, type I and III sum squares. The model used considered degree of infection as dependent variable; whereas age, daily milk yield, stage of lactation, tick burden, quarter condition, blind teat and site were taken as independent variables.

Results

Observation on the management system indicated that 16.9% of the examined animals were sheltered in the tukul during the night, while the others were kept in open kraals. All animals were grazed for 8–10 hr on natural pastures under high stocking. Most of the lactating animals 65% were supplemented with residue of local brewery, *atala,*(65%) and common salt at milking time . In the absence of the supplement lactating cows were allowed to graze early in the morning before milking. Only animals close to veterinary clinics (30.8%) get veterinary services.

Abnormalities of the udder in size and consistency of the quarters were seen and felt on 118 (49.8%) animals by visual inspection and palpation. About 20% of the total quarters were unsymmetrical. By palpation it was found that 72% of udder abnormality was due to atrophy of the quarters, 0.9% gangrenous swelling, 12.7% abscessation and 14.4% mixed type. About 99 animals (41.8%) had 1–3 blind teats. The physical test on milk was carried out on all animals in indirect test method, California Mastitis Test (CMT) and 122 animals (51.5%) were positive for mastitis out of which 24% had blind teats.

All the test animals were infested with ticks, and tick burden significantly affected ($p < 0.05$) the degree of infection of mastitis. A total of 1022 ticks were collected from udder of 20 cows. Four genuses were identified and 93.7% of the collected ticks were found to be the genus Amblyomma (Table 1). Tick burden was categorized in to three infestation levels: mild infestation with an average of 23 ticks (ranging 10–33); moderate infestation with of 45.8 ticks (ranging 39–53), and heavy infestation of 93 ticks (ranging 66–190). Similarly, quarter condition and daily milk yield ($p < 0.001$) and age ($p < 0.01$) affected degree of infection. Least square means for tick burden quarter condition and daily milk yield are presented in Table 2.

Table 1. Tick identified species in the districts around Bako

Tick species	*No. collected*	*%*
Amblyomma spp.	958	93.7
Hyalomma spp.	50	4.9
Repicephalus spp.	3	0.3
Haemaphisalis spp.	6	0.5
Boophilus spp.	5	0.6

Table 2. Least square means for effects of quarter condition, tick burden and daily milk yield

Source	*No.*	*Degree of infection*
Overall mean	237	0.94
Quarter condition		***
0	116	-0.26 ± 0.21
1	86	0.60 ± 0.16
2	2	1.70 ± 0.66
3	16	1.43 ± 0.25
4	17	1.78 ± 0.21
Tick burden		*
1	77	1.31 ± 0.22b
2	100	1.17 ± 0.22b
3	60	1.66 ± 0.23a
Daily milk yield		***
0	3	0.81 ± 0.74
0.25	26	2.00 ± 0.38
0.5	33	2.13 ± 0.17
1.0	85	1.63 ± 0.16
1.5	45	1.50 ± 0.23
2.0	15	1.17 ± 0.20
2.5	20	0.89 ± 0.29
3.0	6	1.10 ± 0.46
3.5	3	1.14 ± 0.86
4.0	5	1.44 ± 0.85

*, $p < 0.05$; **, $p < 0.0$; ***, $p < 0.00$
Means followed by different letters are significantly different.

Stage of lactation and site or location of the animals did not influence ($p > 0.05$) the degree of infection. Least square means for Stage of lactation , site or location and age are shown in Table 3. The highest frequency for degree of infection was attained by trace level of infection on most of the animals followed by moderate infection both of which are subclinical in manifestation. The clinical cases were manifested on 40 animals in the form of severe or acute inflammation of the quarters. There was positive correlation between tick burden and degree of infection ($r = 0.14$, $p < 0.03$). But degree of infection and daily milk yield and tick burden and daily milk yield were negatively correlated ($r = -0.32$, $p < 0.001$, $r = -0.23$, $p < 0.0003$), respectively.

Table 3. Least square means for effects of stage of location, age and site of location of animals

Source	*N*	*Degree of infection*
Overall mean	237	0.94 ±
Stage of location		NS
1	46	0.83 ± 0.21
2	93	1.13 ± 0.20
3	98	1.18 ± 0.19
Age		**
4	6	1.84 ± 0.53
5	45	1.11 ± 0.24
6	23	1.07 ± 0.24
7	27	1.38 ± 0.25
8	42	1.28 ± 0.23
9	17	1.45 ± 0.28
10	36	1.44 ± 0.23
11	14	1.40 ± 0.29
12	27	1.45 ± 0.25
Site or location		NS
1 (Bake Tibe)	31	1.07 ± 0.23
2 (Anno)	34	1.22 ± 0.22
3 (Horro Dongoro)	23	0.53 ± 0.26
4 (Gedo Goba)	31	1.10 ± 0.24
5 (Gedo Karsa)	43	1.15 ± 0.22
6 (Sire Moto)	23	1.33 ± 0.26
7 (Sire Yubdo)	52	1.00 ± 0.19

**, $p < 0.01$; NS, not significant

Discussion

Management in terms of both nutrition and health service is a limiting factor for optimum production. Although good hygiene at milking is useful to reduce exposure to mastitis, in all visited farms hygienic conditions were poor. The hands of the milkers and the udder were not properly washed. There was no routine exercise followed to avoid or control mastitis. As observed from the surveyed farms, the majority of the animals were kept in muddy kraals at night which undoubtedly could exposed them to mastitis.

Abdelaziz (1989) reported that mastitis is considered to be one of the most important causes of culling cows in dairy herds in the Sudan. This report goes in line with this survey result in which almost all farmers interviewed reported mastitis and udder problem as main causes of culling highly productive and young dairy cows. 72% Of the examined animals, were with permanently lost atrophied quarters and blind teats.

Ticks that are armed with long mouth parts attach to the lower part of the body where the skin is thicker, such as dewlap, groin, udder and teats, perineum and margin of the anus. They are known to cause skin and hide damage and also udder and teat wounds with secondary mastitis caused by opportunistic environmental pathogens and myiasis. Belete and Fiseha (1988) reported that from the tick fauna in Nekemte Awraja 57.8% belonged to the genus Amblyomma and 1.8% to Hyalomma. Similarly, the highest proportion of tick species identified during the survey belonged to the genus Amblyomma and Hyalomma both of which are known for their long mouth parts. Clinical records on both farmers milking cows brought to Bako Research Center veterinary clinic and on the center animals veterinary records showed high incidence of udder and teat damage mostly caused by tick-inflicted wounds.

This study demonstrated that failurity to stick to routine hygienic and preventive measures would cause permanent udder damage, and hence loss in productivity and culling of highly productive animals.

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Growth Performance of Boran and their Simmental Crossbred Calves at Adami Tulu

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ABSTRACT

Calf records on 118 Boran and their Simmental crosses of different blood levels were analyzed to investigate the effect of Simmental blood level on birth, weaning, yearling and maturity weight, and pre- and post-weaning growth rate of calves. There was no significant difference in birth and weaning weights between crossbred and purebred calves. Calves with 37.5% Simmental blood were significantly heavier at yearling than those with 25%, and they were heavier at maturity than other groups of animals. During pre-weaning, 37.5% Simmental calves grew significantly faster than 62.5% Simmental calves and in the post-weaning they continued to grow faster. The pre- and post-weaning growth rates of 62.5% Simmental calves were inferior to that of Boran, suggesting possible problems of adaptation for calves with higher exotic blood levels. Male calves were 12.6 kg heavier than females at weaning. Male calves grew faster than females both in pre-weaning (22.5g/d faster) and post-weaning (20.8g/d). Calves born during wet season were heavier at birth and at weaning, and they grew faster during pre- and post-weaning periods than calves born in dry season. The highest mortality rate was observed in pre-weaning growth period in all groups of calves. Pre-weaning mortality rate was higher in Boran calves followed by calves with 25% Simmental.

Introduction

Growth is one of the most important selection criteria for the improvement of meat animals, especially beef. It can be defined as an increase in size or in differentiation or both (Bordy 1945). Measurements of growth usually account for weight gain per day, degree of maturity, maturing rate and body weight at a given age. They vary with genetic potential of the breed and environmental factors.

Breeds and crosses of beef cattle show distinctive differences in size, earliness of maturity and carcass characteristics. Large breeds grow faster than smaller ones and so produce more beef in a given time. Early maturing breeds finish at a faster rate than late maturing breeds when given the same feed. Later maturing breeds eat more feed than the smaller breeds. In general, growth rate and degree of maturity determine the amount of feed required, carcass and meat composition and returns on capital invested in a beef cattle production. Therefore, knowledge of growth parameters is important for a successful beef cattle production program. Birth weight and pre-weaning performance are important components in determining economic performance from beef cattle. It is, therefore, essential to analyze such data to serve as a useful guide for future work in beef production.

Even though a lot of studies on pail fed calves were conducted during the dairy crossbreeding program of Institute of Agricultural Research (IAR), no work has been done concerning growth performance of Boran and their crosses under cow-calf program. The present investigation was undertaken to evaluate the effect of Simmental blood level, sex of calves and season of birth on the growth performance of calves.

Materials and Methods

A monthly growth record of 118 Boran and Boran Simmental crossbred male and female calves with 0–62.5% Simmental blood levels with all its growth information of the calves from birth to the age of 24 months was analyzed using the SAS computer program. The general linear models procedure was used for statistical analysis of each variable. Duncan's Multiple Range Test was used for mean separation of each variable. The daily growth rate of calves was calculated by linear regression.

The data used for the study were collected from calves which were born by the cow-calf crossbreeding program of IAR. Feeding and housing management was similar to all breeds with similar age group. In the cow-calf program, all pre-weaned calves were allowed to go to the field with their dams suckling during the day time. Calves were separated from their mothers every night and housed in the calf pen. The next morning cows of the corresponding calves were milked. Calves were weaned at the age of 180 days in all crosses. Weaned calves were allowed to graze for 8 hr/d. All animals were weighed monthly starting from birth. All the necessary health care was made during the recording period.

Results

There was similar growth pattern of Boran and their crossbred calves at the start, indicating similar birth weight (25–29 kg) of the calves, and abruptly grew up at a relatively faster growth rate (331 g/d on average) up to the age of weaning (180 days). After weaning all the calves in each breed started to grow at a relatively slower growth rate (219 g/d on average). The gap between each growth pattern was not significant ($p > 0.05$) up to the age of yearling (360 days). Significantly ($p < 0.05$) wider gap was observed between the growth patterns of each group of calves after the age of one year. In the later age calves with exotic blood of 37.5% grew significantly faster than any other group of calves and those with 62.5% exotic blood were significantly ($p < 0.05$) inferior than any other group in their growth rate.

The quantitative growth values taken at each stage of age are given in Table 1. There was no significant ($p > 0.05$) difference among blood levels in terms of birth and weaning weight. The 720 days body weight (247.9 kg) of 37.5% Simmental calves was the highest ($p < 0.05$) of all blood levels (Table 1).

Growth performance of Boran and their crosses with Simmental influenced by exotic blood level is shown in Table 2. The pre-weaning growth rate of the calves increased ($p < 0.05$) from 317.4 g/d to 424.4 g/d as the exotic blood level increased from 0 to 37.5% and it reduced ($p < 0.05$) to 424.4–250.4 g/d as the exotic blood level increased to 62.5%. A very similar growth pattern, but at a higher rate, was observed in the post-weaning growth rate of the calves (Table 2).

The highest mortality rate was observed in the pre-weaning growth period in all groups of calves (Table 2). Pre-weaning mortality rate was highest in Boran calves followed by calves with 25% Simmental blood (Table 2).

Table 1. Average weight of calves at different ages as affected by Simmental blood level, season of birth and sex

Calf group		*Average weight (kg) different ages*								
		Birth	90	180	270	360	450	540	630	720
	Calf no.	93	89	86	85	80	75	78	73	68
pure Boran	30	25.6	52.1	84.9	108.9	126.8^{ab}	144.4^{ab}	163.8^{b}	182.5^{b}	196.2^{b}
25% Simmental	25	26.9	54.3	90.5	100.5	114.9^{b}	136.8^{b}	155.7^{b}	176.8^{b}	197.7^{b}
37.5% Simmental	10	29.6	59.4	97.6	119.5	141.7^{a}	168.4^{a}	201.4^{a}	220.4^{a}	247.9^{a}
62.5% Simmental	28	28.7	49.9	82.1	98.6	119.4^{ab}	145.5^{ab}	161.6^{b}	180.2^{b}	200.2^{b}
Female	55	27.1	50.3	80.1	97.0	115.3	132.8^{b}	155.6	176.9	192.3
Male	38	27.4	54.7	92.2	110.2	128.4	155.1^{a}	172.0	190.3	212.6
Calves born in dry season	42	26.9	49.5	83.7	99.8	118.1	129.2^{b}	146.0^{b}	176.6	201.7
Calves born in wet season	51	27.6	55.7	89.5	108.7	126.8	155.3^{a}	179.1^{a}	191.1	206.8

Table 2. Growth performance of Boran and their crosses with Simmental

Simmental blood levels	Boran	25%	37.5%	62.5%	SE
No. of calves	30	25	10	28	
Birth weigh	25.6	26.9	29.6	28.7	1.3
Weaning weight	84.9	90.5	97.6	82.1	6.6
Pre-weaning Growth rate (g/d)	317.4^{ab}	331.1^{ab}	424.4^{a}	250.4^{b}	45.6
Post-weaning mortality rate (%)	176.2^{b}	222.7^{b}	229.6^{a}	178.9^{b}	25.6
Pre-weaning mortality rate (%)	25.4	22.9	9.5	19.9	
Post-weaning mortality rate (%)	0.1	0.0	0.0	0.5	

Discussion

Calf Genotype

Ahunu et al. (1993) reported that significant ($p < 0.01$) genotype differences existed at birth between West African Shorthorn and their Jersey crosses. Thus, the non-significant ($p > 0.05$) differences in birth and weaning weights between Boran and their crosses and the similarity of their pre-weaning growth rate with their crosses found in our study may indicate the genetic potential of Boran cattle for beef production. The significant ($p < 0.05$) increment of post-weaning growth rate from 176.2 g/d to 299.6 g/d as of Simmental blood increased to 37.5% and the decline to 178.9 g/d as Simmental blood increased to 62.5% agrees with the report of Ahunu et al: (1993) in which the average daily gain declined with increasing level of Jersey breeding. This suggests possible problems of adaptation for calves of higher exotic blood levels.

Calf Sex

Male calves were 12.6 kg heavier than female calves at weaning. During pre-weaning period male calves grew 22.5 g/d faster than females, and in the post-weaning period they grew 20.8 g/h faster than female calves. Brinks et al. (1961) reported that bull calves grew on average 6.2% faster than heifers.

Season of Birth

All calves born during the wet season were heavier at birth and at weaning and they were faster in growth during the pre- and post-weaning periods than calves born in dry season. However, all were not significant ($p > 0.05$). This agrees with the report of Ahunu et al. (1993) which indicated that season of birth had no influence on birth and weaning weight and average daily gain of the calves. Lack of season effect on calf growth rate has was observed in Canadian Holsteins in Ghana by Kabuga and Agyemang (1983).

The effect of season on calf weight is known to be caused by the quantity and quality of forage available to calves and their dams (Mwandoto et al, 1988). These effects are, therefore, more marked where animals. are not supplemented. In this study the dams were given concentrate mixture during dry season to supplement grazing. Also, the calves were allowed to suckle their dams all the day time till weaning, so the adverse effects of season caused due to nutrition may completely be removed.

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COSTS AND RETURNS OF CAMELS, CATTLE AND SMALL RUMINANTS IN PASTORAL HERDS OF EASTERN ETHIOPIA

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ABSTRACT

Two questionnaire surveys were conducted to analyse the costs and returns of camels, cattle and small ruminants in pastoral herds in eastern ethiopia. In each survey 44 Somali pastoral households having camels in 3grazing management systems in 4 regions were randomly interviewed. Among them only three households had no cattle or small ruminants. The average number of Tropical Livestock Units (250 kg) was 4.0 per household member. Milk production was the most important revenue (66% of total revenues) followed by sale of livestock (17%) and transport (16%). The income derived from local slaughter (1%) and hides (+0%) was insignificant. High mortality rates were recorded for all livestock species. Ten percent of the milk was converted into butter. The sales price of butter was very low compared to fresh milk. About 25% of the milk was sold fresh or as butter, but nomads rarely sold milk. Sedentary and transhumant grazing management systems showed similar levels of income, whereas nomads had a 2.4-fold higher overall income. The average total gross income of the entire herd amounted to Birr 38684 per household per year. The contribution to the total gross revenue of camels, cattle and small ruminants was 60%, 24% and 16%, respectively. The calculated costs were 30% of the gross returns.

Introduction

Pastoralists rely on livestock for their livelihood. In eastern Ethiopia they keep camels, cattle, goats, sheep and donkeys. The ability of the camel to survive in harsh areas, its endurance in prolonged drought and its high potential to convert the scanty range and water resources into useful products makes it more important to pastoralists than any other animal (Brown et al. 1997).

Despite their socioeconomic importance, the contribution camels, cattle and small ruminants make to the rural household economy is hardly known. Such information is essential for the planning and implementation of development programs in arid and semi-arid East Africa. Therefore, a study was conducted with the objectives of assessing for sedentary, transhumant and nomadic grazing management systems, the costs of inputs and revenues of outputs of camel husbandry as well as the relative economic importance of camels, cattle and small ruminants to households owning camels.

Materials and Methods

Design

The unit of investigation was the herd, comprising camels, cattle, sheep, goats and donkeys, belonging to one household (HH). The HH was defined as the HH head and his wife or wives together with their children and dependants such as parents, grandchildren, etc., but excluding children living elsewhere or those who were married. All HHs belonged to the Somali ethnic group. HHs that owned at least 2 camels were selected at random to fulfil the objectives of the study.

Questionnaire surveys were conducted among HH heads in four areas of eastern semi-arid Ethiopia. Two areas were relatively nearby (10-30 km) and two were away (> 100 km) from the major towns of Dire Dawa and Jijiga (Table 1). Three grazing management systems (GMSs) were distinguished: 1) sedentary (SE), in which HHs permanently settled in the same grazing area; 2) transhumance (TR), in which HHs shifted between two grazing areas every year; and 3) nomadic (NM), in which HHs shifted between three or more grazing areas every year.

Two questionnaire surveys were conducted in two different seasons. The first survey was conducted in the latedry season (July to September 1997). The questionnaire of this survey (N = 44) pertained to the four major economic outputs, i.e., sale, slaughter, draft power and milk, as well as the inputs labour, capital, purchases and drugs. Feed costs were not considered because supplementation is not practised. The second survey (N = 44) was conducted in exactly the same areas but among different HHs and during the early dry season (February 1998). The questionnaire of the second survey detailed on milk production only. The questions referred to the 12 months preceding the interview in both the surveys.

Goats and sheep were considered as one group because they are managed and grazed together. Some pastoralists owning large herds revealed difficulties in specifying the herd structure but not the herd size. In these cases the average of other large herds with identified herd structures were used. If many goats or sheep were sold, the average of the lowest and highest price was estimated.

Table 1. Number of households by region and grazing management system

Region	*Total*	*Sedentary*	*Transhumance*	*Nomadic*	*Distance to major town (km)*
Aydora	12	0	1	11	>100
Fafan	12	6	6	0	10-30
Harshin	8	4	4	0	>100
Shinile	12	7	4	1	10-30
Total	44	17	15	12	

Tropical Livestock Units (TLU) of 250 kg were used to estimate the total herd size, based on the livestock unit conversion factors for camels (1.0), cattle (0.7), goats and sheep (0.1), and donkeys (0.5) (ILCA 1990).

To estimate milk production, pastoralists were asked to show the vessels used for milk collection and to indicate to what level they were filled per milking. It was assumed that for 1kg of butter 25 L of milk was required (Coppock 1994).

Opportunity Cost

The concept of opportunity cost (OC) has been used wherever hard cash was not involved or a commodity was not sold. The OC of capital was calculated based on 7.5% interest rate on the saving account of the Commercial Bank of Ethiopia. The capital value of each livestock species was based on the sales price. The OC of young ruminants up to one year and in the case of camels young-stock from one to four years was estimated at 40 and 70% of the sales price of adults, respectively. The OC of meat through local slaughter was fixed at 30% of the sales price based on another study among African pastoralists (Baars et al. 1996). The OC for short distance transport and HH shifting was based on the earnings of long distance transport. The OC of home-consumed milk and butter was based on their sales price. The OC of skins of cattle and camels was assumed to equal those of small ruminants, as they were larger in size but valued less per unit. The OC of labor was based on the minimum government rate of Birr 105 per month, or Birr 3.5 per day.

Statistical Analyses

The Panacea database program was used for statistical analyses (Panacea 1986). The one-way ANOVA was used to analyse the effect of GMS. Multiple regression analyses were used whenever applicable. Differences were considered significant at $P < 0.05$.

Results

Household Composition

The average HH comprised 11.5 persons, of which 55% were younger than 15 years of age. The HH head had on average 1.4 wives. NM HH's were the largest (Table 2). The available labor in adult equivalent was about 8.4 persons per HH. In all three GMSs, the average number of HHs per village was 5.1, excluding three large SE villages (" 40 HH).

Table 2. **Size and composition of household (HH) of camel-keeping pastoralists**

Grazing management	*Total HH size*	*No. wives/HH head*	*15 years and over*	*< than 15 years*	*Total labor*[1]
Sedentary	11.8	1.3	4.9	6.9	8.3
Transhumance	9.6	1.2	5.1	4.5	7.3
Nomadic	13.5	1.7	5.9	7.6	9.6
Average	11.5	1.4	5.3	6.3	8.4

[1] Adult equivalent calculated as: ≥ 15 years x 1 + < 15 years x 0.5.

Table 3. **Size and composition of pastoral herds**

	Sedentary	*Transhumance*	*Nomadic*	*Mean*
Camels/household				
Male 0–1 year	1.6	1.7	3.0	2.0
Female 0–1 year	1.9	1.6	3.7	2.3
Male 1–4 years	1.8	2.9	3.1	2.5
Female 1–4 years	2.1	2.4	3.8	2.6
Male > 4 years	2.7	2.4	3.6	2.8
Female > 4 years	10.8	9.8	8.8	9.9
Total	20.8	20.7	25.9	22.2
Cattle/household				
Male 0–1 year	1.8	1.5	3.1	2.0
Female 0–1 year	2.1	1.5	2.9	2.1
Male > 1 year	3.0	1.7	5.3	3.2
Female > 1 year	7.3	6.3	14.3	8.8
Total	14.2	10.9	25.6	16.2
Goats + sheep/household				
Male 0–1 year	8.8^{x}	$10.7^{x,y}$	20.2^{y}	12.5
Female 0–1 year	8.8^{x}	$12.1^{x,y}$	23.2^{y}	13.9
Male > 1 year	3.2^{x}	3.5^{x}	9.0^{y}	4.9
Female > 1 year	29.4^{x}	$41.2^{x,y}$	91.8^{y}	50.5
Total	50.2^{x}	$67.5^{x,y}$	144.2^{y}	81.7
Donkeys/household	2.0^{x}	1.0^{x}	4.8^{y}	2.4
TLU/household	36.8^{x}	35.6^{x}	60.6^{y}	42.9
TLU/household	3.8	4.0	4.3	4.0
No. Of herds/household	3.1^{x}	4.2^{y}	5.0^{y}	4.0

^{x,y} Values with different superscript in the same row differ ($p < 0.05$).
TLU, Tropical Livestock unit

Herd Composition

The total numbers of camels, cattle, small ruminants and donkeys per HH were highest for NM, though only the last two were significantly more (Table 3). The average total herd size was 43 TLU, with a significant larger herd size for NM. The average number of herds per HH was 4.0 but ranged from 1 to 8. Typically, there were four herds: one each for camels, cattle, adult goats and sheep, and kids and lambs. Polygamous HH=s had separate herds of goats and sheep for each wife, but the camels and cattle were combined.

The average number of TLU per HH member was 4.0. Regression analysis showed a relationship between total TLU in the herd (Y) and HH size (X) of Y = 9.02 + 2.94 X. However, the r^2 was low (0.39).

Sale, Slaughter and Mortality

The number of slaughters was considerably lower than the number of animals sold in each category of livestock (Table 4). Sale and slaughter of camels occurred in 41 and 16%, cattle in 55 and 16%, and goats and sheep in 92 and 92% of the HHs, respectively.

The average total income derived from sales and slaughter was 6578 and 535 Birr per HH per year, respectively. NM had a much higher income from sales and slaughter than SE and TR, despite their lowest mean sales price (Table 8).

Table 4. Number of animal sold, slaughtered and died in pastoral herds

	Sedentary	*Transhumance*	*Nomadic*	*Mean*
CAMELS				
Total camels in herd	20.8	20.7	25.9	22.2
Saes	1.2	1.9	1.7	1.6
Slaughters	0.1^x	$0.1^{x,y}$	0.9^y	0.3
Deaths	6.4	5.9	7.9	6.7
Mean sales price	830	763	617	731
CATTLE				
Total cattle in herd	14.2	10.9	25.6	16.2
Sales	1.7^x	1.6^x	6.3^y	2.9
Slaughters	0.1x	0.0^x	1.5^y	0.5
Deaths	2.2^x	0.9^x	9.0^y	3.7
Mean sales price	730	732	569	666
GOATS + SHEEP				
Total in herd	50.2^x	$67.5^{x,y}$	144.2^y	81.7
Sales	18.4^x	35.7^x	84.8^y	42.4
Slaughters	7.1^x	6.9^x	36.4^y	15.0
Deaths	23.6^x	26.7^x	71.5^y	37.7
Mean sales price	78	92	73	82
TLU[1]:				
Total TLU in herd	36.8^x	35.6^x	60.6^y	42.9
Sales	4.3^x	$6.6^{x,y}$	14.6^y	7.9
Slaughters	0.8^x	0.8^x	5.6^y	2.1

Values with different superscript in the same row differ ($p < 0.05$)

[1] TLU, Tropical Livestock Unit

Regression analyses between herd size (X) on the one hand and sales (Y_1) and slaughters (Y_2) on the other showed the following relationships; for goats and sheep $Y_1 = 0.45 X$, $r^2 = 0.69$ and $Y_2 = 0.16 X$, $r^2 = 0.35$; for TLU $Y_1 = 0.18 X$, $r^2 = 0.62$ and $Y_2 = 0.06 X$, $r^2 = 0.49$. HH size did not influence these results significantly.

High mortality rates were recorded for all livestock species: camels 30%, cattle 23%, and goats and sheep 46%. For all the species of livestock, highest mortality was noticed in NM systems.

Transport

Three categories of transport were distinguished: long distance trade, shifting HHs, and short distance transport. Thirty percent of the HHs were involved in long distance trade. On average they made 3.8 trips per year with 2.5 camels per trip and 19.9 days per trip. The average earning per trip per camel was Birr 417 (Table 5).

The average income derived from long distance transport, shifting HHs, and short distance transport was 1188, 2024 and 2836 Birr per HH per year, respectively. The total income of transport of NM was 2.7 times higher than SE and TR.

Table 5. Camel transport characteristics in pastoral herds

	Sedentary	*Transhumance*	*Nomadic*	*Mean*
LONG DISTANCE TRADE (N = 13):				
Household involved (%)	35	13	42	30
Trips/year	5.0	5.5	1.7	3.8
Camels/trip	2.3	2.0	2.8	2.5
Days/trip	18.8	16.5	22.6	19.9
Incom/camel/trip (Birr)	460	475	350	417
Income/camel/day (Birr)	24.5	28.8	15.5	21.0
SHIFTING HOUSEHOLDS (N = 29)				
Household involved (%)	18	93	100	66
Trips/year by household	0 (?)^{x}	2.0^{y}	23.6^{z}	10.7
Trips/year by non-household	11.3_{x}	5.3^{x}	40.8^{y}	18.5
Camels/trip	1.5	2.2	3.0	2.5
Days/trip	0.3^{x}	1.9^{y}	2.6^{y}	2.0
SHORT DISTANCE TRANSPORT (N = 39)				
Household involved (%)	88	87	100	91
Trips/year by household	59	58	24	48
Trips/year by non-household	42.5	37.9	38.7	39.8
Camels/trip	1.1	1.2	1.6	1.3
Days/trip	1.1^{x}	0.9^{x}	2.0^{y}	1.3

Values with different superscript in the same row differ ($p < 0.05$).

Table 6. Dry and Wet season milk production of pastoral herds

	Dry season (6 months)				*Wet season (6 months)*			
	SE*	TR	NM	Mean	SE	TR	NM	Mean
CAMELS								
Adult females present (no.)	10.8	9.8	8.8	9.9	10.8	9.8	8.8	9.9
Females lactating (% adult females)	31	46	41	38	33	46	49	41
Potential period of milking (months)	6	6	6	6	6	6	6	6
Milkings per day (no.)	$2.4^{a,b}$	2.1^{a}	2.7^{b}	2.4	2.7^{x}	2.5^{x}	3.0^{y}	2.7
Daily milk offtake (kg)	3.5	2.7	4.7	3.6	5.4^{x}	5.4^{x}	9.0^{y}	6.5
Offtake camel herd (1000 kg/season)	2.14	2.22	3.09	2.47	3.51^{x}	4.44^{x}	7.08^{y}	4.81
CATTLE								
Adult females present (no.)	7.3	6.3	14.3	8.8	7.3	6.3	14.3	8.8
Females lactating (%) adult females)	44	48	34	42	44	48	44	45
Potential period of milking (months)	5.6	4.7	5.8	5.5	6	6	6	6
Daily milk offtake (kg)	1.3^{a}	1.2^{a}	2.0^{b}	1.6	3.6^{x}	3.4^{x}	5.4^{y}	4.2
Offtake cattle herd (1000 kg/season)	0.71^{a}	0.52^{a}	1.72^{b}	0.99	2.11^{x}	1.88^{x}	6.20^{y}	3.04
GOATS AND SHEEP								
Adult females present (no.)	29.4^{a}	$41.2^{a,b}$	91.8^{b}	30.5	29.4^{x}	$41.2^{x,y}$	91.8^{y}	50.5
Females lactating (% adult females)	11	6	9	9	41	45	54	48
Potential period of milking (months)	2.0	2.0	2.3	2.2	$3.6^{x,y}$	4.6^{x}	3.0^{y}	3.5
Daily milk offtake (kg)	0.29	0.30	0.19	0.24	0.40	0.28	0.45^{y}	0.40
Offtake small ruminants (1000 kg/season)	0.06^{a}	0.05^{a}	0.11^{b}	0.07	0.53^{x}	0.73^{x}	2.04^{y}	1.03
Total offtake (1000 kg/season)	2.91^{a}	2.79^{a}	4.92^{b}	3.53	6.15^{x}	$7.05^{a}7.05$	15.32^{y}	8.8

Values with different superscript in the same row within dry season differ ($P < 0.05$)

Values with differnt superscript in the same row within wet season differ ($P < 0.05$)

Milk

Camels were the main source of milk in both the dry and wet seasons for all three GMSs. On average, pastoralists milked their camels more than twice per day. The total average amount of milk offtake was 3.53 and 8.88 t/household in the dry and wet season, respectively (Table 6). The NM system showed the highest daily milk offtake, except for small ruminants in the dry season.

The proportion of female camels and cattle that were milked ranged from 38 to 45%. In the dry season, the proportion of goats being milked was low, whereas sheep were not milked. In the wet season about half of the small ruminants were milked. Several HHs never milked small ruminants.

NM pastoralists used 97% of the milk production for home consumption and sold only 3%. On average 10% of the milk produced was converted into butter, mostly for home consumption (Table 7). The average income derived from milk was 25,454 Birr per HH per year. NM showed a 2.3-fold higher income than SE and TR (Table 8).

Hides

The skin of goats and sheep was occasionally sold for, on average, 4.4 " 1.7 Birr. The majority was locally used as water containers or for other purposes. The skin of cattle, used mainly as bedding material, was never sold. The skin of camels was used to make ropes, shoes or covers for transport, but was sometimes thrown away. The average income from skins was 69 Birr per herd per year.

Manure

None of the NM, 71% of SE and 73% of TR pastoralists cultivated land. Four farmers used manure to fertilise their fields. Camel manure was not used as it generates *Acacia* trees. The OC was estimated to be zero as no market existed and because the majority of the pastoralists considered manure as a burden rather than an output.

Table 7. **Milk utilization pattern as percentage of total milk from camels, cattle and small ruminants of pastoral herds**

	Sedentary	*Transhumance*	*Nomadic*	*Mean*
Fresh milk consumed at home	55^{x}	52^{x}	95^{y}	67
Fresh milk sold	31^{x}	37^{x}	2^{y}	23
Butter consumed at home	14	10	2	8
Butter sold	1	2	1	1

Values with different superscript in the same row differ ($p < 0.05$)

Table 8. Costs and returns of pastoral herds

	Grazing Management system				% of total benefits
	Sedentary	Transhumance	Nomadic	*Mean*	
BENEFITS (Birr[1])					
Sale:					
Camels	996	1450	1049	1170	
Cattle	1241	1171	3585	1931	3
Goats/sheep	1435	3284	6190	3477	5
Sale sub-total	3672	5905	10824	6578	9
					17
Slaughter:					
Camels	25	23	167	66	0
Cattle	22	0	256	100	0
Goats/sheep	166	190	797	369	1
Slaughter sub-total	213	213	1220	535	1
Transport:					
Long distance	1852	679	700	1188	3
Household shifting	23	817	7786	2024	5
Transport sub-total	2648	2595	3110	2836	7
	4523	4091	11596	6048	16
Milk:					
Camels	12261	14319	22272	15798	41
Cattle fresh	3170	2623	16001	6054	16
Cattle butter	1397	1067	595	1215	3
Goats/sheep	1280	1677	4709	2387	6
Milk sub-total	18108	19686	43577	25454	66
Hides	32	31	170	69	0
Total benefits	26548	29926	67387	38684	100
COSTS (Birr)					
Capital	1973	1855	2507	2082	
Purchase	36	53	0	32	
Drugs	840	869	632	791	
Labor:					
Herding	5314	6757	8412	6663	
Transport	646	497	2612	1008	
Milking	882	984	1393	1059	
Labor sub-total	6842	8238	12417	8730	
Total costs	9691	11015	15556	11635	
Benefits-costs	16857	18911	51831	27049	

[1] Average conversion rate during study: 1 USD = 6.35 Ethiopian Birr.

Labor

Labor mainly comprised the herding of livestock. The grazing hours in the dry and wet seasons were 11.5 and 11.1 for camels, 11.0 and 10.6 for cattle, 10.2 and 9.6 for goats and sheep, respectively. No differences between GMS=s were observed. Calves of camels and cattle roamed around freely, if few. Sometimes, some herds or part of the herds grazed elsewhere. On average 3.9 persons from the HH were involved in herding. In 63% of the HHs only children herded, in the remaining adults assisted the children. Sometimes, two persons herded large herds. Additional labor from other HHs was available but not assessed. Three HHs had hired labor. They were paid food, clothes and each year a calf or part of the harvest. The total labor costs for herding amounted to 6663 Birr per year per average HH.

On average there were 288 transport days spread over 2.8 camels. The total labor cost for transport amounted to 1008 Birr per average HH.

Camels were milked by two persons, a third person kept the calf away.Ccattle were milked by one person, another person kept away the calf; while small ruminants were milked by one person. Milking of camels and cattle took 8 minutes on average, including preparation; small ruminants were milked in 3 minutes. The total labor cost for milking amounted to 1059 Birr per average HH.

Capital, Purchase of Livestock and Drugs

Capital consisted of livestock only. The value of the livestock inventory was assessed as the number of animals per species multiplied by the sales price of that species. The cost of capital per HH, calculated at 7.5% of the value of the herd inventory, amounted to 2082 Birr per average herd per year.

Purchase of livestock was limited and comprised few cattle and goats and amounted on average to 32 Birr per herd per year. The NM pastoralists felt embarrassed when asked about the purchase of livestock.

Almost 800 Birr was spent on veterinary drugs per average herd per year.

Discussion

Number of Livestock per Household Member

The amount of TLU required for an acceptable subsistence minimum is 4 to 5 per member of the family (Breman and de Wit 1983). In the present study 4.0 was calculated, indicating that pastoralists of eastern Ethiopia live near the minimum subsistence TLU requirements. However, most SE and TR pastoralists cultivated land so that the minimum required TLU would be less than 4.0 per person (Cossins 1985). Sometimes part of the herds moved for longer periods away from the HH in search of water and forage, resulting in a changing number of TLU per person.

The average TLU per person must have been higher in the years preceding the study because the survey was conducted after a period of heavy livestock losses. An outbreak of a new camel respiratory disease with a high morbidity rate (90–100%) caused severe mortality (5–65%) in Ethiopia during 1995–96 (Brown et al. 1997). The epidemic has now subsided (Bekele 1998).

Sale, Slaughter and Mortality

Sales and slaughters concerned mainly male livestock, particularly goats and sheep. Camels and cattle were slaughtered or sold only for special occasions, such as funerals, or when the price for small ruminants was extremely low. The sales price of all livestock species was lower in the dry season due to poor body condition. However, the number of sales was substantial because pastoralists compensated the low dry season milk production by increased livestock sales.

HH members consumed the greatest part of the meat (slaughter) and the remaining was shared among neighbors and relatives who came to request some. It was never sold as this controverts cultural custom. Therefore, the concept of OC has been applied to estimate the price of meat. The price of locally consumed meat is by far lower than that of sales because slaughter often concerned weak or old livestock and because of the low local market price compared to the (semi-) urban markets where sale on hoof took place. The OC of the present study was fixed at 30% of the sales price, based on another study among African pastoralists (Baars et al. 1996).

An important reason for high death rates was the drought of the 1996/97 dry season. However, diseases, particularly affecting camels and small ruminants, as well as hyenas contributed considerably to livestock losses. Because of the above average death rates, no calculations related to herd increase (births–deaths) have been made.

Transport

The age at which male camels were first used for transport was 5.4 years on average (range 4–7). Some farmers said it depended on the number of camels available and on the load. However, no significant relationship between the number of male camels in the herd and the age of first use for transport was found. Of the 2.8 males older than 4 years per average herd, 0.7 were not used for transport because they were considered too young, some were specifically kept for breeding or few surplus males were ready for sale. Females were used for transport in exceptional cases only.

HH shifting was practised by all TR and NM pastoralists, but even some SE people did shift to escape from ticks, manure accumulation or mosquitoes. Short distance transport was a common practice. It concerned mainly transport to and from urban markets as well as fetching water and salty soil. Only one HH, living near water as well as a main road, never used their male camels. For short distance transport donkeys were also extensively used.

Milk

Milk is the prime source of benefit to the pastoralists, and camels contributed 62% to this source. The present study recorded for camels an average daily milk offtake of 3.6 and 6.5 kg in the dry and wet season, respectively. Three other studies in Ethiopia reported slightly lower milk offtakes: in the south 2.4 kg/day (N=3) (Belete 1985), in the east 3.75 kg/day (N=30) (Kebebew 1998), for lowlands in general 5 kg/day (Hartley 1980). However, these figures correspond well with offtake levels of camels in SE and TR GMSs. The relatively high offtake of 9.0 kg/day among NM is comparable to the 8 kg/day reported for *Hoor* camels in Somalia (Hussein 1993). Eleven camel owners reported equal production levels over seasons. Three others reported even a higher milk offtake in the dry season because of a better forage supply during the dry season. Particularly cactus species provided a good resource during the dry season.

The daily offtake levels of cattle in the present study, 1.6 and 4.2 kg/day in the dry and wet season, respectively, correspond to the 4.0 kg/day recorded in southern Ethiopia (Coppock 1994). The daily offtake levels of goats and sheep in the present study, 0.24 and 0.40 kg/day in the dry and wet, season respectively, correspond to the average offtake per goat recorded in southern Ethiopia of 0.32 kg/d (0.26 during the dry season) (Belete 1985). In south Ethiopia sheep were not milked but in the present study some HHs milked sheep in the wet season.

Men always milked the camels and usually the cattle; whereas women always milked the small ruminants and sometimes the cattle. In Somalia women always milk cattle (Massey 1987).

Out of the total production of milk, 75% was consumed at home and 25% was sold. Of the total amount of milk, 10% was converted into butter, i.e., mainly milk from cattle and little from small ruminants but never from camel. In southern Ethiopia among the Borana, 24% was converted into butter (Coppock 1994). The lower butter making activity among the Somali is likely a result of the higher number of camels in their herds. For the processing of 1 kg of butter approximately 25 L of milk is required (Coppock 1994). The price of milk was 2.17 Birr/L and that of butter 24.5 Birr/kg which equals to about 1 Birr/L of milk required for butter. Thus butter making results in a significant loss in income. This might partly explain the limited sale of butter. In the dry season butter was not processed, instead a part of the wet season production was consumed. To increase the production and marketing of butter a higher sales price is required.

Apart from the effect of GMS, regional effects were observed as well. The Fafan region was in several aspects different from the other three regions. Cultivation was more important resulting in higher prices for cattle (oxen) and use of manure on fields. The number of small ruminants was lower, partly because the people feared crop damage. The Fafan pastoralists were also more market-oriented since livestock was purchased and outside labor was hired.

Conclusions

Gathering economic information on camels in mixed species herds provided quantitative insight into the multi-functional contribution of livestock in providing milk, livestock sales, transport and slaughter. Local slaughter of livestock for meat consumption, hides and manure was of minor economic importance. Milk, on the other hand was, the major source of income for the HH. However, sales of milk and butter were limited and warrants, market improvements. NM systems had a significantly higher gross and net income than SE and TR. The contribution of different livestock species to the total gross benefits was 60% for camels, 24% for cattle and 16% for sheep and goats. The major components of benefits (sales, transport and milk) followed the same trend among the three GMSs.

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LONG-TERM EVALUATION OF MILK PRODUCTION AND REPRODUCTIVE PERFORMANCE OF DAIRY CATTLE AT ALEMAYA

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ABSTRACT

Milk records (987 completed lactations) were analyzed to compare the performance of pure Holstein-Friesian (HF) with HF x Boran crossbred dairy cattle (50% or Boran crosses with higher level of HF). The effects of lactation number, season of calving on milk production and reproductive parameters as well as year differences were assessed. The milk production of 7/8 and pure HF was significantly higher than that of ½ and ¾ HF crossbreds. Average daily milk yields of the breed groups ranged from 9 to 12 kg, whereas the average yield per lactation ranged from 2314 to 3876 kg. Cows in the 3rd and 4th lactations showed the highest milk production. Season of calving had no effect on milk production. A general tendency of decline in daily and lactation yield per cow was observed over the years. The age at first calving increased by 11 months during the study period from 31 to 42 months. No differences in reproductive parameters were observed among HF and their crosses, lactation numbers and season of calving. It was concluded that a change in forage and nutrition management is required to increase milk production levels.

Introduction

Ethiopia has the largest cattle population in Africa, with 30 million heads (17% of the continent) (FAO 1996). The huge cattle resource plays an important role in food security, cash income and as capital assets to face risks. However, the contribution of cattle towards the food supply and other needs is unable to meet the demand of the growing population (Abay et al. 1989) as local cows produce on average 230 kg/lactation (FAO 1996). Therefore, Ethiopia is one of the seven largest importers of milk and milk by-products among Sub-Saharan countries (Von Massow 1989). Nevertheless, the consumption of animal protein of 10 g/head/day is low (FAO 1996).

To develop dairy programs and to improve dairy cattle productivity, a dairy farm was established in 1963 at the former College of Agriculture, now the Alemaya University of Agriculture (AUA) (Wells et al. 1969). Since then, records have been kept to determine the productive and reproductive performance of purebred Holstein-Friesian (HF) dairy cattle and their crossbreds (HF x Boran type) under local conditions (Wagner et al. 1968). Data up to 1987 have previously been analyzed with the aim to assess genetic indices per breed group (Haile-Mariam 1994). However, differences per lactation number, season of calving and year, were not presented in detail. The objective of this paper, therefore, is to evaluate the effects of breed group, lactation number, season of calving and year of calving on milk production and reproductive performances of AUA dairy cattle for the period 1965-96.

Materials and Methods

Description of the Area

The AUA dairy farm is located approximately 510 km east of the capital Addis Ababa, 9.26 °N latitude and 42.03 °E longitude at an altitude of 1980 m. The region is characterized by a mean annual rainfall of 780 mm (range 560–1260 mm), and a mean annual temperature of 18 °C.

Cattle Management

The AUA dairy herd was composed of HF x Boran type crossbred cows with different blood levels, varying from 50% to 100% HF. During 1965–90 the herd had continuously been upgraded by crossing with pure HF. From 1991 onwards new crossbred cows (½ and ¾ HF) joined the herd. No efforts were made to consolidate the proportion of exotic inheritance at an intermediate level. The level of inbreeding over the period 1965–86 was 3.2% (Haile-Mariam 1994). Heifers were first mated after they attained a body weight of 300 kg. All cows were mated at first observed heat after calving.

The animals were kept in a free housing system designed for 50–60 cows and fed ad lib roughage. Grazing was restricted due to tick-born diseases such as heart water. Hay was obtained once per year or twice when early hay making in June/July was feasible. Maize silage was available most of the years. There has been a consistently good feeding management up to 1974, thereafter it was less stable and generally poorer (Haile-Mariam 1994). From 1994 to present, the farm produced oats in 10–15 ha of land instead of or in addition to the silage.

During the first ten years of the study, each cow was provided 3– 9 kg of concentrate, and during the last twenty years 3–6 kg, consisting of corn, wheat bran, oil seed cakes, bone meal and common salt. After 1984, breweries grain was also included. Limited amounts of green alfalfa and fodder beet were available. Drinking water and mineral lick were available throughout.

During 1976–77 and 1991–92, severe feed shortages were encountered.

Disease Control

The herd was regularly vaccinated against foot and mouth disease, rinderpest, anthrax, black leg, and CBPP. The dairy herd was sprayed routinely with recommended chemicals to control external parasites. However, there have been occasional outbreaks of streptothricosis, foot and mouth disease and lumpy skin disease. In 1991–92, skin disease wiped out 30 animals, among which was a considerable proportion of high producing cows. Mastitis has been a major problem which persisted over the years.

Data Recording and Analyses

The dairy herd was milked twice daily. The farm records included milk yield per day and per lactation, 305-days lactation yield, lactation length, gestation length, age at first calving (AFC), number of services per conception (NSC) and calving interval (CI). The annual milk yield and days open (DO) were derived from these variables.

Of the total number of records (1005), lactations lengths shorter than 50 days were excluded, leaving a total of 987 records. For CI 791 records were available. In the analyses the effects of breed group, lactation number and calving season were assessed. Four breed groups were distinguished: ½ HF, ¾ HF, 7/8 HF and high-grade HF. High grade HF (15/16, 31/32, 63/64) were grouped with pure HF since analyses proved that their performance was similar. Five lactation numbers were distinguished: 1, 2, 3, 4 and 5+. Lactation numbers 5 and above were grouped together. Three calving seasons were distinguished: March–June (moderate rain), July–October (heavy rain), and November–February (dry season).

The General Linear Model procedure of SAS (1988) was used to analyze least square means of parameters as well as differences for the effects of breed, lactation number, season of calving, and the interaction of these three effects. None of the interactions was significant. The T-test was employed to compare least square means. Differences were considered significant at $p < 0.05$.

Results

All milk production parameters differed significantly between ½, ¾ and 7/8 plus high grade HF (Table 1). The ½ HF crossbreds had the lowest milk production and shortest lactation length. The abortion rate was 4.2%. CI, DO and NSC and AFC showed no significant differences between ½, ¾, 7/8 and high-grade HF. The average AFC of 33.5 months was similar among breed groups.

The milk production and the 305-days production of the 3rd and 4th lactations were higher compared to other lactation numbers (Table 2). The lactation length of second calvers was significantly lower than others. Lactation number had no effect on reproductive performance. The season of calving showed no significant differences for both milk production and reproductive parameters (Table 3).

Table 1. Reproductive and milk production data of Holstein crosses during 1965-96, Alemaya

Breed group	*1/2*	*3/4*	*7/8*	*1/1*[1]
N_1[2]	78	88	63	758
N_2	64	71	49	607
Calving interval (days)	413	422	405	421
Gestation (days)	278	278	279	278
Days open (days)	135	144	126	143
No. Of services/conception	1.07	1.33	1.33	1.26
Age at 1st calving (months)	32.5	34.2	33.5	33.8
Milk/day (kg)	8.9^a	10.9^b	12.3^c	12.3^c
Milk/lactation (kg)	2314^a	3290^b	3876^c	3796^c
Lactation length (days)	255^a	319^b	331^b	323^b
Milk/year (kg)	2139^a	3122^b	3663^c	3531^c
305-days production (kg)	2484^a	3161^b	3297^b	3700^c

[a,b,c] Values with different superscript in the same row differ ($P < 0.05$).

[1] Pure and high grade (15/16, 31/32, 63/64) Holsteins.

[2] N_2 for calving interval, days open and milk/year, N_1 for the remaining variables.

Table 2. Reproductive and milk production data per lactation number of Holstein crosses during 1965-96 at Alemaya

Lactation number	*1*	*2*	*3*	*4*	*5*
N_1[1]	248	243	190	128	177
N_2	248	200	144	94	105
Calving interval (days)	409	407	419	409	432
Gestation (days)	275	276	276	277	277
Days open (days)	134	131	143	132	155
No. of services/conception	1.1	1.2	1.3	1.2	1.2
Milk/day (kg)	10.2	10.9	11.2	12.4	10.8
Milk/laction (kg)	3351^a	3127^b	3467^a	3483^a	3167^b
Lactation length (days)	320^a	283^b	315^a	$300^{a,b}$	317a
Milk/year (kg)	3024	2913	3201	3451	2980
305-days production (kg)	3061^a	3083^a	3428^b	3473^b	$3115^{a,b}$

[a,b,c] Values with different superscript in the same row differ ($P < 0.05$).

[1] N_2 for calving interval, days open and milk/year, N_1 for the remaining variables.

The AFC increased gradually from 32 to 43 months over the years. Milk production declined over the years (Figure 1). CI did not change over the years.

Discussion

Maximum life-time production is achieved with a CI of 365 days. In practice, CI's are often longer than that, especially in tropical environments. Syrstad (1996) reviewed the performance of *Bos indicus* x *Bos taurus* crosses extensively (54 data sets of (sub-)tropical countries) and reported average CI's of 429, 450, 459 and 460 days for ½, ¾, 7/8 and pure

B. taurus, respectively. The average CI of 405 to 422 days of the different breed groups in the present study can therefore be considered reasonable. DO was 139 days in the present study. DO from other Ethiopian cattle were equal or slightly higher: pure Fogera, F1 Fogera-Friesian and ¼ Fogera-¾ Friesian 151, 151 and 361 DO, respectively (Haile-Mariam 1987); 139 DO for highland crossbred cows (Azage 1981); 199 DO for pure HF (Melaku 1994).

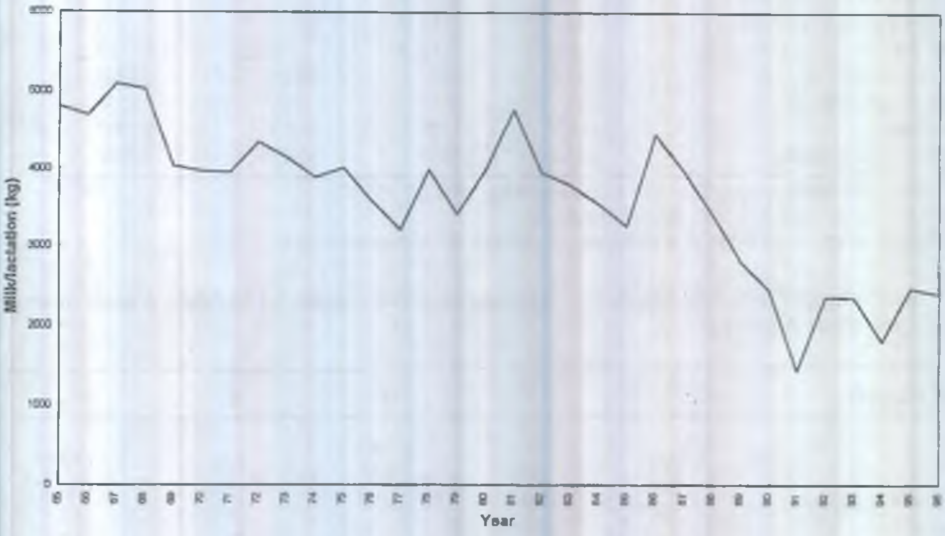

Figure 1. Milk production of dairy cattle from 1965 to 1996, Alemaya

Table 3. **Reproductive and milk production data per season of calving of Holstein crosses during 1965-96 at Alemaya**

Season of calving	*Mar–Jun*	*Jul–Oct*	*Nov–Feb*
N_1[1]	362	333	292
N_2	297	267	227
Calving interval (days)	407	417	422
Gestation (days)	277	276	276
Days open (days)	130	141	146
No. Of services/conception	1.3	1.2	1.1
Age at 1st calving (months)	34.7	34.2	34.3
Milk/day (kg)	11.1	11.4	10.9
Milk/lactation (kg)	3269	3425	3263
Lactation length (days)	312	308	301
Milk/year (kg)	3167	3182	2992
305-days production (kg)	3200	3298	3205

[1] N_2 for calving interval, days open and milk/year. N_1 for the remaining variables.

The average NSC was 1.2. A commercial dairy herd in a sub-tropical climate of the USA, showed a conception rate of 2.0 for HF cattle (Badinga et al. 1985). The NSC for Boran, F1 Boran-Holstein, ¾ Boran-Friesian heifers were 1.81, 1.61 and 1.69, respectively (Haile-Mariam 1994). Although mating was planned at first observed heat 45–60 days after calving, in practice first mating occurred 90–120 days after calving. This might have contributed to the relatively low NSC.

The average gestation length reported in literature is 282 days, but it depends on the breed (Hunter 1982). The average gestation period of 278 days in the present study was below that, and no differences were observed between breeds, lactation numbers and season of calving.

The ideal AFC is 24 months. Syrstad (1996) reported an average AFC of 32.4, 33.9, 34.4 and 31.6 months for ½, ¾, 7/8 and pure *B. taurus*, respectively. In the present study, this parameter increased gradually from 31 months in the 1960s and 1970s to over 40 months at present. Indigenous cattle as well as exotic cattle in Ethiopia showed a similar range of AFC: Friesians 32 to 49 months (Melaku 1994), Barka 35 months (Azage 1981), Boran 45 months (Haile-Mariam 1987), and Fogera 54 months (Asheber 1992). Considering the moderate to good management at AUA, there is a need to decrease the AFC through improved calf husbandry.

Syrstad (1996) concluded that the first crossbred generation (F1) performed well in most cases. Further upgrading to the exotic breed gave variable and often disappointing results. Milk yield increased only slightly or even declined. The average lactation yield reported were 2039, 2091, 2086 and 2162 L for ½, ¾, 7/8 and pure *B. taurus*, respectively. In the present study, the high grade and 7/8 HF produced more milk than ½ and ¾ HF cattle, but differences were larger than those reported by Syrstad (1996). In an earlier analysis of the AUA dairy farm (1965–87 data), a mean lactation milk yield of 4058 kg and a lactation length of 324 days were reported (Haile-Mariam 1994). The results of the present study are lower due to a decline in milk production after 1987. The average lactation yield of HF at Holetta state farm of the first, second and third lactation were 3160, 3314 and 3395 kg, respectively (Mureja 1994), which equal to the 3351, 3127 and 3467 kg/lactation in the present study.

Daily milk production levels in some tropical countries can be far above the levels produced on the AUA dairy farm. In the cold-humid and hot-humid climates of Costa Rica, on average 22 and 13 kg milk/day per lactating cow has been reported among semi-intensive commercial farms (Baars 1998). In the favorable climate of Alemaya, production levels exceeding the present ones could be easily obtained.

No significant differences were observed for season of calving, probably as a result of the favorable climate of Alemaya and the feeding management. Alemaya faces minor fluctuations in monthly temperatures and a relatively short dry season of 4 months. The cows usually did not graze and were fed concentrates.

It was concluded from additional farm evaluations that particularly the feeding management caused decline in milk production. However, political instability contributed. There is a need to increase production levels through improved forage and nutrition management. Productive and reproductive performance must be compared with pre-set targets for individual herds (Brand et al. 1996). The AUA dairy farm needs to start using such targets to bring the production levels back to higher levels.

Conclusions

The CI and DO were slightly longer compared to commercial dairy farms in temperate regions, but quite similar to (sub-)tropical regions. AFC was too high and must be decreased by improved feeding management of young-stock. The milk production has decreased over the years, mainly due to nutrition management. Doubling of present production levels should be aimed for. Once this has been achieved, a further rise in production should be planned.

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Milk Production Performance of Pastorally Managed Camels in Eastern Ethiopia

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ABSTRACT

Milk production of 30 lactating camels belonging to one herd of 100 heads were monitored for 19 months during March 1996 to September 1997 in the Errer Valley, eastern Ethiopia. The effects of season of calving, parity and calf survival up to weaning on mean daily yield, peak yield, total lactation yield, lactation length, days open and calving interval were assessed. The least square means of the daily, peak and lactation yield were 7.5, 11.5 and 2104 L, respectively. The least square means of lactation length, days open and calving interval were 282, 199 and 573 days, respectively. All parameters were significantly affected by the season of calving. The maximum lactation yield was observed for camels in the third and fourth lactations. The lactation curves had a typical shape, although less pronounced for camels that calved during the long dry season. Camels that calved in the long wet season and older camels showed lower persistency. Camels whose calves died before weaning showed a significantly higher yield than camels whose calves stayed alive.

Introduction

The one-humped camel (*Camelus dromedarius*) is most abundant in north-east Africa. In the semi-arid and arid lowlands of Ethiopia, with more than one million heads, camels represent 35% of the domestic herbivore biomass (Schwartz and Dioli 1992).

In eastern Ethiopia, milk is the most important product of camels (Baars 1998). In arid regions, they contribute substantially to the diet of pastoralists, especially during the dry seasons when milk from cattle and small ruminants is scarce. Because camels withstand high temperature and water deprivation, they have the ability to maintain milk production throughout the dry season. Nevertheless, there is a lack of information and even ignorance about the potential of the camel as a milk producer. Reports on traditionally free-ranging camels are limited (Wilson et al. 1990 and Simpkin 1993). Therefore, the present study was conducted with the objectives to estimate milk production performance of camels under pastoral management and to estimate the effects of the non-genetic factors calving season, parity and calf survival up to weaning on milk production performance.

Materials and Methods

Study Area

The study was conducted in the Errer Valley, eastern Ethiopia. The valley, roughly 35 by 50 km in size, lies in a transitional zone between the intensively cropped areas of the northwestern highlands and the lower lying Jijiga plains. The altitude ranges from 1300 m (south) to 1600 m (north). The precipitation, with a bi-modal pattern, ranges from 400 mm (south) to 800 mm (north). The diverse landscape includes sandy and lava alluvial plains, riverine forests, lava hills, and basement complex mountains. Dwarf shrubs (*Indigofera* spp.) as well as thorny bushes and trees (Acacia, Boscia and Cacti spp.) dominate the vegetation (Tamire 1986), making the area less suitable to cattle. Goat production is limited due to predators. The valley is extensively grazed, especially during dry seasons and drought years. The area is inhabited by semi-sedentary and transhumant Somali (traditional livestock herders) and Oromo (mixed crop–livestock farmers) tribes. Although crop production is a relatively new activity, at present the cultivation of maize and horticultural crops is expanding rapidly.

Camel Management

The camels used for the study belonged to Somali people. They were kept under traditional pastoral management. During daytime the camels browsed, and during the night they were kept in a corral made out of thorny bushes. No protection from rain or sun was provided. The camels were separately herded from cattle and small ruminants. Herds had access to communal forage and most water resources. In the wet season, camels browsed shrubs, trees and cacti, but in the dry season mostly cacti. They were watered once in 5 to 7 days in the dry season; whereas there was no need to water during the wet season. Salt was given 2 or 3 times per month.

The camels were not allowed to mate during the first months of the lactation. Thereafter, breeding was uncontrolled. The newly born calf stayed with the mother throughout the day for the first 4 to 7 days, thereafter only during the night. After 4 months of age, calves were corralled separately.

Milk Production Parameters

Thirty complete lactations were recorded for 19 months, from March 1996 to September 1997. All 30 lactating camels were from one herd of 100 camels in total and belonged to 5 households. All females that gave birth were included. Identification of selected females was based on names given by the owners. All camels were milked twice daily throughout the study period. The milk yield was measured in the morning and evening daily by one person living in the village using a graduated cylinder. The calves suckled the dams to stimulate milk let-down, and continued to suckle during the milking process. The total milk yield was estimated as twice the extracted milk yield to account for nursing stock (Field 1979 and Simpkin 1993).

The effects of season of calving, parity and calf survival up to weaning on milk production parameters were assessed. Three seasons of calving were distinguished: the short rainy season, March–April; the long rainy season, July–September; and the long dry season, November–February. There were ten completed lactations for each calving season. During the study period no calves were born in the months of May, June and October. Data on age and parity of individual lactating camels were obtained through interviews. Parities were grouped in: 1, 2, 3+4, 5, 6+8; with 6, 9, 5, 6, and 4 females, respectively. Parities 3 and 8 were combined with others due to few observations. There were no lactating camels with parity 7 in the study herd.

Calf mortality was recorded. Nine out of 30 calves died before weaning. Real weaning does not occur as the calves keep on suckling up to the end of lactation. However, the calves stayed together with the dam at night during the first four months. Thereafter, they were corralled separately. As such weaning in this study was defined as the time that calves are no longer allowed to suckle the dam during the night.

To calculate persistency, two methods were used: P1 and P2. These methods were based on studies with cattle (Danell 1981) because persistency calculations on camels were not available. P1 expressed the milk yield of lactation days 91 to 180 as a percentage of the milk yield of the first 90 days. P1 is a measure to estimate the rate of yield increase during the first 3 months of the lactation. P2 expressed the milk yield of lactation days 121 to 210 as a percentage of the milk yield of lactation days 31 to 120. P2 is a measure to estimate the rate of yield increase during the 2nd to 4th months of the lactation.

Statistical Analyses

Least square means of all data were assessed by the general linear model procedure using Minitab (1991). Differences were considered significant at $P < 0.05$.

Results

Milk Yield and Reproduction

The least square mean of the daily production was 7.5 L. The average lactation continued for 282 days. The lactation curve had a typical shape and showed a peak of 11.5 L/day in 3 to 4 months. The production per lactation was 2104 L. The least square means of days open and calving interval were 199 and 573 days, respectively (Table 1). The persistency was calculated as 120% for P1 and 89% P2 (Table 2).

Table 1. **Least square means of milk production characteristics per season, parity and calf survival up to weaning of camels under pastoral management in eastern Ethiopia**

	N	Lactation length (days)	Average daily yield (L)	Average Peak yield (L)	Total lactation yield (L)	Days open	Calving interval (days)
SEASON							
Short wet season	10	295^{a} ±15	8.6^{a} ±0.5	13.4^{a} ±0.8	2419^{a} ±140	209^{a} ±13	583^{a} ±14
Long wet season	10	243^{b} ±17	7.3^{ab} ±0.5	12.0^{a} ±0.9	1856^{b} ±156	143^{b} ±14	517^{b} ±15
Long dry season	10	308^{b} ±18	6.8^{b} ±0.5	9.0^{b} ±0.9	2036^{c} ±163	246^{a} ±15	620^{a} ±16
PARITY							
Parity 1	6	293^{a} ±20	6.3^{a} ±0.6	10.4^{a} ±1.0	1856^{a} ±182	217^{a} ±16	591^{a} ±17[1]
Parity 2	9	280^{ab} ±18	7.8^{b} ±0.5	12.1^{b} ±1.0	2069^{b} ±166	208^{a} ±15	582^{a} ±16
Parity 3+4	5	279^{ab} ±22	8.0^{b} ±0.6	12.8^{b} ±1.2	2291^{c} ±207	209^{a} ±19	582^{a} ±20
Parity 5	6	284^{ab} ±22	8.0^{b} ±0.7	11.9^{b} ±1.2	2203^{b} ±204	203^{a} ±18	577^{a} ±19
Parity 6+8	4	274^{b} ±25	7.6^{b} ±0.7	10.1^{a} ±1.3	2099^{b} ±232	160^{b} ±21	534^{a} ±22
CALF SURVIVAL							
Dead before weaning	9	282 ±16	7.6 ±0.3	12.6^{a} ±0.8	2247^{a} ±148	188 ±13	562 ±14
Alive at weaning	21	282 ±11	7.0 ±0.4	10.4^{b} ±0.6	1960^{b} ±102	210 ±9	584 ±10
Mean	20	282±10	7.5 ±0.5	11.5 ±0.5	2104 ±97	199 ±13	573 ±14

^{a,b,c} + Means with different superscripts within effect differ ($P < 0.05$)

[1] Calving interval between first and second calving

Season of Calving

The effect of season of calving was significant for all parameters. Lactation length was shorter for camels that calved in the long wet season. The average daily as well as peak production was lowest for camels that calved in the dry season. The longer lactation length of cows that calved in the dry season compensated the lower daily production levels, and significantly exceeded the total lactation yield of camels that calved during the long wet season. The lactation curves showed a peak in the 2nd to 4th months of lactation for camels that calved in the short and long wet season. The peak of milk production for camels that calved in the dry season was less pronounced (Figure 1). Persistency was highest for camels that calved during the short wet season and lowest for camels that calved during the long wet season. Days open and the calving interval were significantly shorter for cows that calved during the long wet season.

Parity

The length of the first lactation was significantly longer than that of the 6th and 8th lactations. First calvers had a significantly lower average daily and lactation yield. The most pronounced peak yields were observed for the 3rd and 4th lactations (Figure 2). The persistency of cows after the 5th lactation was lower compared to camels of lower parities.

The days open and calving interval were significantly lower for camels in the 6th and 8th lactations.

Calf Survival

The least square means of peak and lactation yield of cows whose calves died before weaning were significantly higher compared to those whose calves survived. Persistency was not effected by calf death.

Table 2. Least square means of lactation persistency per season, parity and calf survival up to weaning of camels under pastoral management in eastern Ethiopia (all yields in liters)

	N	1–90 days	91–180 days	31–120 days	12–210 days	P1[1]	P2[2]
SEASON							
Short wet season	10	$788^{a} \pm 52$	$1012^{a} \pm 56$	$940^{a} \pm 46$	$891^{a} \pm 56$	$138^{a} \pm 10$	$101^{a} \pm 9$
Long wet season	10	$749^{a} \pm 58$	$815^{b} \pm 63$	$917^{a} \pm 52$	$639^{b} \pm 63$	$109^{b} \pm 11$	$72^{b} \pm 10$
Long dry season	10	$631^{b} \pm 60$	$668^{c} \pm 65$	$693^{b} \pm 54$	$626^{b} \pm 66$	$113^{ab} \pm 11$	$96^{a} \pm 10$
PARITY							
Parity 1	6	$625^{a} \pm 67$	$698^{a} \pm 73$	$717^{a} \pm 60$	$644^{a} \pm 73$	$117^{a} \pm 13$	$97^{a} \pm 11$
Parity 2	9	$704^{ab} \pm 61$	$837^{b} \pm 67$	$839^{b} \pm 55$	$730^{b} \pm 67$	$122^{ab} \pm 11$	$94^{a} \pm 10$
Parity 3+4	5	$792^{b} \pm 76$	$932^{b} \pm 83$	$947^{c} \pm 68$	$807^{c} \pm 83$	$116^{a} \pm 14$	$95^{a} \pm 13$
Parity 5	6	$700^{ab} \pm 75$	$938^{b} \pm 82$	$852^{b} \pm 67$	$775^{bc} \pm 82$	$153^{b} \pm 14$	$91^{a} \pm 12$
Parity 6+8	4	$793^{b} \pm 85$	$754^{a} \pm 93$	$894^{c} \pm 77$	$637^{a} \pm 93$	$93^{c} \pm 16$	$70^{a} \pm 14$
CALF SURVIVAL							
Dead before	9	$795^{a} \pm 54$	$914^{a} \pm 59$	$933^{a} \pm 49$	772 ± 59	121 ± 10	89 ± 9
weaning	21	$650^{b} \pm 38$	$750^{b} \pm 41$	$767^{b} \pm 34$	665 ± 41	119 ± 7	90 ± 6
Alive at weaning							
Mean	30	723 ± 32	832 ± 45	850 ± 37	719 ± 39	120 ± 6	89 ± 5

^{a,b,c}Means with different superscripts within effect differ ($P < 0.05$).

[1] P1 = persistency 1 calculated as: yield days 91 - 180/yield days 1–90

[2] P2 = persistency 2 calculated as: yield days 121 - 210/yield days 31–120

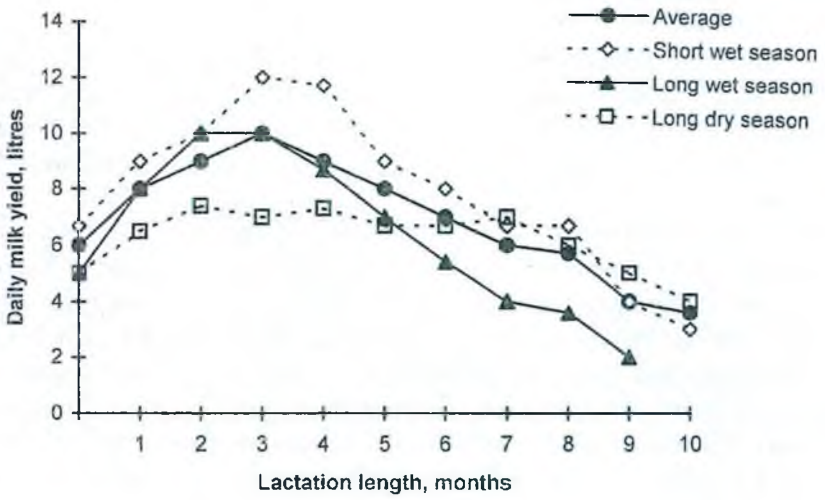

Figure 1. Effect of calving seasons on lactation curves of camels under pastoral management in eastern Ethiopia, March1996–September 1997

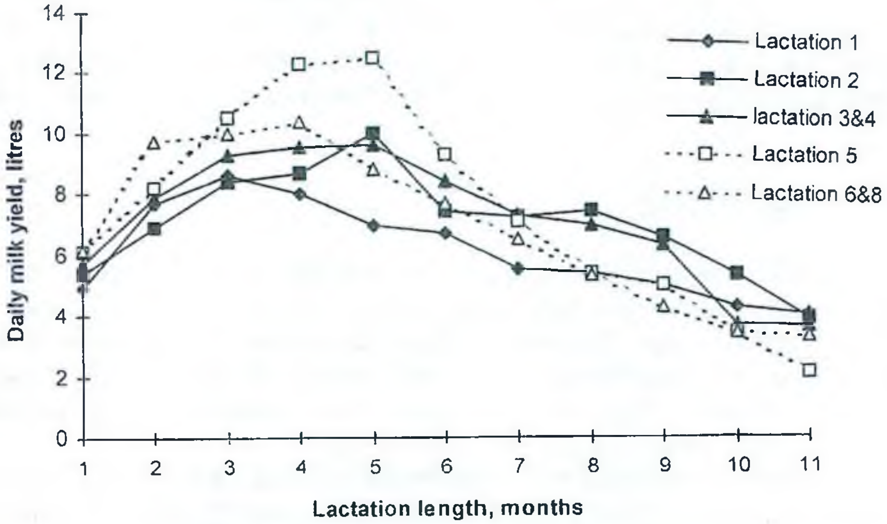

Figure 2. Lactation curves per parity of camels under pastoral management in eastern Ethiopia, March1996–September 1997

Discussion

Milk Yield and Reproduction

The mean daily milk yield in the present study of 7.5 L. was higher than the 2.4 to 4 L. reported for camels under traditional management in Kenya (Simpkin 1993). However, literature reports a very wide range of 0.1 to 50 L/day (Field 1979). The mean daily peak yield in the present study ranged from 6 to 20 L. A similar range was found in Somalia (Hussien 1993).

The least square mean of lactation yield (2104 L.) of camels in this study was similar to several reports: 1950 L/lactation in Somalia (Yagil 1985), 1872–2592 in Ethiopia (Belete 1985 and Knoess 1977), 1500–2500 in East Africa (Schwarz and Walsh 1992) and 1373–2776 in India (Rao 1974). However, lower and higher yields per lactation have also been reported. In the present study, marked differences between individual camel cows were observed. The Ogaden camels used in this study have a large body size compared to other distinguished Ethiopian breeds (Wilson 1989). They are good dairy animals (Abebe 1989).

There was a wide variation in lactation length, which was also observed in Kenya (Simpkin 1993). The average lactation length of camels is 12 months, with 9 months as the minimum average (Mukasa-Mugarwa 1981). The present study estimated 9 months on average. However, shorter lactation lengths of 6 to 7 months have been reported as well for East Africa (Hussien 1989 and Simpkin 1993).

The average gestation length in the present study of 374 days falls in the reported range for camels of 360 to 390 days (Nova 1970). The calving interval in the present study ranged from 12 to 22 months with a mean of 19 months. Evans and Powys (1979) reported similar calving intervals ranging from 12 to 18 months in Israel and 22 months in Kenya.

Season of Calving

Two possible reasons could explain the lower lactation yield of camels that calved during the long wet season. First, during early lactation they suffered from strong rains as well as biting flies. In southern Somalia, camel types have been distinguished with different levels of resistance to biting flies (Hussein 1993). Second, a large part of the lactation coincided with the dry season that resulted in a low lactation persistency. A similar effect of season of calving was found in Kenya (Simpkin 1993).

The clear peak in the curve for camels that calved in the wet season and absence of peak for camels calving in the dry season was also observed by Hussein (1993) for Somali camels.

Both the P1 and P2 persistencies were highest for camels that calved during the short wet season. They benefited from a long wet period after calving (March to October), which helped to maintain the milk production at a high level. The persistency was lowest for camels that calved during the long wet season because they suffered from nutritional stress during the dry season when they were in mid lactation.

The continuation of the lactation depends largely on the humans' need for milk, more being required during dry months when other sources of food and milk are scarce (Yagil 1994). It is therefore possible that camels are not mated during the dry season because the lactation will stop soon after conception. Yagil (1994) assumed that the lactation stops in the fourth month of pregnancy. Therefore, camel cows are not mated shortly after giving birth. Generally, peak calving takes place in March–April and December–January, this last period being in the dry season.

Parity

The average daily yield, peak yield and total lactation yield among parities were similar to trends of other ruminants (Williamson and Payne 1978). The yield was lowest in the first lactation number, increased and remained stable from parity 3 to 5, and decreased in the 6th and 8th parity.

Calf Survival

The death of the calf commonly affects lactation length of camels because oestrus follows immediately and the lactation stops (Yagil 1994). However, in the present study this effect was not found. In fact, when the calf died, a substitute calf or the skin of the dead calf was used to stimulate milk let-down. The lactation yield of cows that lost their calves was higher than those whose calves survived. Because the death of the calf did not restrict milk extraction, a continued supply of milk for humans was ensured.

Conclusions

This study provided an insight in the milk production and persistency characteristics of camels under pastoral management. The variation in milk production among parities had a normal pattern: the lowest and highest parity camels produced lesser milk than mid parity camels. The season of calving affected milk production parameters. However, during the dry season the herd produced a substantial amount of milk for the pastoralists. Milk extraction continued in spite of calf death.

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Camel Marketing in Eastern Ethiopia

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ABSTRACT

Camel marketing was studied in the drylands of eastern Ethiopia. The data were obtained from South East Rangelands Development Project (SERP) in Dagahabour, Jijiga and Babile livestock marketing sites. The data were collected during market days from 1991 to 1993 to understand the extent and patterns of camel supply and demand as well as camel prices and trends. The Dagahabour market site, surrounded by camel dominated areas, was the leading in supply and sale of camels, which accounted for 53% and 60% of the total supplied (N = 73,032) and sold (N = 22,790) camels, respectively. The total camels sold were 31% of the total camels brought to all markets of which the male camels accounted for 69%. Camels were observed in excess during drier months, November–February and June–July. The average prices were Birr 754 for male camels and Birr 573 females. Special attention should be given in the development and improvement of camel marketing to render possible ways to absorb the surplus camels from the markets. Indeed, the improvement of livestock marketing in general can be reflected by the betterment of the livelihood of the animal farming societies of eastern Ethiopia.

Introduction

The camel is one of the most important animal species in the drylands of Ethiopia. Currently, the camel population of Ethiopia is estimated to be one million heads (FAO 1996). The eastern parts of the country, mainly the Somali Region, is believed to be the heartland of the camel population of Ethiopia. According to PADP (1983) in the Harerge province, which is situated in the eastern part of the country, there are 0.7 million heads of camels. Camels are almost everything for inhabitants of the climatically unpredictable fragile dryland environments. Camels secure food and transportation and they also play important roles in the pastoral sociocultural systems. For instance, in a survey held among camel keeping householders in Jijiga and Shinile areas of eastern Ethiopia in 1996, it was found that a household possessed on average 50 Tropical Livestock Units TLUs of which camels shared 65% (n = 84) (Getahun 1997) In spite of their invaluable importance, little is known about the marketing of camels, which are considered as the corner-stone in understanding the pastoral subsistence economy in the eastern Ethiopia. Therefore, this paper attempts to offer a general overview of the extent and patterns of camel marketing in eastern Ethiopia.

Materials and Methods

For the present study the data on camel marketing were obtained from South East Rangelands Development Project (SERP). As part of the project component, SERP monitored different livestock markets for various species. The data were collected on every market day during 1991 to 1993. Out of these markets, Dagahabour, Jijiga, and Babile were selected for this study. The data include information on the number of camels offered and sold and price rates for both male and female camels.

Features of the Livestock Market Sites

The Babile, Jijiga and Dagahabour livestock market sites are located at the distance of about 90, 160, and 390 km from Dire Dawa town to the eastern part of Ethiopia. The majority of the inhabitants of Bible and Jijga are pastoralists with farming practices, but Degahabour inhabited by pure pastoralists due to the dominance of arid climates. The Somali ethnic group constitute the majority of the population with a higher number in areas approaching Dagahabour.

Result and Discussion

Supply and demand of Camels

The total camels supplied and sold in the three market sites from 1991 to 1993 were 73,032 and 22,790 heads, respectively (Table 1). The number of camels sold were by far less than the camels brought to markets. The sale of camels for Dagahabour was 3.5%, Jijiga 30% and Babile 22%. The excess supply of camels may be attributed to the low demand of camels to each market site. The contribution of each market to the total supply and demand of camels differ significantly. The Dagahabour market accounted for 53% and 60% of the total camels supplied and sold. This is may be due to the presence of large camel population in and around its vicinity, good forage resources and salt water reserve in which many pastoralists get a chance to congregate together to use these resources and at the same time use the available market, and its proximity to the illegal livestock trades which might give a better chance to the pastoralists to bring their camels and sale. The drought that occurred during the study period was reported to contribute to the increment of the camel supply in this area.

The number of male camels were significantly greater than the females both in supply and demand in all market sites (Table 2). On average, the male camels supplied were almost double than females (62 to 38%) and more than double in the number sold (67 to 33%). The variation observed in the supply between the two sexes is mainly due to the tendency of the pastoralists in selling excess males of the herd with a relatively better body condition than the females. The female camels coming to the markets were mostly culled either due to age or disease or other fertility problem. As a result, the demand for the female camels both for slaughtering and breeding was low. Nevertheless, this condition was different in the actual herd structure of the camels outside the markets. In a survey held in Jijiga Wereda in 1996, on average the females comprised 75% (n = 53) of a herd (Getahun 1997, unpub.).

The number of camels offered and sold in each market varied with the season of the year (Figure 1). In all markets the number of camels offered and sold were relatively higher in long dry season (November to February; Jilale season) and short dry season (May to June; Hagai season). This may be due to the herders' management decision to utilize the limited resources of feed and water available in the area efficiently. In general there appeared a slight response of supply towards the low rainfall months (Figure 2). Similar trends were observed for other livestock species in Borena (Coppock 1994).

Prices of Camels

The three years average prices of camels for each market and sex group are presented in Table 3. The average prices for male and female camels in varied between Birr 855 and 610 in Babile to 679 and 529 in Dagahabour markets, respectively. There was a slight price reduction in both male and female camels while going from Babile to Dagahabour area; the price reductions observed for males and females were about 34 and 13% respectively. The figure indicated that the price of female camels were more stable than the males. This might be in response to the more supply of camels in Dagahabour.

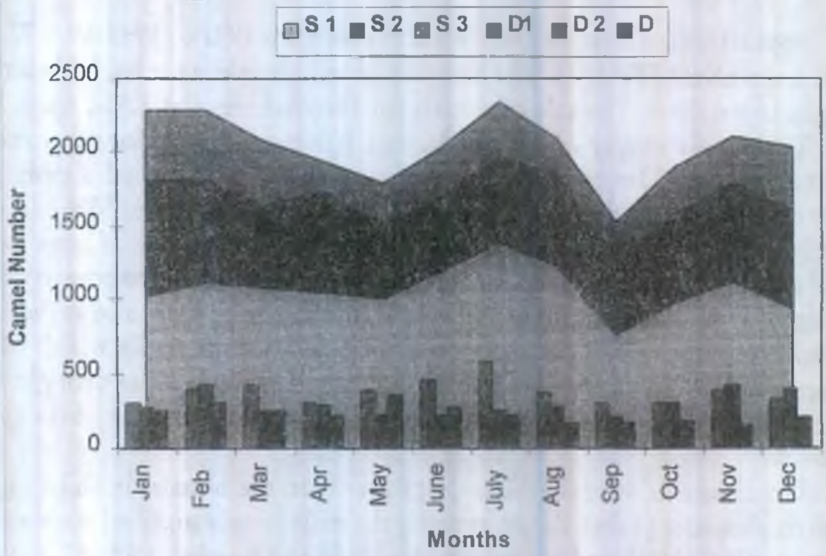

Fig. 1 Relationship Between Supply and Demand.

S and D represent Supply and Demand; S 1 and D 1, S 2 and D 2, and S .3 and D3 represent the supply and demand for Degahabour, Jijiga, and Babile market sites respectively.

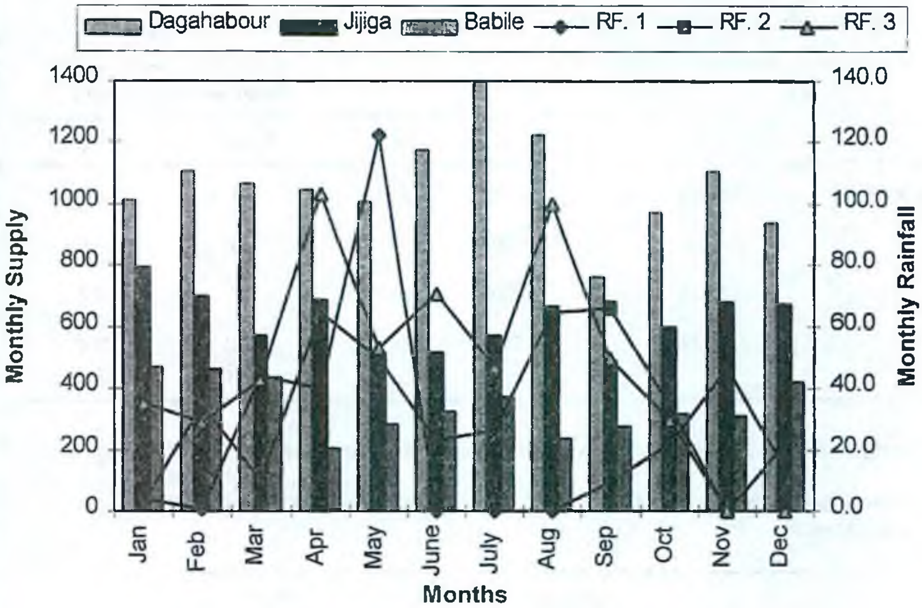

Fig. 2 Relationship Between Camel Supply and Rainfall.

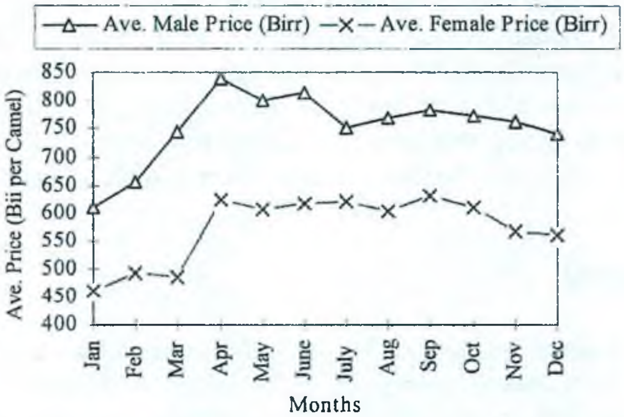

Figure 3. Monthly average price variations in three markets, 1991–1993

Table 1. Total supply and demand of camels in three market sites in eastern Ethiopia

		Demand		*Relative contribution*	
Market	Supply no.	No. Heads	%	Supply	Demand
Dagahabour	38450	13648	35	53	60
Jijiga	22228	6428	30	30	28
Babile	12354	2714	22	17	12
Total	73,032	22,790	31	100	100

* Relative contribution of each market site to the overall camel supply and demand.

Table 2. Percentage of average distribution of total male and female camels in three market sites

	Offered		*Sold*	
Market	Male	Female	Male	Female
Dagahabour	65	35	73	27
Jijiga	61	39	63	37
Babile	60	40	65	35
Total	62	38	67	33

The prices of camels were affected by seasons (Figure 3). The prices of both male and female camels raised during the rainy months of March and April (Gu season). The male camel price fluctuated on average between Birr 850 in months of March and April to below Birr 750 in dry months of November through February (Jilale season). Though the price for both sexes was higher of April, the herders brought relatively few number of camels to the markets during this time. At this point it seemed that the pastoralists were not market-oriented, rather they sold camels when rainfall is low and cash is in need.

Trend Analysis

The trends of camel supply and demand and price are shown in tables 4 and 5, respectively. The supply increased on average by 39.8% from 1991 to 1992 and then declined sharply by 40.8% from 1992 to 1993. The demand, however, increased only by 0.5% during 1991 to 1992 and declined by 19.5% in 1992 to 1993 (Table 5) for all markets. It was interesting to average the response of demand (0.5%) to the increment of supply (39.8%) during 1991 to 1993. In addition, there was significant variation among markets. The Babile market remained positive both in supply and demand till 1993 than the other two markets. This may be due to the relatively better demand for camels in this area.

There was an increasing trend in the price of camels over the three years; the average increment for males and females were 13.7% and 4.5% in 1991 to 1992, and 38.2% and 39.5% in 1992 to 1993, respectively (Table 4).

Table 3. Average camel prices (in Birr) by sex and market site during 1991–1993

	Male			*Female*		
Market	Max.	Min.	Mean	Max.	Min.	Mean
Dagahabour	740	572	679	592	400	529
Jijiga	789	561	729	658	490	580
Babile	1032	680	855	797	377	610

Table 4. Summary of average camel prices trends

	1991		1992				1993			
Market	M**	F	M	% (+)	F	%(+)	M	% (+)	F	% (+)
Dagahabour	740	657	607	-18.0	434	-33.9	689	13.5	497	14.5
Jijiga	580	420	622	7.2	472	12.4	985	58.4	849	79.9
Babile	511	396	852	66.7	633	59.8	1202	41.1	801	26.5
Average	610	491	694	13.7	513	4.5	959	38.2	716	39.5

* The change indicated by (+) sign is for per cent increase and (-) for per cent decrease
** M = Male; F = Female

Table 5. Summary of average camel prices trends*

	1991		1992				1993			
Market	Offered	Sold	Offered	%(+/-)	Sold	%(+/-)	Offered	%(+/-)	Sold	%(+/-)
Dagahabour	13,227	4,922	17,632	33.3	4,931	0.2	7.581	-57.0	3,795	-23.9
Jijiga	7,237	2,714	9,040	24.9	2,102	-22.5	5.951	-34.2	1,612	-23.3
Babile	2.170	460	4,976	12.9	1,107	140.6	5,208	4.7	1,145	3.4
Total	22,644	8,098	31,649	39.8	8,140	0.5	18,740	-40.8	6,552	19.5

* The change indicated by (+) sign is for per cent increase and (-) for decrease

Conclusion and Recommendation

Special attention should be given in the development and improvement of the camel marketing conditions in order to render possible ways to absorb the surplus camels from the markets in the study areas. The pastoralists should have access to market information and they should be advised to bring their animals before the animals' loss of body condition in order to get good price. Finaly, further detailed study should be undertaken in this area to generate important market information. Indeed, the improvement of livestock marketing in general will be reflected by the betterment of the livelihood of the animal farming societies of eastern Ethiopia.

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PRELIMINARY OBSERVATION ON CAMEL TYPES AND MAJOR PARASITIC DISEASES OF CAMEL IN THE EASTERN LOWLANDS OF ETHIOPIA

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ABSTRACT

In this preliminary study two major types of camel, the Arrog and the Ayyon, were observed in the eastern lowlands of Ethiopia. The Ayyon type can be further divided into three sub types: the Aden, Assen Awele and Dume ade. The Arogg is large and relatively good for milk and meat production; whereas the Ayyon is smaller, good for transportation and relatively drought resistant. The major parasitic disease problems identified were *Trypanosoma evansi* (7.79%), gastrointestinal helminths (95.1%), *Cephalopsis titilater* (86.4%) and ticks. The dominant ticks were *Rhipicephalus pullchellus* (49.38%), *Amblyomma gemma*, (22.33%), and *Hyalomma dromedarrii* (8.41%). A detailed study on camel types and the parasitic disease of camel is highly recommended to improve camel production and productivity in the area.

Introduction

One-humped camels (*Camelus dromedarius*) play a significant role as a primary source of subsistence in drylands of Ethiopia. Camels possess peculiar genetic potential to withstand the semi-arid and desert conditions, feed scarcity, and water shortage. Camel utilises wide arid and semi-arid lowlands which are not suitable for crop production and less suitable for other livestock production. Thus, in this part of the country the camel is superior to all other livestock in terms of food security. With continuing land degradation and the rapidly growing human population, the importance of the camel is enhancing.

Despite its importance to a large population of pastoralists, the camel is a neglected animal in improvement programs. But the current condition is more favorable for the nomads and their camels because of increased attention of the government and researchers. Therefore, the objective of this paper is to give baseline information on camel types in the Miesso and Afdem areas and on major parasitic diseases in the eastern lowlands of Ethiopia.

Materials and Methods

Study Area

The observations on camel types were made in nomadic villages around Miesso and Afdem areas where the Issa and Haweya Somali clans breed camel and other livestock to lead their nomadic and semi-nomadic life. Observations on camel parasitic diseases were conducted in Afdem, Adegala, Shinelle, Denbele, Jijiga and Dire Dawa districts.

The climate in most parts of the eastern lowlands is harsh with low, unreliable and unevenly distributed rainfall with regularly high temperatures. The mean annual rainfall varies from 100–550 mm. The eastern lowlands has largest area of grass cover, around 10 million hectares, covering 38% of the region. However, the largest part of the region (54%) constitutes of bushes, shrubs and afroalpines.

Camel Types

A questionnaire survey was conducted among 27 camel owners to acquire basic data. Two respected camel owners were selected based on their long-time experience in managing camels and the large number of camels they owned.

Parasitic Disease

To identify the major parasitic diseases of camels, samples of blood, faeces, ticks, and post-mortem were collected from different watering points, villages and slaughter houses. To study the prevalence rate of trypanosomiasis and to identify different types of ticks affecting camels, multi-stage sampling method was used to select the target population. Six districts were selected at the first stage and followed by watering points and villages. The camels owned by the nomads at watering points and villages were then taken as the target population.

A total of 693 thick and thin blood smears were collected from the target population. The blood smears were fixed with methanol under field condition and brought to laboratory. The smears were stained with giemsa and examined (Soulsby 1982).

Tick were collected from the ear, head, upper neck, lateral part of leg, chest floor, udder, anus, and tail of 65 camels and placed in a universal sampling bottle pre-filled with 4% formaldehyde solution. The examination was done by stereo-microscope at Dire Dawa Zonal Veterinary Investigation Laboratory. The identification was conducted according to Hoogstral (1956) and Kaiser (1987).

A total of 348 faecal samples were collected from two districts and Dire Dawa municipality slaughter house. The samples were transported in ice to the laboratory and examined using flotation, sedimentation and McMaster egg counting technique (MAFF 1984).

To study the prevalence rate of camel *Cephalopsis*, 66 camels slaughtered in Dire Dawa and Jijiga were used. The facial cranium was opened to reach the predilection site of the *C. titillator* in the anterior and posterior chamber of the pharynx. The larvae were recovered, counted and recorded.

Result and Discussion

Camel Types

There are two major types of camel: the Arogg and Ayyon. The Arogg are large in body size, long, the neck is broader from the base, the foot pad is broader, with a large mammary gland and good in milk and meat production. This type is rarely found in Issa and Haweya, but it is mainly found in the Ogaden region of Somali.

The Ayyon types of camels are smaller in body size and length, the foot pad is narrower, the neck is narrower, they have smaller mammary gland, are good for transportation, drought resistant. But they are relatively poor in milk production compered to Areg. This type of camels is mainly found in the Shinelle zone of Somali region and they are commonly called the Issa camel.

The Ayyon type of camels are further divided into three sub types: Adene, Assen Awele and Dume Ade. The Adene is whitish in color, relatively week in strength and milk production. The eye lash is white and this camel has difficulty of sight during nights. The Assen Awele camels are reddish-white. They are fairly strong, and hence preferred for transportation. They are relatively good milk producers. The Dume Ade are blackish-white, very strong animals. They are good for long distance transportation and milk production. The Somali camels are categorised into the northern and the southern types. The southern type is again divided into three sub types: Hoor, Siifdaar, and Eyddimo (Mohammed 1993). The characteristics of the Hoor camel is related to the Issa type camel (Ayyon); while the Eyddimo is similar to Ogaden type camel (Arogg). Based on their function, camels are divided into riding and baggage types, and based on their living habitat into the lowland and mountain types (Wilson 1984). Detailed study on camel types and breeds has paramount importance for animal breeders and geneticists or zoologists, and for any camel improvement program.

Parasitic Diseases

Camel trypanosomiasis

The camel trypanosomiasis, locally known as Dukan or Kinine, is one of the major health problems in the eastern lowlands. Trypanosomiasis causes economic losses through mortality and morbidity and loss of milk, meat and reduced working ability of the baggage camel.

The overall prevalence rate of trypanosomiasis was found to be 7.79% (Table 1). The identified species from 54 positive camels was *Trypanosoma evansi*. The highest prevalence rate was from Jijiga (15.6%), because the samples were collected from Fafenne and Jerere valleys which are highly suitable sites for fly breeding. The present finding is in agreement with previous works in the area: Abebe 1991 (6.5%) and TCS 1982 (8.2%). In Somalia prevalence rate of trypanosomiasis was found to be 7.8% (Bornstein 1993).

The major flies identified are *Tabanus and Hypobusca*. The local name of the *Tabanus* fly is Adale. The same flies were reported by Melaku and Fesseha (1988). The role of *Hypobusca* fly in the transmission of trypanosomiasis requires future investigation. Wilson (1984) has considered surra, caused by. *T. evansi*, to be the most important health problem in camels. The low prevalence rate of trypanosomiasis may be due to the low level of the parasite in the blood of infected camels; or the available diagnostic method used in this study and previous works might have not been satisfactory to detect chronic cases.

Camel ticks

From 1142 adult ticks of camels examined, three major genera (*Rhipicephalus, Amblyomma and Hyalomma*, consisting of eight species were identified (Table 2). According to Wilson (1984), the major ticks of camel are the genera of *Rhipicephalus*, *Amblyomma* and *Hyalomma*. The quantitative hierarchy of ticks identified indicated that the most abundant ticks were *R.. pulchellus* (49.38%), *A. gemma* (22.33%) and *H. dromedarii* (8.41%). The qualitative distribution of ticks showed that *Amblyomma variegatum* was found in the lowlands bordering the highlands. R. pullahellus, A. gemma and R. e. evertsi were distributed in border areas with the lowlands, in arid and semi-arid lands. All the *Hyalomma* species were identified from semi-arid and arid lands.

Table 1. **Prevalence of camel trypanosomiasis in six districts of the castern lowlands**

District	*Total no. of samples*	*No. positive*
Afdem	200	5 (2.5)*
Adegala	102	9 (9.8)
Asbuli	65	5 (7.7)
Dire Dawa	75	3 (4)
Jijiga	141	22 (15.6)
Mello	110	9 (8.2)
Grand total	693	
Mean		53 (7.7%)

*Figures in parentheses are percentage values

Camel helminths

Out of a total of 348 camels for which faecal samples were examined (Table 3), 331 (95.1%) were found positive for different types of gastrointestinal parasites ova. These were *Strongyle* (92%), *Trichuris* (23.9%), mixed infection of different ova (18.3%) and *Trophozoites* of Balantidium (2%). Other ova identified included *Moniezia expansa*, *M. benedeni* and *Eimeria*. The mean egg per gram in the faeces for the sampled area was 2940 with a range of 50–19000. Similar infestation rates were reported for eastern Ethiopia by Abebe (1991) (87%), Graber (1975) (93.6%) and Melesse (1996) (95.27%). According to field observation, camels with a high EPG developed emaciation, constipation, loss of appetite, and diarrhoea. The gastrointestinal parasites are economically important because of the hidden losses incurred which lead to reduction in productivity and performance of the animal. The parasites may also predispose the highly infected camel to other infection.

Table 2. Average number of adult ticks

Species	Averag no. Ticks/camel	Total
	Rhipicephalus	
R. Pulchellus	8.67	564 (49.38)*
R. E. Evertsie	0.55	36 (3.15)
	Amblyomma	
A. Variegatum	0.76	37 (3.24)
A. gemma	3.92	255 (22.33)
A. Lepidum	0.97	63 (5.52)
	Hyalomma	
H. Marg. Rufipes	1.02	66 (5.87)
H. Dromedarii	1.48	96 (8.41)
H.impeltatum	0.38	25 (2.19)

*Figures in parentheses represent percentage

Camel cephalopsis

In Dire Dawa and Jijiga municipality slaughter houses 39 and 27 camels were examined, respectively. Out of these 57 camels (86.4%) were infested with C. titillator in the frontal sinus and anterior and posterior chambers of the pharynx. The mean number of larvae counted was 63 with a range of 3–120. This result is in agreement with that of Abebe (1991) (85.3%) in Jijiga and Melaku and Fesseha (1988) (83.33%) in Dire Dawa. This nasal cavity myiasis causes deterioration of frontal sinus and pharyngeal mucosa, and this may predispose the animal to upper respiratory tract infection by favoring the multiplication of the normal flora bacteria in this region such as *Pasteurella* and other organisms. Based on the previous works mentioned above and the present finding *Cephalopsis* can be considered as a major parasitic problem of camel.

Table 3. Prevalence of camel helminthiasis and average eggs per gram (EPG)

Location	*No. of sample*	*No positive*	*Mean EPG*
Afdem	160	149 (93.1)**	2950 (100–18,2000)
D.D.S.H*	98	95 (96.9)	3200 (50–19,000)
Mello	90	85 (94.4)	2670 (100–14,900)
Sum/average	348	331 (95.1)	2940 (50-19,000)

*Dire Dawa Slaughter House

**Figures in parentheses represent percentage (second column) and range (third column)

The current preliminary survey has elucidated the important pathogenic parasite of the dromedary in the eastern lowlands. Hence, a detailed epidemiological study of the dromedary disease is highly recommended to institute both practically and economically feasible preventive measures.

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CARCASS CHARACTERISTICS OF MENZ SHEEP AND THEIR CROSSES WITH AWASSI AND CORRIEDALE BREEDS REARED UNDER DIFFERENT FEEDING REGIMEN

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ABSTRACT

A total of 36 ram lambs (from 2 feeding x 3 genotype), 6 supplemented and 6 non-supplemented lambs each from Menz, Awassi x Menz and Corriedale x Menz sheep were randomly selected from 36, 44, and 38 ram lambs, respectively, and slaughtered at a mean age of 410 ± 2 days. Corriedale x Menz and Awassi x Menz lambs were significantly better ($P < .05$) than purebred Menz sheep in all carcass traits except dressing percentage abdominal fat weight, and fat thickness over the loin muscle. The weight of tail fat in the Awassi x Menz cross exceeded that of Corriedale x Menz and purebred Menz lambs by 349 and 237 g, respectively ($p <. 01$). When carcass parts were expressed as a percentage of carcass weight, most of the differences between genotypes were eliminated. On this basis still tail fat of Awassi x Menz and kidney fat, hid-saddale and loin weight of Corriedale x Menz remained higher than those of other genotypes. Pre-slaughter liveweight significantly correlated with kidney fat (0.67; $p <. 01$), hot and cold carcass weight (both 0.98; $p <. 01$), dressing percent (0.50; $p <. 01$) and tail fat weight (0.54; $p <. 01$). Loin eye muscle area was significantly and positively associated with back fat thickness (0.80; $p <. 01$) and abdominal fat (0.74; $p <. 01$). In general, crossbreds performed better in most carcass traits and responded well to supplementary feeding than purebred Menz sheep.

INTRODUCTION

Ethiopia has a large sheep population, but the productivity per animal and the contribution of the sub-sector to the national economy is relatively low. Sheep are kept mainly for meat production. The annual total off-take of mutton and lamb production is estimated to be 80,000 metric tons, but with a low carcass yield of 10 kg/head. Sheep meat accounts for only 18 % of the total 13.5 kg per caput consumption of red meat in Ethiopia (ILCA, 1993). The majority of the sheep belong to small breeds with low productivity (Gall 1983). Domestic market survey reported by MOATC (1975) shows that the average weight of sheep sold in local markets was 20 kg. The mature weight of indigenous breeds is only about 30 kg (Gall 1983).

Inadequate feeding, health, and genetic potential and poor management practices hinder increased sheep productivity. In an attempt to alleviate these problems and to improve productivity, exotic breeds have been introduced for crossing with the local breeds. Awassi x Menz and Corriedale x Menz crosses have been recommended from past experiments as improved genotypes to increase meat and wool production in the Ethiopian highlands (Zelalem 1989). The evaluation of these genotypes has to date been done only under conditions of generous supplementary feeding with comprehensive disease and parasite control. However, the extent to which these additional inputs and management could increase meat production and quality from crossbred animals has not yet been determined. The present work was conducted to study the effect of genotype and dry period supplementary feeding on carcass characteristics of Menz sheep and their crosses with Awassi and Corriedale breeds.

Materials and Methods

Experimental site. This study was conducted at Sheno Research Center that located on the central-northern highlands of 80 km north of Addis Abeba in a mixed barley and sheep farming area. Although the area lies close to the equator (09 °05' N latitude), its climate is modified by altitude. The mean minimum and maximum temperatures are 5 °C and 18 °C, respectively. Frosts are common from October to December, and rainfall (>800 mm annually) is bimodally distributed, with short (but unreliable) and long (and reliable) rainy seasons in March–April and June–September, respectively. Natural pastures are predominantely *Andropogon chrysostachys, Eragrostis botryodes* and *Steria atrata.*

Experimental animals and management. Thirty six purebred Menz (M), 44 Corriedale x Menz (CM) and 38 Awassi x Menz (AM) ram lambs born in September–October 1989, were allocated (within genotype) by stratified random sampling based on liveweight to two groups at weaning (3 months of age). For each of the three genotypes, animals in group 1 were grazed on natural pasture at a stocking rate of 7 animals/ha until January 1992, when the experiment concluded. From January to June 1991, a period which corresponds to the dry season of the area, this group was supplemented with 300 g/head/day of a mixture of 44% wheat middlings, 50% noug meal, 4% bone and meat meal, and 2% salt (providing crude protein of 24% of dry matter). The concentrate was fed individually at 08.00 h daily before the rams were turned out onto pasture. The animals in group 2 were treated exactly as those in group 1, except that no supplement was fed. Both groups were grazed from 08.30 to 16.30 h daily, and housed at night (the local management practice). All received appropriate treatment for internal and external parasites, watered daily, and were weighed at birth and 14-day intervals thereafter.

Carcass data collection. A total of 36 lambs, 6 supplemented and 6 non-supplemented ram lambs from each genotype were randomly selected and slaughtered at a mean age of 410 ± 2 days. These animals were deprived of feed and water for a night prior to slaughtering and were weighed to the nearest 0.1 kg immediately before slaughter. Immediately after slaughter and removal of the skin, abdominal and thoracic organs, hot carcass weight was recorded. Dressing percentage was calculated based on pre-slaughter liveweight, that is, not excluding the gut fill. Cold carcass weight was taken after the carcasses were left to cool overnight for approximately 12–14 hours at the environmental temperature of 1 to 5 °c which prevailed during the night. Kidneys and kidney fat that were left intact during dressing were then removed and the separate weight of each was recorded. The carcass was then cut between the 12th and 13th ribs perpendicular to the backbone. This exposed the cross-sectional area of the *M. longissimus dorsi* (rib-eye muscle), the outlines of which on both sides were traced on a special paper. The area of the squares (each 1 x 1 mm) that fell within the tracer mark were then counted on both sides and the average of the two was used to calculate rib-eye area in square centimeters. Average fat thickness over the longissimus muscle was measured on both sides to the nearest mill meter using a hand ruler. The fore-saddle and hind-saddle were further separated into wholesale cuts following the procedure of Levie (1967) and weights of each of these parts were recorded to the nearest 0.01 kg.

Statistical Analysis

The data were analysed using the General Linear Model (GLM) procedure of SAS (1987), using a fixed model with genotype, feeding and their interaction as the independent variables and carcass characteristics as dependent variables. All effects was tested against the error mean squares. When the effect was found significant, separation of means was done using Duncan's New Multiple Range Test. Effect of interactions between feeding and genotype were not significant for all variables studied.

Result and Discussion

Genotype Effects

The differences among the genotypes were large ($p < .05$) for most variables studied (Table 1). Corriedale x Menz and Awassi x Menz crossbred lambs were significantly ($p < .05$) superior in most carcass characteristics to straightbred Menz lambs (tables 1 and 2). Awassi x Menz lambs deposited significantly ($p < .05$) more tail fat than both the Corriedale x Menz and purebred Menz. The high tailfat observed in Awassi x Menz lambs might indicate the significant influence of the Awassi breed on this trait. In contrast, Corriedale x Menz lambs had significantly more internal fat, particularly kidney fat, than the purebred Menz. The difference in kidney fat weight between Corriedale x Menz and Awassi x Menz lambs, however, was not statistically significant, except the kidney fat expressed as percentage of carcass weight (Table 3). Similar to this finding the higher kidney fat for Corriedale lambs was observed by Dickerson et al. (1972). Also, breed differences in kidney fat between temperate and tropical or temperate to temperate sheep were reported by many (Boylan et al. 1976; Dickerson et al. 1974, and Thomas et al. 1976).

Table 1. Mean and standard errors for slaughter weight (SW), hot carcass weight (HCW), cold carcass weight (CCW), dressing percentage (DP), front-saddle weight (FSWT), and hind-saddle weight (HSWT), tail fat weight (TFWT) and rib-eye muscle area (REMA) in ram lambs

Factors	Sw (kg ± SE)	HCW (kg ± SE)	CCW (kg ± SE)	DP (% ± SE)	FSW (kg ± SE)	HSW (kg ± SE)	TFW (g ± SE)	REMA (cm^2 ±SE)
Genotype								
Menz (M)	21.7 ± 1.21^{a}	9.2 ± 0.62^{a}	8.7 ± 0.60^{a}	41.9 ± 0.55	4.6 ± 0.31^{a}	3.6 ± 0.24^{a}	297 ± 53^{a}	6.9 ± 0.49^{a}
Corrie. x M	29.1 ± 2.13^{b}	12.5 ± 1.08^{b}	12.1 ± 1.03^{b}	42.4 ± 1.16	6.3 ± 1.16^{b}	5.2 ± 0.44^{b}	185 ± 25^{a}	8.5 ± 0.61^{b}
Awassi x M	28.8 ± 2.01^{b}	12.1 ± 1.06^{b}	11.6 ± 1.02^{b}	41.6 ± 0.75	41.6 ± 0.75^{b}	4.8 ± 0.44^{b}	534 ± 10^{b}	9.2 ± 0.56^{b}
Signifi.	$p < 0.001$	$p < 0.01$	$p < 0.001$	NS	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p< 0.05$
Feeding								
NSP	21.7 ± 1.05^{a}	8.8 ± 0.51^{a}	8.4 ± 0.46^{a}	40.5 ± 0.69^{a}	4.4 ± 0.25^{a}	3.6 ± 0.22^{a}	226 ± 28^{a}	8.2 ± 0.55
SP	31.3 ± 1.42^{b}	13.7 ± 0.06^{b}	13.2 ± 0.66^{b}	43.3 ± 0.51^{b}	7.0 ± 0.35^{b}	5.5 ± 0.27^{b}	451 ± 78^{b}	8.2 ± 0.45
Signifi.	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.01$	$p < 0.001$	$p < 0.001$	$p < 0.001$	NS

Within factors, column means followed by different Within factors, column followed by different letter differ significantly ($p < .05$, $p < .01$ or $p < .001$),
NS = Non-sginificant; NSP = non-supplemented; SP = supplemented

Table 2. Mean and standard errors for double chuck weight (DCWt), bracelet weight (BRW), loin weight (LOWt), leg weight (LEWt), Abdominal fat weight (AFWt), fat thickness over rib-eye muscle (FTRM) and kidney fat weight (KFWt) in ram lambs

	DCWt (kg ± SE)	BRWt (kg ± SE)	LOWt (kg ± SE)	LEWt (kg ± SE)	AFWt (g ± SE)	FTRM (mm ± SE)	KFW (g ± SE)
Genotype							
Menz (M)	3.1 ± 0.23^{a}	1.4 ± 0.09^{a}	0.8 ± 0.06^{a}	2.8 ± 0.17^{a}	125.0 ± 35.2	1.7 ± 0.37	39.3 ± 6.52^{a}
Corriedale x M	4.1 ± 0.36^{b}	1.9 ± 0.19^{b}	1.2 ± 0.12^{b}	3.8 ± 0.31^{b}	176.6 ± 41.9	2.3 ± 0.42	122.7 ± 15.00^{b}
Awassi x M	4.1 ± 0.35^{b}	1.9 ± 0.16^{b}	1.0 ± 0.09^{b}	3.5 ± 0.28^{b}	166.2 ± 31.5	2.3 ± 0.37	97.6 ± 16.67^{b}
Significance	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	NS	NS	$p < 0.001$
Feeding							
NSP	3.0 ± 0.17^{a}	1.3 ± 0.09^{a}	0.8 ± 0.69^{a}	2.8 ± 0.16^{a}	153.9 ± 34.5	3.0 ± 0.17	65.4 ± 7.61^{a}
SP	4.7 ± 0.23^{b}	2.1 ± 0.11^{b}	1.2 ± 0.09^{b}	4.1 ± 0.20^{b}	158.0 ± 24.3	4.7 ± 0.23	107.6 ± 16.39^{b}
Significance	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.01$	NS	NS	$p < 0.001$

Within factors, column means followed by different letter differ significantly ($p < .05$, $p < .01$ or $p < .001$)
NS = non-significant; NSP = non-supplemented; SP = supplemented

Differences in dressing percentages of the different genotypes were not significant ($p > .05$ (Table1). Contrasting reports were available from studies involving tropical and temperate breeds or breed-cross comparisons in dressing percentage (Gilmp 1971, Hohenboken, 1977, Thomas et al. 1976, Dickerson et al. 1972). In back fat thickness, differences among genotypes were not significant, but there was a tendency for Corriedale x Menz and Awassi x Menz lambs to have larger amounts of external fat cover (Table 2). The average back-fat thickness of 1.7 to 2.3 mm observed in the study were lower than that reported by Dickerson et al. (1972) for temperate breeds (2.4 to 4.2 mm).

Lambs produced by straightbred Menz sheep had significantly ($p < .01$) smaller loin eye areas than lambs from either Corriedale x Menz or Awassi x Menz breeding. Even though the differences between Awassi x Menz and Corriedale x Menz lambs were not significant, the former were superior by 8%. Wholesale cuts expressed as percentage of carcass weight are shown in Table 3. Corriedale x Menz lambs had a significantly higher percentage of hind saddle and loin than Awassi x Menz and straightbred Menz lambs. This indicated good hind muscle development in Corriedale crosses, which also had the heaviest weight of leg (Table 2).

Table 3. Mean kidney fat (KF), kidney and abdominal fat (KAF), tail fat (TF), front-saddle (FS), hind-saddle (HS), double chuck (DC), bracelet (BR), loin (LO) and leg (LE) weights as a percentage of carcass weight in ram lambs

	Mean (%) Standard Error								
Factors	KF	KAF	TF	FS	HS	DC	BR	LO	LE
Genotype									
Menz (M)	0.46 ± 0.06^{a}	1.74 ± 0.31	3.23 ± 0.41^{b}	53.0 ± 0.83	42.0 ± 0.21^{ab}	36.1 ± 0.65	16.0 ± 0.48	9.4 ± 0.23^{ab}	33.1 ± 0.39
Corried. x M	0.98 ± 0.12^{c}	2.78 ± 0.56	1.49 ± 0.14^{a}	52.3 ± 0.87	43.1 ± 0.42^{b}	36.0 ± 0.58	16.9 ± 0.37	10.4 ± 0.35^{b}	33.1 ± 0.45
Awassi x M	0.79 ± 0.09^{b}	2.29 ± 0.36	4.32 ± 0.48^{c}	53.1 ± 0.59	41.8 ± 0.29^{a}	37.0 ± 0.28	16.0 ± 0.33	9.0 ± 0.59^{a}	33.1 ± 0.37
Signific.	$p < 0.01$	NS	$p < 0.001$	NS	$p < 0.05$	NS	NS	$p < 0.05$	NS
Feeding									
NSP	0.76 ± 0.09	2.51 ± 0.44	2.70 ± 0.33	52.6 ± 0.73	42.7 ± 0.40	35.7 ± 0.49	15.8 ± 0.33	9.5 ± 0.22	32.2 ± 0.28
SP	0.73 ± 0.10	2.03 ± 0.23	3.33 ± 0.47	53.0 ± 0.57	42.0 ± 0.35	37.1 ± 0.30	16.9 ± 0.28	9.7 ± 0.51	33.2 ± 0.26
Signific.	NS	NS	NS	NS	NS	$p < 0.01$	$p < 0.01$	NS	NS

Within factors, column means followed by different letters differ significantly ($p < .05$, $p < .01$ or $p < 0.001$)
NS = non-significant; NSP = non-supplemented; SP = supplemented

Table 4. Viscera full (VF), viscera empty (VE) and gut-fill (GF) weights as a percentage of empty liveweight in ram lambs

	Mean (%) standard error		
Factors	VF	VE	GF
Genotype			
Menz (M)	25.5 ± 0.92	6.1 ± 0.35	19.4 ± 0.98
Corriedale x M	27.5 ± 1.10	6.1 ± 0.12	21.3 ± 1.10
Awassi x M	26.0 ± 1.10	5.8 ± 0.16	20.4 ± 1.04
Significance	NS	NS	NS
Feeding			
NSP	27.7 ± 0.61	6.4 ± 0.22	21.7 ± 0.69
SP	24.3 ± 0.79	5.8 ± 0.10	19.1 ± 0.78
Significance	$p < 0.01$	$p < 0.05$	$p < 0.05$

Within factors, column means followed by different letters differ significantly ($p < .05$, $p < .01$ or $p < .001$)
NS = non-significant; NSP = non-supplemented; SP = supplemented

Table 5. Phenotypic correlations between and among slaughter weight and carcass traits in Menz, Corriedale x Menz and Awassi x Menz lambs combined[1]

	1[a]	2	3	4	5	6	7	8	9	10	11
1	-	.6739**	.9386**	.9839**	.0310	-.0887	.4991**	.5441**	-.0552	-.1062	-.0176
		–	.6401**	.6813**	-.1051	-.0964	.2655	.3357*	-.0077	.0737	.0656
			–	.9957**	.0477	-.1031	.6297**	.5602**	-.1165	-.1616	-.0667
				–	-.0034	-.1299	.6043**	.5664**	-.1170	-.1424	-.0497
					–	.0465	.1268	-.1006	.1418	.0964	.0135
						–	-.0220	-.4198*	.1789	.1693	.0868
							–	.2811	-.2273	-.3056	-.2203
								–	-.1430	-.0303	.0076
									–	.8845**	.7405**
										–	.8028**
											–

*p < 0.05, **p < .01

[1] Estimates were made from 36 lambs (six from each genotype x treatment group)

[a] 1 = slaughter weight, 2 = kidney fat, 3 = hot-carcass weight, 4 = coldcarcass weight, 5 = front-saddle %, 6 = hind-saddle %, 7 = dressing %, 8 = tail weight, 9 = abdominal fat weight, 10 = fat thickness and 11 = eye muscle area

Supplement Effects

A summary of mean carcass traits for sheep grazing natural pasture with or without concentrate supplement are shown in tables 1, 2 and 3. Grazing lambs supplemented with concentrate had significantly higher slaughter weight, hot carcass weight, cold carcass weight, front and hind saddle weight and dressing percentage, than non-supplemented lambs. However, the differences in fat thickness over the longissimus muscle, loin eye muscle area and percentage abdominal fat were not significantly different.

Galal et al. (1979a) reported significantly heavier carcasses and more fat as indicated by kidney fat, omental fat, and tail weight for Adal lambs grazing established grass supplemented with concentrate. Similarly, Galal et al. (1981), in studies of the performance of Horro sheep grazing cultivated pasture with concentrate supplement during the dry season, observed significantly heavier carcasses, higher dressing percentages, larger longissimus muscle areas, thicker backfat, heavier tail and more kidney and omental fat for the supplemented lambs. These two reports are thus in general agreement with the present finding on the Menz and its crosses. The sub-cutaneous fat cover observed in the current experiment (2.5 mm) was lower than the 3–5 mm recommended by Rattray et al. (1976) to prevent moisture loss from the carcass during storage.

The rib-eye area, which is the overall index of muscling used in this study, was 6.9, 8.5 and 9.2 cm^2 in Menz, Corriedale x Menz and Awassi x Menz lambs, respectively. These values are small, even when compared with other reports for indigenous breeds (Galal et al. 1979a, 1979b, and 1981), and sub-tropical desert sheep (Galal et al. 1971). Comparisons with specialised temperate breeds, in which rib-eye area is commonly 11 cm^2 or more (Kemp et al. 1976,) highlights the level of muscle development in the current lambs. This could be attributed to the dual-purpose nature of the current breeds, the level of supplementation used, or the slaughter weights achieved.

The differences in wholesale cut weights between supplemented and non-supplemented lambs were significant (Table 2), but these differences were eliminated when the parts were expressed as a percentage of carcass weight, except for double chuck and bracelet (Table 3). In agreement to this study, Summer et al. (1978) reported a significant effect of supplementation on dressing percentage of grazing lambs. Similarly, Jacobs et al. (1973) observed that lambs subjected to nutritional stress prior to slaughter produced carcasses with significantly less kidney fat and smaller longissimus muscle areas than controls. Jacobs et al. (1973) further noted that the major wholesale cuts were reduced both in weight and as a percentage of carcass when feed intake was reduced.

The non-supplemented lambs had a significantly higher percentage of viscera full, viscera empty and gut content than the supplemented lambs (Table 4). This presumably indicates that animals on poor feed were forced to fill their gut with less digestible roughage, and had a proportionally bigger gut as a consequence.

In general, the differences observed in the carcass traits due to genotype and supplementation effects in the current work followed the trend observed in liveweight. For this reason, simple correlations between and among slaughter weight and carcass traits for combined Menz, Corriedale x Menz and Awassi x Menz lambs were calculated (Table 5). Kidney fat weight, hot carcass weight, cold carcass weight, dressing percentage and tail weight had each highly significant, positive association with slaughter weight. The associations between slaughter weight and percentage hind saddle, abdominal fat weight, fat thickness over longissimus muscle, and loin-eye muscle area were negative but not significant. Since most of the variation in cold carcass weight was explained by slaughter weight, the possibility of developing a prediction equation for carcass weight from slaughter weight for these types of lamb was considered. The significant linear model $Y = 0.468x - 1.615$ was estimated (or relationship found), where, Y is carcass weight and x is slaughter weight.

The association of hot carcass and cold carcass weights with other carcass traits followed similar patterns as those observed with slaughter weight. The correlation coefficient between hind saddle and tail weight was estimated as -.42 ($p < .01$). This could be attributed to the presence of Corriedale x Menz crosses that have higher percentage hind saddle and lower tail weight in the estimation of the coefficient. Galal et al. (1979a) reported estimates of the correlation coefficients among slaughter weight, carcass weight and dressing percent for Ethiopian highland sheep similar to those obtained in the current study. Botkin et al. (1971) observed positive association between fat depth, fat weight and carcass grade, and also noted positive correlation among lean traits and negative relation of these characteristics with traits indicating the amount of fat. Contrary to this, the lean muscle indicator (loin eye area) and fat thickness over longissimus muscle were highly associated with each other ($r = 0.80$; $p < .01$).

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CARCASS AND EDIBLE NON-CARCASS COMPONENT YIELDS IN MENZ AND HORRO RAM LAMBS

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ABSTRACT

Slaughter data from 304 Menz and 153 Horro ram lambs were analyzed to determine between-breed differences in yields of carcass and edible non-carcass components. Average age at slaughter was 515 days. Total edible non-carcass component yield (ENCC) was obtained as the sum of weights of blood, lungs (with trachea), liver (with gall bladder), heart, kidneys, reticulo-rumen, omaso-abomasum, hind gut and abdominal and kidney fats. Total yield of usable products (TUP) was calculated as the sum of hot carcass weight (HCW) and ENCC. Slaughter weight (SW), HCW, ENCC and TUP were 24.7, 10.5, 4.3 and 14.8 kg, respectively, in Menz and 24.9, 10.4, 4.6 and 14.9 kg, respectively, in Horro. The difference between breeds in ENCC was statistically significant ($p < 0.01$). Additionally, the Menz dressed higher ($p < 0.01$) than the Horro (42 vs. 41%). This study emphasizes the need to pay attention to the total yield of usable products, rather than only to carcass weight and dressing percentages, in evaluating the suitability of various genotypes for meat production in cultures in which ENCC is traditionally consumed. Inclusion of this component in breed comparison may help understand farmer and consumer preferences for certain breeds.

Keywords: Carcass, edible non-carcass, Menz, Horro.

INTRODUCTION

Sheep production in Ethiopia is primarily for meat. Fiber (coarse wool) is also an important product from some breeds, while some communities also milk their sheep (Galal 1983). Much of the sheep research for meat production is largely focused on carcass yield and quality as defined in developed countries, and tends not to be concerned with the non-carcass components. However, in many African countries, including Ethiopia, many of the non-carcass components are also important. In Ethiopia, it is common to find dishes exclusively made from these items (*dulet, milasina senber, tripa*, etc.) in the majority of the restaurants in Addis Abeba and other big towns of the country. With regard to nutritive value, research has shown that the non-carcass items are comparable or even superior to carcass components (Lawrie 1981). Thus, it can be said that much of the research on meat or meat production has ignored an important component of traditional meat consumption.

Riley et al. (1989), Zygyiannis et al. (1990) and Hadjipanayioutou and Koumas (1994) reported that the yields of carcass and non-carcass components were affected by breed. In this study, an attempt was made to compare the yields of carcass and edible non-carcass component items of Horro and Menz sheep, which are widely distributed in the highlands of Ethiopia and are primarily kept for meat production.

Materials and Methods

Study Area

The study was conducted at the Debre Berhan Research Station of the International Livestock Research Institute (ILRI). The Station is located at about 120 km NE of Addis Ababa at an altitude of 2780 above sea level, in the central highlands of Ethiopia. The climate is characterized by a long rainy season (July–September), a short rainy season (February–March) and an extended dry season (October–February). Annual rainfall averages 920 mm while air temperature ranges from 2.4 in November to 23.3 °C in June.

Animals and Management

A total of 457 ram lambs, consisting of 153 Horro and 304 Menz, born as singles or twins from multi-parous (parity ranging 1–4) ewes were slaughtered for a study designed to determine genetic variation in fat deposition. These lambs were obtained from a flock of on-station reared sheep, produced in eight lamb crops (birth group) over four years from October 1992 to July 1996, at the station. The lambs entered the experiment at average age of 12 months. From this age to slaughter at the age of 515(±22) days, lambs were stall-fed: they were offered ad libitum hay consisting of *Andropogon, Festuca and Pennisetum* species (5.12% CP). In addition, each lamb received 300 g day-1 of a supplement, consisting of 50% wheat bran, 30% maize and 20% cotton seed cake (18.01% CP). Water and salt lick were always available.

Slaughter Data

Feed and water were withheld 12 hr prior to slaughter. Slaughter weight (SW) was taken about half- hour before slaughter. The weights of blood, skin, head, hot carcass, abdominal fat, gastro-intestinal tract content (digesta), empty reticulo-rumen, omaso-abomasum, hind gut, lungs (and trachea), heart, liver (and gall bladder), kidneys, kidney fat, testicles (and penis), genital fat and legs were recorded during the slaughter process. Each lamb record comprised lamb breed, birth group (1–8), type of birth (single or multiple), date of birth, and parity of dam (1–4: 1) = first parity to 4 = fourth or greater parity). Slaughter age, in days, was available for each animal. Dressing percentage was based on hot carcass weight

(HCW). Total edible non-carcass component yield (ENCC) was obtained as the sum of weights of blood, lungs (and trachea), liver (and gall bladder), heart, kidneys, reticulo-rumen, omaso-abomasum, hind gut, the spleen, abdominal and kidney fats. Total yield of usable products (TUP) was calculated as the sum of HCW and ENCC.

Data Analyses

Data were analyzed by General Linear Models (GLM) procedure of the SAS (SAS, 1994). The statistical model used for analyses included breed, birth group, type of birth and parity of the dam as classification variables. Two-way interactions were included when found significant ($p < 0.05$) in preliminary analyses. Slaughter age was included in the model as covariate.

Results and Discussion

Overall and sub-class least squares means (and standard errors) for breed, coefficients of variation and regression coefficients for age for the variables studied are presented in Table 1. The Horro weighed 0.2 kg more at slaughter than the Menz. However, HCW of the Menz was 0.1 kg heavier than that of the Horro. These breed differences were not significant ($p > 0.05$). The carcass weight was within the range of those previously reported by Beniam et al. (1983), who obtained 12.7 ± 2.98 kg in yearling Horro lambs, and Sendros (1993), who reported 9.2 ± 0.6 kg in Menz sheep slaughtered at 410 days of age.

These results showed that most of the tissues and organs considered as ENCC such as viscera (reticulo-rumen, omaso-abomasum and hindgut), internal organs like liver (with gall bladder), kidneys and spleen were heavier in Horro. The weight of blood was also higher in Horro. Only fat tissues considered as ENCC (abdominal and kidney fats) were heavier in the Menz. Breed differences in all of these components were all significant (at least $p < 0.05$). Consequently, ENCC was significantly ($p < 0.01$) heavier (+0.3 kg) in Horro lambs. Lung (with trachea) and kidney weights were not different ($p > 0.05$) in the two breeds.

TUP, the sum of HCW and ENCC, was slightly higher in Horro. However, breed difference in TUP was not significant ($p > 0.05$). The weights of the individual non-carcass components of the Horro lambs in the current study are in agreement with those previously reported for yearling Horro lambs (Beniam et al. 1983).

A one-day increase in slaughter age (data for the two breeds) resulted in 0.01and 0.02 kg increase in HCW and TUP, respectively, in the present study. Both regression coefficients were significant ($p < 0.05$).

Table 1. Overall and sub-class least squares means (and standard errors) for breed, coefficients of variation, F-statistics, and partial regression coefficients for age

Variables	*Overall*	*CV (%)*	*Least squares mean (± SE)*			*Age, days (covariate)*
			Menz	*Horro*	*F-test*	
Slaughter weight (SW)	24.8 ± 0.2	9.9	24.7 ± 0.2	24.9 ± 0.3	NS	0.02
Carcass weight (kg)	10.4 ± 0.1	11.2	10.5 ± 0.1	10.4 ± 0.1	NS	0.1*
Dressing percentage	41.7 ± 0.1	4.8	42.3 ± 0.2	41.2 ± 0.2	**	0.03**
ENCC (total)	4.4 ± 0.0	9.1	4.3 ± 0.0	4.6 ± 0.0	**	0.00
Blood (g)	862.7 ± 8.8	14.7	844.3 ± 9.4	881.3 ± 12.5	**	0.18
Lung + trachea (g)	479.3 ± 8.1	24.0	476.6 ± 8.6	481.8 ± 11.5	NS	-0.21
Hear (g)	106.0 ± 4.4	60.4	99.4 ± 4.7	112.4 ± 6.2	*	-0.12
Liver + gall bladder(g)	351.2 ± 3.0	12.0	324.5 ± 3.1	3768.2 ± 4.3	**	0.33
Kidneys (g)	66.4 ± 1.4	28.7	64.3 ± 1.6	68.6 ± 2.5	NS	0.12
Kidney fat (g)	57.0 ± 2.0	44.0	68.5 ± 2.0	45.4 ± 2.8	**	-0.05
Reticulo-rumen (g)	622.5 ± 5.2	11.6	596.3 ± 5.4	648.8 ± 7.4	**	0.10
Omaso-abomasum (g)	197.6 ± 7.3	53.3	182.0 ± 7.9	213.1 ± 10.4	**	0.33
Hind gut[a] (kg)	1.2 ± 0.0	13.4	1.1 ± 0.0	1.2 ± 0.0	**	0.00
Abdominal fat (g)	98.0 ± 4.2	53.7	123.5 ± 4.4	72.6 ± 6.0	**	0.27
Spleen (g)	71.7 ± 1.1	20.3	69.7 ± 1.1	73.7 ± 1.4	**	0.02
ENCC as % of SW	18.0 ± 0.1	7.9	17.5 ± 0.1	18.5 ± 0.2	**	-0.01
TUP (kg)	14.9 ± 0.1	9.8	14.8 ± 0.1	14.9 ± 0.2	NS	0.02*
TUP as % SW	59.8 ± 0.2	4.8	59.7 ± 0.2	59.8 ± 0.3	NS	0.02
Non-edible components						
Head (kg)	1.7 ± 0.0	11.5	1.8 ± 0.0	1.6 ± 0.0	**	0.00
Skin (kg)	2.5 ± 0.0	15.2	2.7 ± 0.0	2.2 ± 0.0	**	0.00
Testicles + penis (g)	367.2 ± 4.0	14.8	352.8 ± 0.0	381.7 ± 0.0	**	0.91**
Genital fat (g)	59.9 ± 1.9	44.2	64.3 ± 2.0	55.6 ± 2.7	**	0.14
Legs[b] (g)	560.5 ± 5.3	13.4	535.1 ± 5.6	585.4 ± 7.5	**	-0.47
Gut contents (kg)	4.7 ± 0.1	16.6	4.3 ± 0.1	5.0 ± 0.1	**	0.00

[a] Hind gut includes and small intestine and large intestine; [b] Legs includes weights of limbs below the carpo-metacarpal and tarso-metatarsal joints of the fore- and hind limbs, respectively.

** $P < 0.01$, * $P < 0.05$, NS = $P > 0.05$.

Although breed differences in SW and HCW were not significant, the Menz dressed significantly ($p < 0.01$) heavier than the Horro. This was, partly, due to the fact that the Menz had a slightly lower slaughter weight and slightly heavier carcass weight. Also, the differences in ENCC (favoring the Horro) and the total weight of the non-edible components (9.8 vs. 9.7 kg in Horro and Menz) indicate that a larger proportion of slaughter weight in the Horro was in the non-carcass component, thereby decreasing the dressing percentage. Digesta in the gut alone weighed 0.7 kg more in the Horro ($p < 0.01$).

In general, the slightly lower carcass weight of the Horro was compensated by the higher ENCC weight, and TUP was about the same in the two breeds. Also, TUP, when expressed as percentage of slaughter weight, was not different ($p < 0.05$) in the two breeds. If the ranking for meat production potential were only in dressing percentage, the Menz would be considered superior to the Horro. However, if edible non-carcass components are also considered with the carcass component, then there was no breed difference.

Because the consumption of the non-carcass components widely differs from place to place, the figures reported here should be interpreted accordingly. The items included in this paper as edible may not be consumed in some parts of the country; and some of them which were considered non-edible (e.g., testicles and the skin), may be consumed in other parts. Furthermore, since this study was not specifically designed for this purpose, items like tongue and esophagus were not weighed individually and, thus, were not included in the analyses of edible totals.

On the other hand, because gall bladder and liver were weighed together, gall bladder was considered as edible product. Additionally, the flesh on the head was not dissected and, thus, not included in the edible totals. Admittedly, mainly because of the above reasons, this study by itself is by no means a complete one. However, it can help in creating awareness in the way animal evaluation for meat may be modified to incorporate local cultures.

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EFFECT OF DIETARY PROTEIN SUPPLEMENTATION ON THE RESISTANCE OF LAMBS TO ARTIFICIAL INFECTION WITH HAEMONCHUS CONTORTUS—PRELIMINARY RESULTS

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ABSTRACT

The effect of dietary protein supplementation on the resistance of lambs to endoparasites was examined in Horro and Menz lambs artificially infected with Haemonchus contortus. The experimental design involved 2 breeds, 2 infection treatments (infected Vs non-infected) and 3 nutrition treatments. A total of 152 lambs were assigned to 12 treatment combinations, with an average of about 13 animals per cell. Diets were formulated to be isocaloric, but with varying protein and/or nitrogen sources. The nutritional control group of lambs were maintained on a basal diet of hay offered ad libitum, while the second and third nutrition treatments consisted, in addition to the basal diet, of supplements of cotton seed cake (165 g head-1 day-1) and urea molasses blocks (150 g head-1 day-1), respectively. At four months of age, the 'infected' group of lambs were exposed to an experimental infection of 1000 L3 (third stage larvae) given orally 3 times a week for 3 weeks. Faecal egg output was monitored 3 times a week starting 3 weeks after the first dose. Packed cell volume and body weight changes were recorded weekly. During the course of the study, infected lambs gained less weight and had lower packed red cell volumes (higher levels of anaemia) ($p < 0.01$) than those non-infected counterparts. Control lambs (infected but kept on the basal diet) gained less weight and had lower packed red cell volumes than supplemented (infected) lambs ($p < 0.01$). The mean faecal egg counts, at the end of the experiment, of lambs on supplemented diet were lower (though not statistically significant, $p > 0.05$) than that of lambs on the basal diet. It was concluded that improved dietary protein supplementation either from CSC or UMB would substantially reduce production losses attributable to infection with contortus.

Key words: Haemonchosis, Horro sheep, Menz sheep, resistance, protein supplementation.

Introduction

Helminthosis is of considerable significance in a wide range of agro-climatic zones in Sub-Saharan Africa and constitutes one of the most important constraints to small ruminant production (ILCA 1991, Over et al. 1992). Losses due to infection by nematode parasites occur through mortalities, reduced production due to sub-clinical parasitism and direct cost associated with control measures (Holmes 1985). Effects on productivity are through reduction in feed intake and efficiency of feed utilization, the severity being influenced by rate of larval intake, species of parasite and site of infection (Coop and Holmes 1996). The wide-spread occurrence of infections with internal parasites in grazing animals, the associated loss of production, the cost of anthelmintics and death of infected animals are all major concerns. There are also increasing environmental concerns, which may influence anthelmintic use through consumer demand for animal products and pastures free of chemical residues.

Current measures for control of internal parasites outside Africa focus on reducing contamination of pastures through anthelmintic treatment and/or controlled grazing. In Africa, however, these control methods are limited by the high cost of anthelmintics, their uncertain availability, increasing frequency of drug resistance and limited scope, in many communal pastoral systems, for controlled grazing (Waller 1991 and Mwamachi et al. 1995). Few alternative strategies that are now being considered include exploiting genetic variation in host resistance to endoparasites, improved nutrition to aid the development of immunity and development of vaccines. These three approaches may all interact with each other: supplementary nutrition may improve the response to prophylactic or therapeutic intervention, or the effect of improved nutrition may vary between resistant and susceptible hosts.

The interaction between the level of nutrition and the ability of animals to cope with internal parasites has long been recognized (Dobson and Bawden 1974 and Mukasa-Mugerwa et al. 1991). Protein supplementation has been shown to improve the resistance of lambs to Oesophagostomum columbianum (Dobson and Bawden 1974) and Trichostrongylus colubriformis (Kambara et al. 1993) and also to ameliorate the pathogenic effects of haemonchosis in lambs (Abbott et al. 1985). The objective of this study was to investigate the effects of different nutrition treatments on the resistance of lambs to artificial infection with Haemonchus contortus.

Materials and Method

Study Site

The experiment was conducted at the International Livestock Research Institute (ILRI), Debre Berhan Research Station. The station is located in the central Ethiopian highlands, about 120 km NE of Addis Abeba at an altitude of 2780 m. The climate is characterized by a long rainy season (July–September), a short rainy season (February–March) and an extended dry season (October–February). Annual rainfall averages 920 mm. Air temperatures range from 2.4 °C in November to 23.3 °C in June. The pasture at the station is dominated by Andropogon grass (*Andropogon longipes*) with variable proportions of Trifolium legume species.

Animals and management. Lambs of both sexes (n = 152) from two breeds—Menz (indigenous to the study area) and Horro (introduced from mid-altitude area in western part of Ethiopia) with 3–5 months of age and average 9.3 kg body—weight with a mean body condition score (CS) of 1.68 (0 = extremely emaciated and 5 = extremely fat) (Hossamo et al. 1986) were used. Animals were housed indoors on concrete floor. All animals were dosed with fenbendazole (Panacur®, Hoechst, UK, Ltd, England) at a dose rate of 7.5 mg kg-1 body weight against nematodes and with Niclosamide for tape worms at the beginning of the experiment. Ram lambs were castrated before the study began at weaning. In the course of the study, lambs were closely monitored and promptly treated accordingly for any illness other than the effects of the parasites. Mortalities were recorded as they occurred and post-mortem examinations were performed to ascertain cause of death. Animals were weighed weekly to monitor body weight changes.

Experimental Design

The experiment was a 2 x 2 x 3 factorial design involving: 2 breeds (Menz and Horro), 2 levels of infection (infected vs non-infected) and 3 levels of nutrition (Group 1, 2 and 3) as described below. The randomization of lambs to the 12 treatment combinations followed initial blocking by weight within breed.

Animal Feeding

The three levels of nutrition were formulated to be isocaloric, but with varying protein and/or nitrogen sources. The two high protein groups had similar levels of 'protein', which was about twice that of Group 1, but the N was from divergent sources and of different degradability values.

Group 1 lambs were fed mainly on the basal diet, grass hay (7.0 MJ ME kg-1 DM and 68 g kg-1 DM crude protein) ad libitum. In addition, this group was given about 200 g head-1 day-1 wheat bran, fed in two portions (morning and afternoon) to supply an additional 2.0 MJ ME to cater for maintenance and limited growth.

Group 2 lambs were fed hay as for Group 1 plus, according to the initial design, 150 g head-1 day-1 urea molasses block (UMB) plus 80 g head-1 day-1 wheat bran. However, after 14 days from the beginning of the study, it was observed that the intake for UMB was low (on average 50 g head-1 day-1). As a result, it was decided to increase the wheat bran to 160 g head-1 day-1 to balance the ration for energy. Supplements, also fed in two portions (morning and afternoon), provided 2.0 MJ ME lamb-1 day-1 over and above the supply from the grass hay. UMBs were made at the station using sugarcane molasses, common salt, fertilizer grade urea, Di-ammonium phosphate fertilizer, cement (mainly to act as a binding material) and wheat bran at proportions of 42, 5, 10, 3, 15 and 25%, respectively.

Group 3 lambs received hay as for Groups 1 and 2, plus 165 g cotton seed cake (CSC) head-1 day-1 to supply about 2.0 MJ ME over and above the amount supplied by the grass hay. CSC was also fed to animals individually in two portions (morning and afternoon).

Water and mineral licks were provided ad libitum. Total hay ration for animals in each pen were provided to the animals as a group in two portions (morning and afternoon). The hay was measured daily and refusals were determined each morning before fresh amounts were added to the feeding troughs. The amounts of hay and concentrates consumed every day were recorded. The bran, UMB and CSC were fed to each animal in individual feed boxes fitted with yokes to harness the lambs in the feed boxes during feeding. Thus, the experimental design allowed for pen total hay intake and individual supplement intake to be measured daily. Standard feed composition determinations such as DM, ash, Kjeldahl N (AOAC 1980), NDF, ADF, ADL (Goering and Van Soest 1970) were carried out. The three diets were quantitatively adjusted weekly based on individual body weight to standardize the energy intake.

Parasitological Techniques

Infective larvae. Faecal samples collected from infected donor lambs were cultured at 27 °C for 5 to 7 days and larvae extracted using the Baermann technique (Hansen and Perry 1994). Larvae were stored at room temperature and used within a week, after which fresh samples were prepared. At four months of age, the 'infected' group of lambs were exposed to an experimental infection of 1000 L3 (third stage larvae) given orally three times a week for 3 weeks to induce a sub-clinical infection based on our pre-experimental trial on the station.

Faecal egg counts (FEC). Faecal samples were taken directly from the rectum three times a week starting 3 weeks after the first dose of infective larvae. Egg counts were done using the modified McMaster method (Whitlock 1948) and expressed as eggs per gram (EPG) of faeces.

Packed cell volume (PCV). Blood samples were collected weekly from all animals by puncturing the ear vein and allowing blood to flow directly into a heparinized capillary tube in which heamatocrit values (PCV) were determined as described by Murray *et al.* (1983).

Statistical Analysis

Data were analysed using the General Linear Model (GLM) procedures of SAS (1994) by fitting a fixed effect model with the effects of nutrition, breed and infection status and their interactions. The effects of factors such as age, sex, type of birth, etc, were included in the final model if they were statistically significant ($p < 0.05$) in preliminary analysis. Faecal egg counts were analysed following a logarithmic transformation, Log10 (egg counts + 25), to account for the skewed distribution. Data were analysed at two points: 26 days after the first dose of infective larvae and at the end of the study (34 days post-infection).

Results and Discussion

There are two principal findings of the present experiment. Firstly, subclinical - haemonchosis, at this level of artificial infection, resulted in significantly reduced body weight gain and lowered PCVs. This result is consistent with previous finding (Kambara et al. 1993). Secondly, lambs kept on low protein diet (basal diet) appeared to suffer more severely the consequences of gastrointestinal parasitism, than lambs on high protein diets (CSC and UMB).

Table 1. Least squares means (and S.E) of body weight changes, packed cell volume (PCV) and anti-logarithm of FEC (AL-FEC) for the experimental lambs

	Weight gain		PCV (%)		AL-FFC (epg)	
	Gain 1 (g)	Gain 2 (g)	Period 1	Period 2	Period 1	Period 2
Overall	1050.8	365.9	26.6	23.9	263	354.8
CV%	51.0	147.4	13.4	15.9	11.0	9.1
Infection	**	**	**	**	**	**
Infected	808.2 ± 70.4	147.1 ± 70.3	23.6 ± 0.5	21.3 ± 0.5	2454.7 ± 1.1	5888.4 ± 1.1
Non-infected	1214.8 ± 71.9	485.0 ±70.2	29.8 ± 0.5	26.9 ± 0.5	29.5 ± 1.1	28.2 ± 1.1
Nutrition	**	**	**	**	*	NS
Control	705.7 ± 79.8	93.9 ± 79.8	25.7 ±0.6	23.1 ± 0.6	316.2 ± 1.1	436.5 ± 1.1
CSC	1537.9 ± 89.6	657.8 ± 87.6	29.3 ± 0.6	26.7 ± 0.7	275.4 ± 1.1	407.4 ± 1.1
UMB	791.0 ± 86.9	196.3 ± 84.9	24.9 ± 0.6	22.4 ± 0.7	218.8 ± 1.1	380.2 ± 1.1
Nutrition x Infection	*	*	*	NS	*	NS
Control x infected	544.6 ± 111.4	-214.6 ± 112.5	21.6 ± 0.8	19.2 ± 0.8	3467.4 ± 1.2	7079.5 ± 1.1
CSC x infected	1463..5 ± 115.9	599.0 ± 113.2	26.6 ± 0.8	24.6 ± 0.9	2238.7 ± 1.2	5623.4 ± 1.1
UMB x infected	416.5 ± 117.6	57.0 ± 14.8	22.6 ± 0.8	20.0 ± 0.9	1862.1 ± 1.2	5248.1 ± 1.1
Control x non-infected	866.8 ± 108.8	402.5 ± 106.1	29.9 ± 0.8	27.0 ± 0.8	28.8 ± 1.2	27.5 ± 1.1
CSC x non-infected	1612.4 ± 118.4	716.7 ± 115.5	32.1 ± 0.8	28.9 ± 0.9	34.7 ± 1.2	28.8 ± 1.1
UMB x non-infected	1165.4 ± 113.9	335.7 ± 11.2	27.3 ± 0.8	24.8 ± 0.8	25.1 ± 1.2	27.5 ± 1.1

Period 1, 26 days after the first infection of larvae.
Period 2, at the end of the study (33 days post-infection).
Gain 1, cumulative liveweight gain from start to 26 days.
Gain 2, cumulative liveweight gain from 27th day to the end of the study
** P < 0.01; 01 P < 0.05; NS - P > 0.05

Liveweight Gain

Results of the least squares analyses of variance are summarised in Table 1. Cumulative liveweight gain at the two periods of measurement were 808.2 g and 147.1 g for infected lambs and 1214.8 g and 485.0 g for non-infected lambs, respectively. These differences in gain were statistically significant (p < 0.01). All lambs among the different nutrition

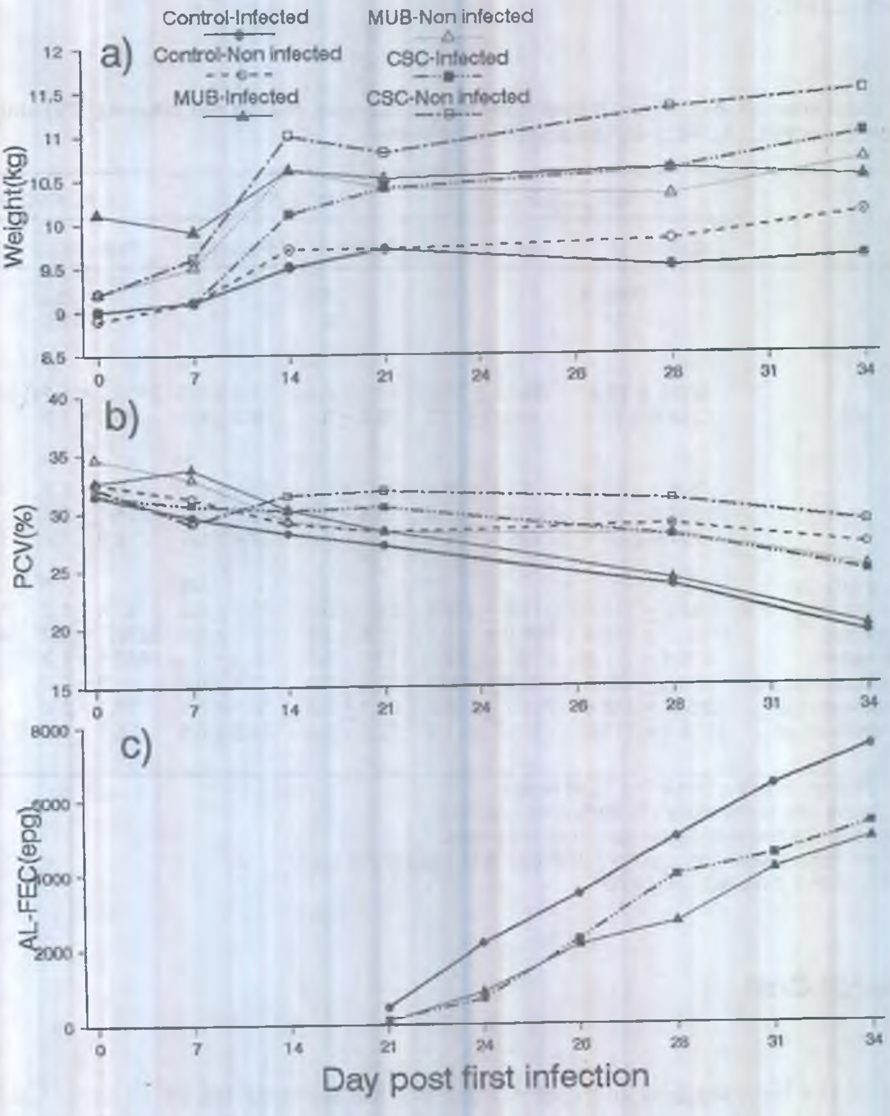

Figure 1. Least squares means for liveweight gain: (a), packed cell volume; (b)faecal egg counts and (c) from infected and non-infected lambs with different nutrition levels

treatments continued to gain weight throughout the experiment (Figure la), a significantly greater ($p < 0.01$) cumulative increase in weight being observed in the high protein groups at both the periods. As shown in Table1, lambs fed with CSC had a higher weight gain than those kept on the basal diet and UMB ($p < 0.01$). However, lambs on the basal diet and UMB did not differ significantly ($p > 0.05$). This finding was consistent with results obtained in a study by Wallace et al. (1995) using Hampshire lambs. Coop et al. (1995), however, did not show increased cumulative weight gain in casein-supplemented lambs compared to an unsupplemented group: this result was associated with an overall reduction in the dry matter intake by animals in the experiment.

Faecal Egg Counts

From patency (21 days after infection) to the end of the experimental period, the mean faecal egg counts (FEC) were lower in the lambs on the supplemented (Groups 2 and 3) diet (Figure 1c), although this was not statistically different ($p > 0.05$) from the FEC of lambs kept on the basal diet at period 2. At period 1, however, lambs on UMB had significantly ($p < 0.05$) lower FEC than lambs on basal diet. Thus, the supplemented lambs were able to control faecal egg output from an earlier age than the lambs on the unsupplemented diet, suggesting development of a better immune response. This finding was in agreement with other studies (Abbott et al. 1985; Wallace et al. 1995) which reported lower mean faecal egg counts in protein supplemented lambs compared to their unsupplemented contemporaries. The FECs of non-infected lambs were almost nil throughout the experiment, except a few lambs which had 50 eggs per gram of faeces (EPG), possibly due to contamination.

Packed Cell Volume

There was a significant decrease in PCV starting two weeks following infection to the end of the experimental period in infected lambs ($p < 0.01$), whereas it remained stable in non-infected groups. The decrease in PCV was most obvious in lambs on basal diet and UMB (Figure 1b), higher rate of decline being observed within the first 26 days. Results of PCV (Table 1) indicated that the effects of nutrition were significant ($p < 0.01$) at the two periods, lambs fed on CSC having significantly higher PCV values than lambs fed on the basal diet and UMB. The of significantly low PCV in lambs on the basal diet and UMB suggested that these lambs were less able to control the anaemia.

The relatively poor performance of lambs on UMB compared to those kept on CSC was probably due to low intake of the UMB since animals were only allowed to feed for a fixed period of time. In this regard, improvement of intake should be considered if the desired benefits of this high non-protein nitrogen source are to be fully exploited. One option may be to offer UMB for a longer period of time.

Mortalities

Only one case of mortality was recorded during the experiment. The primary cause of death of the particular animal was identified as Coenurosis.

Conclusion

In conclusion, these preliminary results, also supported by literature, indicated that supplementing the diet of lambs with a protein source such as CSC can help improve their ability to withstand the pathogenic effects of haemonchosis with minimum use of anthelminthics at infection levels similar to those applied in this study.

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DAIRY–DRAFT ON-FARM PERFORMANCE OF CROSSBRED COWS IN HOLETTA AREA

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ABSTRACT

Based on the promising results obtained from on-station, the cow traction study was further taken to on-farm for verification under the Ethiopian smallholder farmers management conditions. The study was undertaken in Holetta area between 1992 and 1996 by involving 14 farmers. Mean daily milk yield was similar between working (5.08 kg) and non-working (5.58 kg) crossbred cows that were kept under smallholder farm management conditions. Lactation yield of non-working cows was significantly higher (2103.57 versus 1725.17 kg) than that of working cows. This difference emanated from lactation length where non-working cows had exhibited significantly longer lactation length. Mean milk composition of working and non-working cows was similar in fat, protein and total solid contents. Working cows were observed to lose more weight after calving than non-working cows at both onset of first postpartum estrus and conception though not statistically significant. There were no significant differences between working and non-working crossbred cows in mean intervals of calving to first postpartum estrus and calving to conception. The interval from first estrus to conception after second calving was shorter than during first calving where working and non-working cows conceived about 42 and 32 days, respectively, after exhibiting first estrus. This suggests that postpartum anestrus was a more important problem than conception failure during the second than the first calving period. In general, the crossbred cows have been in negative energy balance as this was seen from their body weight loss over the most period of the year (March to end of October). It was concluded that as long as improved feeding management and lower level of work are coupled, it is unlikely for traction to have adverse effect on productive and reproductive performances of crossbred dairy cows.

Introduction

Draft animals support agricultural production in Ethiopia and the level of dependence on animal power source is particularly high in the highland agro-ecological zone. The tradition of using oxen for land cultivation is an ancient age-old practice in the highlands of Ethiopia. Plowing of land at the smallholder level is carried out almost exclusively with the co-evolved traditional ard called *maresha* which is fitted to a pair of Ethiopian small-sized zebu oxen (Goe 1987). Ethiopia's extensive association with animal traction is typical compared other Sub-Saharan African countries where the use of animals for tillage and carting was introduced only during the later part of the 19th and beginning of the 20th centuries (ILCA 1981). It is evident that the crop and livestock subsystems in the highlands of Ethiopia are complementary to each other and thus remain to be highly integrated. Even though well quantified evidences for the role and contribution of livestock in the smallholder farming systems are scanty, the inseparability of the crop and livestock production subsystems is very well recognized. However, with the ever increasing population pressure and the resultant shrinking of land holding, an extensive mode of livestock keeping might no longer be sustainable in the mixed crop–livestock farming systems of the highland regions. It is estimated that herds of 8–16 heads of cattle should be kept by individual farmers in order to ensure a pair of oxen available at the farm at any one time of the year (Agymang et al. 1991). As a result, it is becoming progressively more difficult for the farmers to feed their stock all the year-round with the scarcely available feed resources at the farm. On the other hand, individual farmers could not be in a position to own a pair of oxen which is required to satisfy the minimum farm power requirement for plowing activities provided if the associated stock number gets lower than the one which can supply a pair of oxen. Studies by International Livestock Center Africa have confirmed this phenomenon through identifying the unequal distribution of oxen among smallholder households as a major constraint to crop cultivation (Gryseels et al. 1986, 1987).

The existing constraints of smallholder farming systems is unlikely to permit the traditional way of livestock rearing systems to continue any longer. Hence, it is very important to search for possible alternative options which can pave a way to intensify the farming systems. The use of cows for dual purpose of milk production and traction is one means of reducing the effective number of draft animals needed to support agricultural production in the highlands and it would also allow for better utilization of the scarce feed resources available at smallholder farms. On-station studies on dairy–draft cows were comprehensively undertaken to explicitly elaborate the inter-play of factors affecting work output, milk production, metabolism, physiological responses and reproductive performances. Based on the promising results obtained from on- station, a subsequent on-farm study was conducted to verify the on- station results. Hence, this paper reports the effect of draft work on lactation and reproduction of F1 crossbred dairy cows kept under smallholder farm management conditions in the Holetta area.

Materials and Methods

Location

The study was carried out on-farm in the Holetta area. The farm sites are located within a radius of 15 km from Holetta Research Center which is 50 km west of Addis Abeba. The study area is situated at an altitude of 2400 m and receives an average annual rainfall of 1100 mm. The natural pasture of the trial sites is predominantly composed of *Andropogon*, *Hyperrhenia*, *Trifolium* and some species of the Cyperaceae (Lulseged and Hailu 1985).

Cattle are the dominant livestock holdings of the smallholder farmers in the Holetta area and farmers also keep a limited heads of small ruminants and equines. Animals largely depend on grazing of the natural pasture and are less frequently supplemented with crop residues late in the dry season.

Treatments

A total of 28 F1 (Friessian x Boran) crossbred cows were distributed to 14 selected participating farmers, and each farmer received a pair of the crossbreds. Out of the 14 project farmers, seven of them used these cows for milk production only while the remaining seven farmers kept their crossbred cows for dual purpose of milk production and draft work. Hence, the treatment comprised working (cows used for dual purpose) and non-working (cows used for milk production only) groups.

Management

The animals were kept in an improved barn which was constructed according to the recommendation given by the project. The barn included a feed trough structure so as to feed the cows individually and measure their feed intake. Before distribution of the crossbred cows to the farmers, each farmer was required to develop good quality hay from oats/vetch mixture grown on 0.5 ha of land. They also developed backyard forage for green feeding. The farmers were also advised to buy concentrate feeds from closer market source (Addis Alem) for supplementing their crossbred animals. The working animals had been trained to learn plowing acitivity on farmers field. Onset of oestrus was monitored by farmers and reported to enumerators. Hence, cows were mated mainly with artificial insemination. The men and household wives were given training on how to manage their crossbred animals and handle milk hygienically.

Data Collection

A wide spectrum of animal data were collected from 1993 to 1996. Seven enumerators were trained on how to collect the required data on-farm and the enumerators were permanently stationed at the farm until the project life lasted. Feed intake of concentrate, hay, and crop by-products at the farmwere measured daily for five days per week. The time spent on grazing was also recorded. Milk production was recorded at every milking over five subseqent days in a week. Body weight measurement and condition score determination were undertaken once in a month. Pregnancy diagnosis was performed 45 days after last mating date. The data were analized using General Linear Model (GLM) of SAS program.

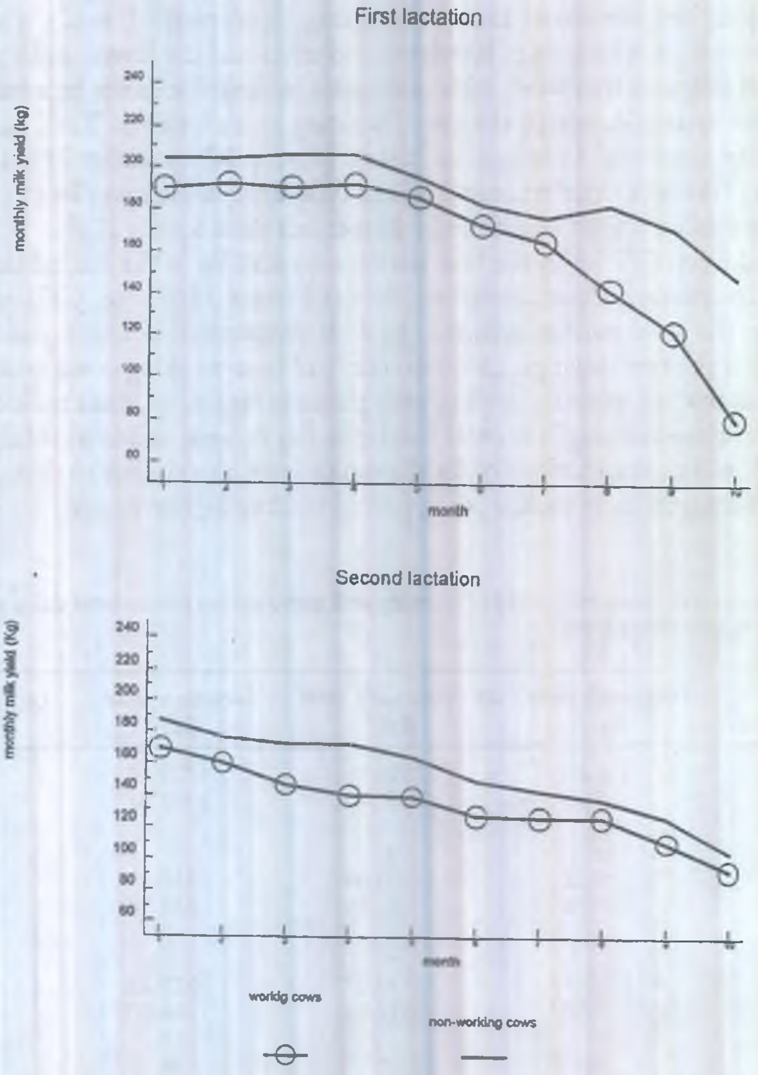
Results and Discussion

Mean daily milk yield was similar between working and non-working crossbred cows that were kept under smallholder farm management conditions (Table 1). The mean 305-daysmilk yield of working and non-working cows did not also differ significantly.These results are in agreement with the report of Zerbini et al. 1996 on-station work which indicated that milk yield of working and non-working cows (1770 versus 1792 for working supplemented and non-working supplemented) was not significantly different. However, working non- supplemented cows had the lowest milk yield among all groups. This indicates that work with inadequate feeding would not be a feasible option for a production system involving the use of lactating cows for draft. Total lactation yield of non-working cows was found to be higher ($p < 0.04$) by about 22% than that of working cows. This difference emanated from a difference in lactation length where non-working cows had exhibited significantly longer lactation length (Table 1). Mean milk yield decreased from 5.77 kg in the first lactation to 4.90 kg in the second lactation. But statistically significant difference was not detected in total lactation yield and lactation length between the two parities even though wide variation of lactation yield occured ($p < 0.07$) between the two calvings. Lactation curve of non-working cows exhibited better persistency than that of working cows in both parities (Figure. 1). Mean milk composition of working and non-working cows was similar in fat, protein and total solid contents of milk (Table 2). Milk compositions of local animals were also similar to that of crossbred cows although magnitudally local cows appeared to have higher values.

Table 1. Least squares mean milk yield of working and non-working F crossbred dairy cows at samllholder farms level

Works status	*Daily milk yield (kg)*	*305-days milk yield (kg)*	*Lactation yield (kg)*	*Lacation length (days)*
Working	5.08	1501.16	1725.17	381.36
Non-working	5.58	1681.76	2103.57	426.32
F-test	ns	ns	*	*
SE ±	0.22	70.84	119.91	20.74
CV%	21.56	23.58	33.14	27.17
LACTATION				
First	5.77	1739.97	2070.73	409.89
Second	4.90	1442.94	1758.00	397.79
F-test	*	*	ns	ns
SE ±	0.22	70.84	119.91	20.74
CV (%)	21.56	23.55	33.14	27.17

* = significant a + $p < 0.05$; ns = not significant



First lactation

Second lactation

Figure 1.Lacation curve of working and non-working crossbred cows kept at smallholder farms in Holetta area

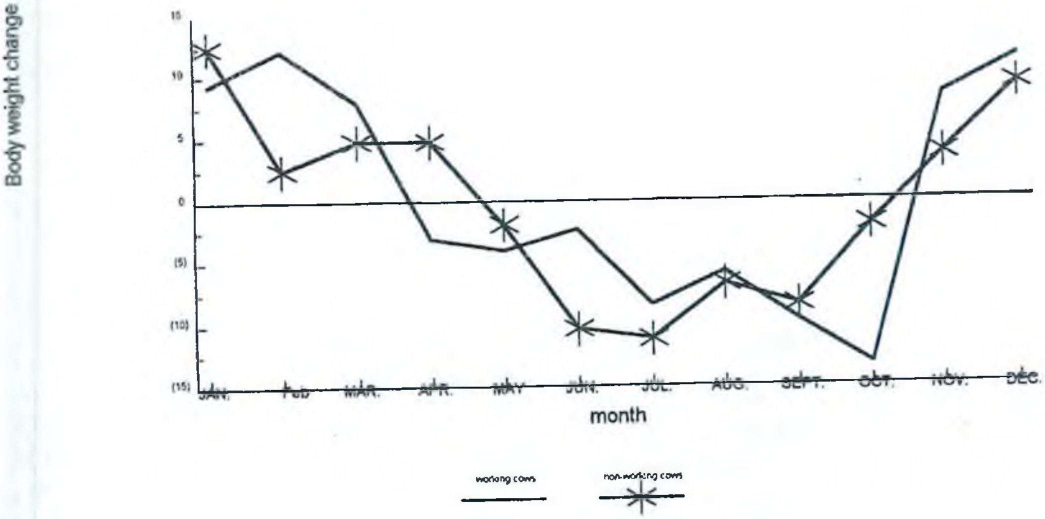


Figure 2. Body weight changes (kg) of working and non-working crossbred cows kept at smallholder farms

Table 2. Least squares mean milk composition of working and non-working F_1 crossbred cows and local cows kept at smallholder farms

Works status	*Fat (%)*	*Proteing (%)*	*Total solid (%)*
Working	4.15	3.77	12.19
Non-working	4.16	3.81	12.36
F-test	ns*	ns	ns
SE ±	0.15	0.09	0.25
CV (%)	12.82	9.20	7.36
Breed type			
Crossbred	4.31 ± 0.21	3.79 ± 0.13	12.28 ± 0.24
Local	4.74 ± 0.29	4.10 ± 0.20	12.55 ± 0.62
F-test	ns	ns	ns
CV (%)	224.75	17.38	9.73

* ns = not significant

Table 3. **Body weight losses of working and non-working F1 crossbred cows at first postpartum estrous and at conception from calving under smallholder farm management conditions**

Work status	*Weight at calving*	*Weight loss at 1st estrous*	*Weight loss at conception*
Working	409.68 ± 5.49	18.30	17.71 ± 5.24
Non-working	381.62 ± 5.82	13.92 ± 4.64	14.33 ± 5.55
F-test	**	ns	ns
CALVING			
First	397.83 ± 5.60	12.82 ± 4.47	11.79 ± 5.34
Second	393.46 ± 5.72	19.50 ± 4.56	20.26 ± 5.46
F-test	ns	ns	ns

**, significant at $p < 0.01$; ns, not significant

Body Weight Change

Working cows showed greater body weight loss after calving than non-working cows at both onset of first postpartum estrous and conception though not statistically sifnificant (Table 3). Hence, both working and non-working cows lost body weight at a rate of 18.3 and 13.92 kg, respectively, between calving and onset of first postpartum estrous. The loss in body weight at onset of first postpartum estrous to progressed towards second calving (12.82 kg after 1st calving against 19.5 kg after 2nd calving). Body weight at calving, onset of first postpartum estrous and conception was not affected by parity. Mean body weight was consistently higher in working than in non-working cows at any one time. Both working and non-working cows underwenta series of body weight loss and were in negative energy balance after March until end of October (Figure 2). This period covers absence of aftermath grazing due to plowing of the crop lands and followed by waterlogging on the pasture lands thereby causing unavailability of feeds.

Reproductive Performance

There were no significant differences between working and non-working crossbred cows in mean intervals of calving to first postpartum estrus and calving to conception (Table 4). Esubalew (1994) reported similar values for days from calving to first visual estrus that ranged between 180 and 250. And also a range of 275–343 days interval between calving and conception. However, the present results are not in harmony with the reports of Zerbini et al. (1996) which described that work significantly delayed days to conception. The difference of these results perhaps emerged from the case where the crossbred cows on-farm worked for only 26 days which might not be enough to induce considerable effect on the reproductive performance of the cows. Zerbini et al. (1996) also emphasized that the diet effect was considerably larger than the work effect for occurence of first estrus. Gemeda et al. (1994) reported that if work and inadequate nutrition persist for as long as one year, milk production and number of conceptions could be reduced by 54 and 78%, respectively, than to those of adequately fed cows. The interval of about 100 days between the onset of first postpartum estrus and conception during the first lactation shows that there was generally low reproductive management efficiency. This might be associated with problems of estrus detection, poor artificial insemination practices or the use of poor quality semen. The interval to the first estrus after second calving was longer (p < 0.01) than during first calving. On the other hand, the interval from first estrus to conception after second calving was shorter than during first calving where working and non-working cows conceived 42 and 32 days, respectively, after exhibiting first estrus. This suggests that postpartum anestrus was a more important problem than conception failure during the second than the first postpartum period.

Table 4. Days to first postpartum estrus, days to conception from calving and calving interval of working and non-working crossbred cows under smallholder farm management conditions.

Work status	Days to 1st postpartum estrus	Days to conception	Calving interval
Working	221.07 ± 15.19	288.21 ± 19.63	547.45 ± 20.47
Non-working	200.33 ± 16.09	277.00 ± 20.79	513.89 ± 21.03
F-test	ns	ns	ns
CV (%)	35.39	37.60	17.24
CALVING			
First	158.36 ± 15.48	264.07 ± 20.01	519.85 ± 20.47
Second	263.04 ± 15.81	301.14 ± 20.43	541.49 ± 21.03
F-test	**	ns	ns
CV (%)	35.39	37.60	17.24

**, significant at p < 0.01; ns, not significant

Table 5. Dry matter (DM) intake of supplementary feeds offered to crossbred cows at the farm and daily average of time spent for grazing

Work status	Supplementary DM intake (kg/day)	Grazing
Working	4.72	8.22
Non-working	4.76	7.66
F-test	ns*	ns
SE ±	0.33	0.49
CV (%)	26.17	22.87

NS, not significant

Feed Intake

Working cows were not offered extra feed allowance for their additional use as draft animal. Crossbred cows were supplemented with concentrate, hay that was made from oats and vetch mixture and improved forages grown at the backyard of smallholder farms. In general, the crossbred cows were in negative energy balance as this was seen from their body weight loss over the most period of the year. The animals travelled overa 2-km distance from homestead areas in search of pasture. They spent 8 hr/day for grazing. Grazing provided the bulk of the daily intake of the animals.

CONCLUSION

As long as improved feeding management and lower level of work are coupled, it is unlikely for traction to have adverse effect on productive and reproductive performances of crossbred dairy cows under smallholder farm management conditions. A series of farmers training to create their awareness on feasible options of intensifying the farming systems is highly required. There is also a need for studying how the crossbred herd can be well integrated together with the existing local cattle of farmers holding.

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session III

FEEDS and ANIMAL NUTRITION

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EFFECT OF NOUG CAKE OR MAIZE GRAIN AS FLUSHING DIET ON LITTER SIZE IN HORRO SHEEP

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ABSTRACT

Noug cake, (high protein diet), ground maize grain, (high energy diet) and no supplementation were compared as flushing diet for their effect on litter size of Horro sheep. Three weeks before-mating, feeding of the treatment diets was applied and lambings from the first 17 days of mating were considered in this study. Treatment had no significant effect on litter size though there was a clear trend of improvement in average litter size from control to high energy feeds and to high protein feeds (1.14, 1.22. and 1.27, respectively). Flushing resulted in significant difference in weight gain with high protein (0.8 kg)and high energy (1 kg) diet, while no supplement resulted in only maintenance of pre-flushing weight pre-flushing weight (weight at the start of flushing) resulted in nearly significant difference in average litter size ranging from 1.02 to 1.38. Condition change in the first month after mating was also found to affect lambing rate. With the level of supplementation used in this study, noug cake was observed to have either better or equal effect with ground maize grain on lambing rate of Horro sheep when used as a flushing diet. Different levels and length of supplementation are suggested as future areas of work in this line.

Introduction

Increase in litter size when coupled with lamb survival is one of the means to increase sheep production. As two lambs rarely come from the shedding of an egg (Cockrem 1979), ovulation rate is the most important determinant of litter size and ovulation rate and nutrition have been known to be associated (Lindsay 1976). In addition to its effect on ovulation rate there are indications that nutrition influences embryonic mortality (West et al. 1991), thereby limiting the proportion of ova shed and fertilized to be represented by live lambs born.

Flushing, giving ewes which are in fairly poor condition an improved diet a few weeks before mating for the purpose of improving lambing rate (Thompson and Aitken 1959 cited in Coop 1966), is a common practice. Both high energy and high protein feeds were found to be important in influencing ovulation rate (Smith 1985). The relative importance of energy and protein has been studied by different works (Torrel et al. 1972, Fletcher 1981, Oldham and Lindsay 1984, and Teleni et al. 1984) and the results were equivocal.

Results from characterization studies of Horro sheep in Ethiopia have shown lambing rate to vary among years from 119% to 155% (IAR 1983 and 1990). The role flushing can play in causing lambing rate variation in Horro sheep and the effect of different types of diets is felt worth investigation since it helps to develop economic management practices for increased lambing rate. Thus the objective of this study was to investigate the effect of high energy or high protein nutrition prior to mating on lambing rate.

Materials and Methods

Data were, collected at Bako Research Center. The center is located at 09°6'N, 37°09'E with 165 m elevation 1200 mm annual rainfall, and 28°C and 13°C mean maximum and minimum temperatures).

Treatments

A total of 270 ewes (117 in 1995 and 153 in 1996) were used for the experiment of which only 210 ewes (88 in the first year and 122 in the second year) were used as a source of data. All the ewes were stratified on the basis of body weight, age (2–9 years) and type of birth (single, twin, and purchased) and randomly assigned to the following 2 treatments and a control.

- 300 g of ground maize starting 3 weeks prior to mating
- 300 g of mechanically extracted (about 34% CP) noug cake (*Guizotia abyssinica*) starting 3 weeks prior to mating
- Control (no supplement)

Ewes grazed during the day time and received supplement upon their return from grazing. In the first year the grazing area was partly an established pasture of Rhodes grass (*Chloris gayana*) and partly natural pasture of mixed species, mostly Bermuda grass (*Cynadon dactylon*), which was in a relatively good condition while in the second year the grazing area was the same natural pasture but in poor condition.

Mating Management

Ewes were kept indoor during mating (December to February) and were fed ad libitum Rhodes grass (*C. gayana*) hay and 333 g/head/day concentrate (49% maize, 49% noug (*G. abyssinica*) cake, 1% common salt and 1% bone meal) supplement. To avoid confounding of ram effect with treatment ewes in each replication of a treatment were grouped into two or three equal sub groups and were joined in single-sire groups of 15 to 21 ewes with sub groups from other treatments. Ewes grazed during pregnancy with some ewes being supplemented during late pregnancy in the first year, while in the second year with no supplementation to all the ewes. Health management practice comprised vaccination (anthrax, sheep pox, pasteurellosis, and CCPP), fortnightly spray against external parasites and prompt treatment of sick animals.

Statistical Analysis

Catmod procedure of SAS (1987) was used to analize the data. The model incorporated litter size as dependent variable while absolute weight and weight change, and condition score and condition score change during flushing and in the month after the start of mating were considered as independent variables after being categorized into different classes along with year, age, type of birth of ewe and treatment. Some of the independent variables were removed from the analysis when they were found to have no significant contribution in accounting for the variability in the dependent variable during a preliminary analysis. Means and standard deviations were calculated by means procedure of SAS (1987).

Table 1. **Maximum likelihood analysis of variance of litter size as related to treatment, age, body weight and condition at different stages prior to post mating**

Source	Df	Chi-square	Probability
Intercept	1	32.81	0.0000
Treatment	2	2.72	0.2562
Age	2	7.46	0.0240
wcbf*	2	4.93	0.0849
wcaf	2	5.65	0.0593
ccaf	2	3.44	0.1790
wc4w	2	7.03	0.0298
wcc4	2	7.03	0.0298
ccc4	1	4.12	0.0423
Likelihood ratio	143	130.72	0.7605

*Wcbf = weight category at the beginning of flushing,
wcaf = weight category at the end of flushing,
ccaf = condition category at the end of flushing,
wc4w = weight category 4 weeks after the beginning of mating (end of flushing),
wcc4 = weight change category in the 4 weeks post mating (end of flushing),
ccc4 = condition change category 4 weeks after the beginning of mating (end of flushing).

Results and Discussion

The overall average litter sizes observed in this study (1.21) is lower than previous reports (Galal 1983, Solomon et al. 1996). This is due to the fact that the ewes used in the study were mainly young.

The effect of treatment on litter size was not significant ($p > 0.05$) (Table 1). In Polworth and Corriedale ewes either unsupplemented or supplemented with 500 g or 1000 g feed/day before mating the incidence of twinning was found to increase from 2.3% to 13.6% to 30.5% and from 0.6% to 9.4% to 22%, respectively (Roda and Otto 1993). The lack of significant difference between treatments in this study could be the result of the low level of supplementation or the use of high proportion of young animals in the study (Table 2). The overall supplementation is low being only about 1% of body weight on dry matter basis.

Despite lack of significant difference between treatments, the trend in mean litter size showed that flushed groups had higher litter size, those flushed with noug cake having had the highest. Similarly, high response in ovulation rate to high protein diet (lupin grain) was reported by Oldham and Lindsay (1984). However, Teleni et al. (1984) found similar ovulatory response to lupin feeding in ewes given high energy nutrition (intravenous infusion of glucose and acetate) for nine days. Fletcher (1981) found significant effects of protein on ovulation rate at low (4 MJ ME/ewe/day) and moderate (11.1 MJ - ME/ewe/day) energy levels, in addition to responses to increased energy level at a constant protein intake. High protein diet resulted in better lambing rate than high energy diet. Since noug cake in addition to its high protein content is not that low in its energy content (about 12 MJ/kg ME), the superiority could be the additive effect of both energy and protein. Obviously maize is deficient in crude protein with only 9% of CP.

Weight after flushing (at the beginning of mating) showed nearly significant difference ($p = 0.059$). The weight gain realized during the flushing period was significant ($p < 0.05$) with ewes receiving noug cake and maize gaining 0.8 and 1.0 kg while the control group only maintained weight. Fletcher (1971) indicated that effect of flushing per se did not influence ovulation rate, but that the increase in body weight brought about by flushing was the responsible factor.

Weight at 1 month post mating and weight and condition change in the month after mating showed significant effect on litter size (lambing percentage) (Table 1). The effect of weight a month after mating and condition change during this period could be due to the effect on embryonic survival. High level of embryonic mortality as a result of low (Mackenzie and Edey 1975) or high level (Cumming et al. 1975) of feeding have been reported. Weight before flushing have also shown a nearly significant difference ($p < 0.085$). Adalsteinson (1979) reported that ewe fecundity increased linearly with ewe body weight at 8 weeks prior to mating (1.05 lambs/kg per 100 ewes), curvilinearly with ewe body condition score at 8 weeks before mating (maximum 3.32 kg) and curvilinearly with weight gain from 8 to 2 weeks before mating (maximum 2.3 kg).

Table 2. Arithmetic means (standard deviation) of litter size for different variables considered in the model

Variable	*No.*	*Mean (sd)*
Total	188	1.21 (0.41)
Treatment		
1	70	1.27 (0.45)
2	60	1.22 (0.42)
3	58	1.14 (0.35)
Age (yr)		
2–3	109	1.12 (0.33)
4–5	37	1.19 (0.40)
≥6	42	1.48 (0.55)
Wcbf (kg)*		
<26.0	70	1.09 (0.28)
26.0–30.0	79	1.26 (0.41)
>30.0	39	1.34 (0.50)
Wcaf (kg)		
<26.0	71	1.11 (0.32)
26.0–31.0	79	1.23 (0.42)
>31.0	38	1.37 (0.49)
ccaf		
<2	37	1.22 (0.42)
2–2.5	72	1.26 (0.44)
>2.5	79	1.16 (0.37)
wc4w (kg)		
<26.5	52	1.06 (0.24)
26.5–30.0	65	1.17 (0.38)
>30.0	71	1.37 (0.49)
wcc4 (kg)		
<1	48	1.17 (0.38)
1–3	85	1.27 (0.45)
>3	55	1.16 (0.37)
ccc4		
¾0	65	1.17 (0.38)
>0	123	1.24 (0.43)

*Wcbf = weight category at the beginning of flushing; wcaf = weight category at the end of flushing; ccaf = condition category at the end of flushing; wc4w = weight category 4 weeks after the beginning of mating (end of flushing); wcc4 = weight change category in the 4 weeks post mating (end of flushing); ccc4 = condition change category 4 weeks after the beginning of mating (end of flushing).

Condition before mating had no significant effect (Table 1). Usually once the variability accountable to ewe body weight was removed, ewe body condition score did not account for any significant further variation (Cumming 1977 and Sanson et al. 1993). Doney et al. (1982, as cited by Gunn 1983) concluded that in a diverse population of a given breed, body weight may be the most useful parameter for prediction while in a uniform flock with known history, body condition may be the most useful. In this study variations in age, type of birth of ewes and initial weight were evident and, hence, may lead to the effect of condition score to be non-significant.

Age showed significant effect ($p < 0.05$) on litter size (Table 1). Similar increase in litter size with increase in age was observed by Mclaughlin (1970), and for the same breed by Galal (1983).

Conclusion

At the level of feeding used in this study, it was observed that flushing for 3 weeks with either maize grain or noug cake diet did not significantly improve litter size in Horro sheep. But the trend showed that litter size increased with feeding and that noug cake was better than maize grain. Though the economics of such practice depends on feed price, the value given for each additional lamb and survival of such lambs to a market age, varying periods of flushing and feeding level may be tried for their effect and economic advantage.

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FACTORS AFFECTING IN VITRO GAS PRODUCTION FROM FERMENTATION OF FORAGES AS DETERMINED BY PRESSURE TRANSDUCER TECHNIQUE

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ABSTRACT

A pressure transducer assembly connected to a digital read-out meter was used to determine the fermentation kinetics of temperate and tropical forages during in vitro digestion in batch cultures inoculated with rumen micro-organisms. The forages included straws and hays harvested as part of a forage evaluation program at different stages of growth from research centers in Ethiopia. Factors influencing the fermentation kinetics of these forages were investigated using parallel curve analysis. The factors included: (1) atmospheric pressure, (2) anaerobic status and composition of the culture medium, (3) the amount of microbial inoculum used, (4) the interval between successive pressure transducer readings, (5) the extent to which culture medium buffer contributed to the accumulating gas pool and (6) variability of the rumen microbial inoculum. Reproducibility and repeatability of gas accumulation measurements and the optimal construction of gas accumulation profiles were also investigated. All factors had significant ($p < 0.05$) influence on gas accumulation profiles emphasizing the need for standardized experimental conditions and procedures in evaluation of in vitro fermentation kinetics of ruminant feedstuffs. As a result of these experiments suggestions were made on routine procedure for in vitro determination of forage fermentation kinetics using the pressure transducer technique.

Introduction

Information on the kinetics of forage digestion is important as rate and extent of digestion of feeds in the rumen to a large extent, determine voluntary intake (Hovell et al. 1986, Ørskov et al. 1988). Several indirect methods have been used to estimate the extent of forage digestibility. The two-stage in vitro technique of Tilley and Terry (1963) has been widely used in predicting forage digestibility for ruminants and for screening large numbers of forages in plant breeding programs. However, the method provides no information on digestion kinetics and measures only an end-point of digestion after 48 hr. Grant and Mertens (1992) showed the method could be modified by using only the first stage of incubation to measure in vitro dry matter (DM) degradation pattern with time. However, this involved destructive sampling of the contents of digestion tubes thereby limiting the number of samples that could be tested at a given time.

The Dacron bag method, in which nylon bags are suspended in the rumen of fistulated animal and removed sequentially for DM determination, can serve as a tool in supplying information on rate and extent of DM disappearance of feeds (Ørskov and McDonald 1979). However, due to the cost and the difficulty of maintaining large numbers of fistulated animals the method is not convenient for concurrent evaluation of large numbers of samples. Given that in situ DM disappearance measurements reflect the rumen environment involving diet and animal differences, they are therefore inherently more variable than the corresponding in vitro measurements of digestion (Noeck 1985). The accuracy of the Dacron bag method is also influenced by certain technical aspects such as amount of sample in relation to bag size, bag pore size, sample particle size, the washing procedure for bags after removal from the rumen and the basal diet of the fistulate animals (Noeck 1985, Uden et al. 1974 and Van der Koelen et al., 1992). Thus, for these reasons it is often difficult to make comparisons of results from different research works or research centers.

Recently, it has been shown that measurement of rate of gas production during in vitro fermentation of forages with microbial rumen inoculum can be used to assess fermentation kinetics (Theodorou et al. 1991, Beuvink and Kogut 1993, Blümmel and Ørskov 1993, and Khazaal et al. 1993). Theodorou et al. (1991, 1994) developed the pressure transducer technique (PTT) for measuring in vitro gas production of forages. The method has been used to estimate rate and extent of gas accumulation of forages. The procedure is inexpensive and can handle large numbers of samples. In order to determine the precision of the results obtained, factors that may affect the kinetics of gas production need to be investigated. The present series of experiments were therefore undertaken on the factors that may affect gas accumulation of test forages as determined by the pressure transducer technique. The work was undertaken at Holetta Research Center, Ethiopian of Agricultural Research Organization, Ethiopia, Reading University, Reading, UK, and Institute of Grassland and Environmental Research, Aberystwyth, UK.

Materials and Methods

The list of experiments undertaken at different locations is as shown in Table 1.

Forage Samples

Forages were grown in the highlands of Ethiopia as part of the national forage evaluation program of the Institute of Agricultural Research and straws were obtained from Holetta Research Center. They comprised of wheat straw, barley straw and Rhodes grass (*Chloris gayana* var "Massaba"), rye grass hay (*Lolium perenne*), pasture hay from permanent pasture (mixed species), Phalaris hay (*Phalaris aquatica* var. Sirroco), oat hay (*Avena sativa*), Panicum hay (*Panicum coloratum*), Tef straw, Pigeon grass (*Heteropogan whitei*), Molasses grass (*Melinis minutiflora*), and Stylo hay (*Stylosanthes guianesis*). Except for Pigeon and Molasses grasses which were harvested at the post flowering stages, all forages were harvested at flowering stage. All forages were air-dried and milled through a 1.0-mm dry mesh screen using a Christy-Norris laboratory mill.

Microbial Inoculum

Samples of rumen digesta were taken as grab samples from three rumen fistulated sheep maintained on rye grass hay fed ad libitum with 200 g/day of concentrate (3.2% N), or four rumen fistulated steers fed grass ad libitum collected from permanent pastures and 3 kg/day of noug (*Guizota abyssinica*) seed cake. The digesta were transported to the laboratory in a warm (ca. 39 °C) vacuum flask . The digesta was squeezed through two layers of muslin and the strained rumen fluid collected in a flask while gassing with CO_2. The residual digesta solids were comminuted for 1 minute in a Kenwood electric blender after addition of anaerobic buffer equal in volume to the rumen fluid collected in flask. Fluid from the comminuted digesta was strained through muslin as above and combined in equal volumes with the rumen fluid. The microbial suspension was stirred and flushed with CO_2 during inoculation.

Table 1. List of experiments undertaken on factors affecting gas accumulation of forages as determined by the pressure transducer technique

Experiment no.	*Experiment title*	*Source of inoculum used in the experiment*	*Experiment location*
1	Effect of atmospheric pressure on gas production	-	IAR (Holetta Research Center) Ethiopia, and IGER , Aberystwyth , UK
2	Effect of type of medium on gas production profile of test forages	Three rumen fistulated sheep	Reading, UK
3	Effect of presence or absence of typrticase peptone and/or cystein in culture medium on gas production of test forages	Four rumen fistulated steers	IAR, Ethiopia
4	Effect of amount of rumen inoculum in culture medium on gas production of test forages	Four rumen fistulated steers	IAR, Ethiopia
5	Effect of gas reading interval on gas production profile of test forages	Four rumen fistulated steers	IAR, Ethiopia
6	Contribution of culture medium	Three rumen fistulated sheep	IGER, UK
7	Reproducibility and repeatability of gas production	Four rumen fistulated steers	IAR, Ethiopia

Culture Medium

The medium was composed of a basal solution, prepared by mixing together, (in numerical order), the following components: Trypticase peptone (Becton Dickinson Microbiology Systems, Cockeysville, MD 21030, USA), micromineral solution, buffer solution, macromineral solution, resazurin solution and distilled water. Each solution was prepared using glass distilled water and kept in the dark at 4 °C until required. The basal solution was pre-reduced by bubbling a stream of oxygen-free CO_2 through the medium for *ca.* 3 hr.

To complete the medium, a reducing agent , the forage sample to be fermented (1 g ± 0.5%) and 90 ml of basal solution were dispensed into serum bottles (Phase Separations Ltd., Clwyd, UK; nominally of *ca.* 160 ml capacity, but retailed as 125 ml bottles) (4–5 replicates per sample) using anaerobic procedures and sealed with butyl rubber stoppers and aluminium crimp seals (Bellco Glass Inc., Vineland, NJ, USA). The reducing agent was freshly prepared prior to use and had the following components: Cysteine Hcl, distilled water, 1 M NaOH and Sodium sulphide.

Sealed bottles were chilled to 4 °C (for not longer than 24 hr prior to inoculation), warmed to 39 °C and inoculated with 5 ml of microbial inoculum using a 10 ml syringe fitted with a 23 gauge x 1.5 inch needle (Sabre International Products Ltd., UK). Bottles were incubated at 39 °C until the end of the fermentation period.

In some experiments, the medium and culture procedures described above were slightly altered. Modifications included: (a) excluding Trypticase peptone and/or cystine HCl from the culture medium (Experiment 3), (b) varying the amount of microbial inoculum from 5 to 10 or 15 ml per 100 ml of culture medium (Experiment 4), (c) incubating test forages in medium above and in the medium of Tilley and Terry procedure (1963); the constituent and preparation of the medium used in Tilley and Terry procedure was as modified by Minson and McLeod (1972) (Experiment 2).

Acidification of PTT Medium (Experiment 6)

Culture medium with or without microbial 5 ml of incoculum (each replicated in 25 culture bottles), was incubated without forages and the volume of gas released measured 30 minutes after stepwise addition of 1–2 ml of a 2 M solution of acetic acid. Acetic acid was added stepwise to each bottle through the butyl rubber stopper, using a syringe and needle and after each measurement, two serum bottles each from medium with or without rumen inoculum were removed and used for pH readings.

Gas Accumulation Measurements

Measurement of gas accumulation from the fermentation serum bottles were as described by Theodorou et al. (1994). In brief, a pressure transducer with a LED (light emitting diode) digital readout meter was used to measure the accumulation of fermentation gases in the head space of the culture bottles. Gas pressure was read from the display unit after insertion of the needle through the butyl rubber stopper in the head-space above the medium. The gas volume above the medium was transferred into the syringe barrel by withdrawal of the syringe plunger until the pressure in the transducer display unit became zero. The head-space pressure and volume of gas were recorded. The syringe was withdrawn from the bottle and the gas was discarded. Only a few bottles were taken (10–12 bottles) at a time from the incubator for readings in order to minimise the time that bottles were outside the incubator. The reading sequence followed the sequence of inoculation of the bottles. Gas readings were recorded at 3 to 4 hr intervals during the 12 hr incubation time and less frequently afterwards. However, in Experiment 5, five reading intervals (every 1, 3, 6, 8 or 12 hr) were set up during the 48 hr incubation time.

In the procedure outlined by Theodorou et al (1994), linear regression analyses of head-space gas pressure versus recorded volume was determined prior to summation and then cumulative gas production was calculated by the summation of the predicted (regression-corrected) gas volumes from the replicate serum bottles. This was done in order to correct possible slight differences between bottles caused by the pipetting procedure and the bottle size. However, constructions of cumulative gas production profile by summing up the measured volume was investigated in this study.

Statistical Analyses

The model proposed by France et. al. (1993) was fitted to the exponential profile to estimate values after subtraction of the mean control profiles . In the model, rate of gas production is expressed by two fractional rates. The equation is in the form:

$$\mathbf{Y = A\{1\text{-}ev^{[-bf(t-T)-cf(Öt-ÖT)]}\}}$$

The model was transformed and fitted with the functional form:

$\mathbf{G = A\text{-}BQ^{t}Z^{Öt}}$; where,
G is the cumulative gas volume (ml),
A is the asymptotic gas pool value (ml),
$B = A\ e^{(bfT+cfÖT)}$,
T is the lag time (hr),
$Q = e^{-bf}$,
$Z = e^{-cf}$ with b_f (h^{-1}) and c_f ($h^{-0.5}$) being the two rate constants.

A combined rate of gas production (m) (rates vary with time) was calculated as:
$\mathbf{m\ (/hr) = b_f+(c_f/2Öt)}$ where,
b_f and c_f are rate constants as defined above and t is incubation time.

Differences in estimated parameter due to treatments were analysed using parallel curve analysis (MLP; Ross 1987).

Variance components of repeatability errors (between replicates of a feed in a single run) and reproducibility errors (between runs), repeatability and reproducibility of gas production from the mean of 10 forages over 5 runs were calculated based on the statistical procedure of ISO, 1981 using the REML of Genstat (1987). The number of culture bottles used to incubate each test forage was regarded as replicates within a run.

Gas production and pH data from the acidification of the culture medium after stepwise addition of acetic acid were analysed using one node linear spline curve analysis (MLP; Ross 1987).

Results and Discussions

Construction of Cumulative Gas Production Profile of Test Forages

Gas accumulation data from 25 culture bottles were selected at random and linear regression analyses performed for each culture bottle between head-space gas pressure and volume. The relationship obtained between head-space gas pressure and gas volume was highly significant ($p < 0.01$) and the error from the predictive equation (RSD) was small (< 1.0 ml) indicating that the corrected gas volume data were not significantly ($p > 0.05$) different from that of the original data of measured gas volume. Provided the dispensing solutions and recording of volume for each serum bottle is done as accurately as possible, the use of measured volume of gas and not regression corrected volume would not affect the final results of cumulative gas production. Thus, the measured volume of gas was used to calculate cumulative gas production and the data were corrected for the controls.

Experiment 1: Effect of Atmospheric Pressure on Gas Measurements

This study was conducted to assess the relationships between gas-pressure and volume at the two locations viz UK (IGER, Aberystwyth, 100 m asl, atm. 752 mm Hg) and in Ethiopia (Holetta Research Center, 2400 m asl, atm 587 mm Hg). The relationship between pressure (x, psi) and volume of gas (Y, ml) at each location was:

- **V (ml) = 10.48 x (psi) ($R^2 = 0.99$, RSD = 0.293)** in UK and
- **V (ml) = 13.32 x (psi) ($R^2 = 0.98$, RSD = 1.145)** in Ethiopia.

The result shows that for the same gas pressure reading, the volume of gas measured at Holetta (Ethiopia) was 21% higher than the volume of gas measured at Aberystwyth (UK). The observations made above were also shown for gas production measurements from forage samples fermented in 100 ml medium. At Aberystwyth, for each psi (head-space gas pressure) reading the corresponding gas volume was 4.5 ml. However, in Ethiopia the volume of gas for each psi was about 5.9 ml.

It is necessary to record the atmospheric pressure of the site when measuring gas production of forages. Gas production results measured at different locations can be standardised to 1 atmospheric pressure (760 mm Hg) (V') by calculating the quotient using Boyles' Law:

$V' = P/P'* V$; where,
P is the atmospheric pressure at the site of measurement,
V is the volume of gas measured and
P' is the standard atmospheric pressure.

The same quotient can also be used to standardise the estimated parameters A and B fractions representing the gas pool obtained using the France et al (1993) equation.

Experiment 2: Effect of type of medium on gas production profile of test forages

Five forages (wheat straw, barley straw, Rhodes grass and two samples of rye grass hay) were each incubated either in medium used in the pressure transducer technique (PTT) or medium used in the Tilley and Terry (TT) procedure and gas production from each of the fermented forages was measured during a 122 hr incubation period. Each forage had significantly ($p < 0.05$) higher rates of gas production when fermented in the PTT than when incubated in the TT medium. Wheat straw, Rhodes grass and rye grass II had smaller gas pool (A, B) when fermented in the PTT medium than in TT medium.

The higher rates of gas production of forages fermented in PTT medium as compared with TT medium could result from provision of nutrients for micro-organism or maintaining anaerobic conditions in the medium or a combination of the two. Grant and Mertens (1992) compared the effect of two media on the kinetics of forage fiber digestion. They reported that maintaining anaerobic conditions had a major effect on the rate of digestion and that this was more important than differences in media compositions. Poor anaerobisis (Grant and Mertens 1992) resulted in reduced rate of fiber digestion and increased lag time which is consistent with these results obtained here. According to Leedle and Hespell (1983), the effect of aerobic conditions in TT medium would lead to a substantial loss of cellulolytic as compared with amylolytic bacteria. Thus, the lower rate of gas production in TT could be caused by a decreased number of cellulolytic micro-organisms since these bacteria are responsible for digesting fiber of forages.

Experiment 3: Effect of Presence (or Absence) of Trypticase Peptone and/or Cystein in Culture

Four culture media were prepared, with the presence and/or absence of Trypticase peptone and/or Cysteine HCl. Four test forages (barley straw, pasture hay from permanent pasture (mixed species), Phalaris hay (*P. aquatica* var Sirroco) and oat (*A. sativa*) hay) were incubated in each medium and gas production was measured over a 96-hr incubation period.

The presence or absence of Trypticase peptone and Cysteine HCl did not affect the rates f gas production (b, c) of each forage significantly ($p > 0.05$). However, the presence of Trypticase peptone and Cysteine in medium increased estimated parameters of gas pool ($P < .05$). On average, the inclusion of Tyrpticase peptone increased the gas pool (A fraction) by 20.0 (± 0.2) ml while inclusion of Cysteine HCl resulted in an increase of 11.5 (± 0.5) ml.

It was reported that inclusion of Trypticase peptone in medium would stimulate the growth of rumen micro-organisms and increased forage digestion (Grant and Mertens 1992). The present study demonstrated that gas pool was more affected by the presence or absence of Trypticase peptone than was the rate of gas production. It may be argued that inorganic nitrogen (ammonium) and nitrogen source in the rumen inocula might have provided enough N for the rumen micro-organisms. The increased gas pool with forages could be from the deamination of peptone.

Inclusion of sodium sulphide and flushing the medium with CO_2 for 3 hr seemed to be enough to reduce the PTT medium to the same extent as with the addition of Cysteine HCl. As a routine procedure, it is desirable to remove sodium sulphide from the medium as sodium sulphide is potentially toxic. Inclusion of sodium sulphide and flushing the medium with CO_2 for 3 hr seemed to be enough to reduce the PTT medium to the same extent as with the addition of Cysteine HCl.

Experiment 4: Effect of Amount of Rumen Incoulum in Culture Medium on Gas Production Profile of Test Forages

Three levels of inoculum (5, 10 or 15 ml per 100 ml of the medium) were used to study the effect of estimated parameters of gas production of grass hay (mixed species) from grazing pasture, Rhodes grass (*gayana* var Massaba), oat (*sativa*) hay and Panicum (*coloratum*) hay. Increasing the amount of inoculum increased gas production from each of the test forages, although the differences in gas production between bottles inoculated with 10 or 15 ml of inoculum were small. Increasing the volume of rumen inoculum in the medium did not increase the rates of gas production (b, c) of forages significantly ($p > 0.05$).

The volume of rumen inoculum in medium had a significant ($p < 0.01$) effect on the gas pool size (A and B parameters) of each of the test forages. Forage fermented in 5 ml inocula had a lower gas pool ($p < 0.01$) than when fermented either in 10 or 15 ml of inoculum. The gas pool from fermentations conducted using 10 or 15 ml of rumen inoculum were not significantly different ($p > 0.05$).

The absence of significant differences in rate of gas production due to increasing the level of rumen inoculum from 5 to 10 or 15 % of the medium does not agree with the results of Pell and Schofield (1993) where it was shown that an inoculum of less than 20% of the medium decreased the rate of gas production of forages. However, although Pell and Schofield (1993) showed increased rate of gas production with increased amount of inocula in medium, their data were not subjected to statistical analysis. The lack of a significant effect on rate of fermentation in the current study could be as a consequence of the method of preparation of the microbial suspension used in the PTT method. The homogenisation step, for example would have increased the microbial population required to saturate the system. Forsberg and Lam (1977) reported that ca. 75% of the bacteria population are associated with solid particles of the feed. Other researchers (Fay et al, 1980 and Senshu et al, 1980) have also recommended the procedure adopted in this study as a method of choice to obtain representative microbial species at a satisfactorily high concentration in vitro cultures.

Experiment 5: Effect of Gas Reading Intervals on Gas Production Profile of Test Forages

The effect of five reading intervals (1, 3, 6, 8, or 12 hr) during a 48 hr fermentation period on the pattern of gas production of tef (*Eragrostic abyssinica*) straw and three hays viz Rhodes grass (*C. gayana*), oat hay (*A. sativa*), and Phalaris hay (*P. aquatica*) was investigated. Gas production from each forage was higher when read at 1 hr interval as compared with either 3, 6, 8 or 12 hr reading intervals. After 48 hr of incubation, when considering the mean of the four forages, the volume of gas measured using a 1 hr reading interval was only 2% higher than that measured using a 3 hr reading interval. However, for the other reading intervals the volume of gas measured decreased in greater proportions as compared with the 1 h reading interval. Percentage decreases in cumulative gas production as compared with the 1 hr reading interval were 15, 19 and 30% for reading intervals of 6, 8, and 12 hr, respectively.

The data have limitations in fitting to the model of France et al. (1993) as the incubation was only done for 48 hr. The gas production asymptotes of each forage were not reached within this time. The model of France et al. (1993) has a weakness of predictive capacity when the substrate does not reach the asymptote. Therefore, some of the estimated parameter values may not be realistic. Analysis continued, however, to show the effect of reading intervals on the estimated parameters of gas production. Reading intervals influenced ($p < 0.05$) the estimated parameters of gas production of each forage sample. Increasing the reading interval tended to increase the lag time. The estimated parameters of gas production of forages read at 1 hr were different from the parameters derived from reading at 3 hr interval. There was no difference ($p > 0.05$) between the estimated parameters of gas production of forage sample read at either 6 or 8 hr interval. As it can be seen from the mean gas production at each hour of the four forages, there were substantial differences in the volume of gas measured using the four reading intervals within the first 21 hr of incubation. The magnitude of the differences between the intervals depended on the incubation time.

Experiment 6: Contribution of Culture Medium to Gas Production

This experiment intended was to quantify the CO_2 released from buffered cultured media with or without microbial inoculum. With progressive addition of acetic acid, gas production from the media increased linearly although the rate of increase tended to decline during the later steps of addition, but failed to reach a plateaux within the present level of acetic acid addition (16 mmol). Thus the data was analysed using single node linear spline curve analysis.

For both media (with or without microbial source), the break point at which the rate of gas production tended to decrease with increased addition of acetic acid was after 10.2 mmol. The estimated parameters were the same in the two media. After the break point in each case, values for the slope of the line were 10.8 and 11.7 ml, respectively, for medium without and with rumen inoculum.

At 39 ^{0}C, the molar gas volume is 25.62 ml, and this was used to calculate the gas production in mmol from media with and without microbial inoculum for each mmol of acetic acid added. Thus, from 0 to 11 mmol acetic acid/100 ml, the addition of 1 mmol of acetic acid released 0.66 and 0.63 mmol of gas from the medium and medium with microbial inoculum, respectively.

In the case of pH data, the break point for the two lines for medium with rumen inoculum was after the addition of 5.9 mmol of acetic acid at a corresponding pH of 6.3. The slopes of the two lines before and after break point were -0.045 and -0.134, respectively. Although the inflection points for the two media were not different, the slope of the lines for medium alone were higher than corresponding slopes for the medium with microbial inoculum medium. The inflection point for medium alone was at 6.0 mmol of acetic acid addition with slopes of -0.085 and -0.154 before and after the break point, respectively. The volume of CO_2 released from PTT medium with rumen inoculum (16.8 ml/mmol of VFA) was similar to that reported by Beuvink and Spoelstra (1992) (20.8 ml gas per mmol VFA production or 0.87 mmol gas). The volume of medium used by Beuvink and Spoelstra (1992) was 60 ml and gas measurements were recorded at 20 ^{0}C. In the current experiment, however, gas measurements were made at 39 ^{0}C and from 94 ml medium. When these two differences are taken into consideration results from the two experiments were similar.

In the rumen, VFAs are absorbed through the rumen wall into the blood, or removed by passage from the rumen with rumen fluid to the omasum. Absorption by diffusion is influenced by both pH and VFA concentration, with low rates of absorption at low pH and high VFA concentration (Tamminga and van Vuuren 1988). In the in vitro method, since there is no mechanism for the absorption of the VFAs produced during fermentation, their accumulation would ultimately exhaust the buffering capacity of the medium. The results of this study demonstrated that in the PTT medium, after the production of 6 mmol (pH 6.34) of VFA, the pH of the medium declines at a faster rate. Thus, in the PTT medium VFA production should not exceed more than 6 mmol per 100 ml PTT medium with microbial inoculum (5%).

Experiment 7: Reproducibility and Repeatability of Gas Production

This experiment used the statistical procedure of ISO (1981) to determine reproducibility and repeatability of gas volume from the fermentation of 10 feeds (Tef straw, Pigeon grass, molasses grass, native hay, *P. aquatica* "Sirroco" hay, oat hay, wheat straw, Rhodes grass, Panicum hay and Stylo hay) measured in five consecutive runs. Estimated parameters of gas production of each forage at five runs were determined by fitting the data to the equation of France et al (1993). For each forage, parallel curve analysis was used to test differences in the estimated parameters of gas production obtained from the five runs.

Both repeatability (W) and reproducibility (B) errors depended on the volume of gas production from the forage samples which in turn were affected by incubation period. The linear functional relationship between repeatability (W) and volume of gas production (V, ml) from a forage sample was:

$$W = 6.4\ (\pm 0.47) + 0.070\ (\pm 0.0031)\ V\ (R^2 = 0.98;\ RSD = 0.78).$$

The linear relationship between reproducibility (B) and volume of gas production (V, ml) from a forage substrate was:

$$B = 5.8\ (\pm 0.46) + 0.099\ (\pm 0.0030) V\ (R^2 = 0.99;\ RSD = 0.76).$$

The reproducibility error was much higher than the repeatability error and both varied more in the first 20 hr incubation time. After 30 hr incubation time, the repeatability and reproducibility errors constituted 10 and 12% of gas productions of forages.

Variations occurred in the rates of gas production (b, c) and gas pool (A, B) for each forage estimated from each of the five runs. Differences in rates of gas production (b, c) between the five runs were significant ($p < 0.05$) for Rhodes grass and hay from pasture but not significant ($p > 0.05$) for the remaining eight forages. The rates of gas productions of these two forages measured in the fifth run were different ($p < 0.05$) from the rates of gas production determined in the previous four runs.

Gas pool for each forage showed significant differences ($p < 0.05$) between the five runs. For some of the forages, the highest gas pool was determined in the second run while for others the highest gas pool was in the fifth run. However, in the majority of cases forages showed their highest gas pool estimates in the second and their lowest in fifth run.

Pell and Schofield (1993) recommended that reproducibility of gas production of forages among runs can be improved by following strict schedules in collecting rumen inoculum for each run. However, Beuvink et. al, (1992) used the same procedure as Pell and Schofield (1993).

Beuvink et.al (1992) reported that the within-days mean square variances of gas production for glucose, rice starch and cellulose were 181, 458 and 139, respectively. The mean square variances between days for the same samples, respectively, were 1374, 1546 and 5072. The variances within and between runs of gas production after 34 hr incubation reported in the current experiment were lower as compared with these values. The coefficient of variation between runs was 4%.

General Discussion and Conclusion

The results showed that results from gas production experiments could be affected by several factors, notably constituents and the method of preparation of the culture used to incubate test forages, size and variability of microbial inoculum and the reading intervals used in recording gas pressure and volume from the fermentation bottles. In addition to these factors, it was shown that gas production volumes were influenced by atmospheric pressure. Variation in PTT results caused by different experimental procedures of PTT could be reduced by using standard procedures. Sample size, constituents and method of preparation of PTT medium were as described by Theodorou et al (1991). However, based on the results of this study, certain procedures need to be modified. Recommendations on experimental procedure for PTT are outlined in Table 2.

Table 2. Recommended experimental procedures for Pressure transducer, technique (PTT)

Variable	*Recommendation*
Construction of cumulative gas production	Determine cumulative gas production by summation of gas volumes experimentally read (not regression corrected) from the set of replicate cultures. Gas production profile is determined after subtraction of gas amounts which accumulated in control cultures (inoculated bottles incubated in the absence of forage substrate)
Amount of rumen inoculum	10 ml/ 100 ml medium
Preparation of microbial inoculum	Collect rumen digesta, squeeze through two layers of muslin. Comminute the residual digesta solids for 1 minute in a - Kenwood electric blender after addition of anaerobic buffer equal in volume to the rumen fluid.
Medium	As described in Theodorou *et al* (1991, 1994) except that there is no need to add trypticase peptone and Cysteine HCl
Preparation of medium	Maintain anaerobic condition during preparation of the medium as well as during inoculation
Reading interval	Every 3 hr for the 15 or 18 hr incubation period
Incubation period	At least 72 hr
Correction factors	Use of standard samples in each run and correct results for blanks. In comparing with other experimental results, the results have to be corrected for site elevation (atmospheric pressure).

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EFFECT OF LEVEL OF SUBSTITUTION OF LABLAB (*Dolichos lablab*) FOR CONCENTRATE ON GROWTH RATE AND EFFICIENCY IN POST WEANING GOATS

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ABSTRACT

A feeding trial was conducted at Adami Tulu Research Center to assess the effect of level of substitution of lablab for concentrate on the growth rate of goats. Thirty indigenous male goats, aged 15–18 months, were divided into five groups and randomly allocated to five treatments: grazing (G); G + 250 g concentrate (Conc.); G + 125 g Conc. + 280 g lablab hay (La.); G + 60 g Conc. + 420 g La. and G + 560 g La. Concentrate and lablab intake were recorded daily and body weight weekly. Generally total supplement consumed by the goats reduced from 250 g/h to 167 g/h as more concentrate was substituted by more Lablab hay. The intake of lablab ($p < 0.05$) increased from 98.5 to 167 g/d as the concentrate was reduced from 125 g/d to zero. The feed efficiency observed by supplementing grazing goats with lablab hay (8.9 g feed intake/m gain) was ($p < 0.05$) better than that supplemented with concentrate (12.5 g feed I/g gain). All concentrate and/or lablab supplemented groups gained more than the control (grazing) animals. The difference in weight gain between those supplemented with concentrate and lablab was not significant. The weight gain obtained by supplementing with lablab was 90.7% of the gain obtained by supplementing concentrate. This indicates that lablab hay can partly substitute for concentrate.

Introduction

Goats are the predominant small ruminant species in the Middle Rift Valley, where most of them are kept under extensive management systems and depend almost exclusively on natural pasture. During the dry season the nutritive value of pasture grasses deteriorates and they become deficient in many nutrients, especially protein. As a result, animals depending on those pastures progressively lose weight until the wet season comes. Alternatively, animals can be supplemented to minimize or prevent weight losses.

Most of the protein supplements used, such as noug cake, are expensive and frequently not readily available to farmers. Mafwere and Mtenga (1992) proposed leguminous multipurpose trees and forages as the best alternative protein supplements in terms of their sustainability and low cost. One of such species is lablab (*Dolichos lablab*) which can be easily cultivated and is relatively drought resistant. At Adami Tulu it has grown successfully and given yield of up to 29 q/ha of DM (IAR 1976).

In Nigeria, supplementation of goats with lablab resulted in a daily live weight gain of 48 g/animal, as opposed to a gain of 5 g/day in control. Improved liveweight gain in sheep fed lablab supplements justified its use in preventing liveweight losses during the critical period of the dry season (Adu et al. 1992). The objective of this study is to investigate, on the basis of equivalent crude protein contents, the extent to which lablab can substitute for a conventional protein concentrate mix in the fattening ration.

Materials and Methods

The experiment was conducted at Adami Tulu Research Center which is located 167 km south of Addis Abeba atan altitude of 1650 m. The annual rainfall is 760 mm. The mean minimum and maximum temperature are 12.6 and 26.9 °C. The soil type is fine, sandy-loam with sand:silt:clay in the ratio of 34:38:18. The pH is 7.88.

Thirty indigenous male goats, aged 15–18 months, were used for this study. After they have been treated for both external and internal parasites, all experimental animals were assigned to one of the following treatments by stratified randomization on the basis of liveweight.

- (T1) Grazing alone (control)
- (T2) Grazing + 250 g concentrate/h/d
- (T3) Grazing + 125 g concentrate + 280 g lablab hay/h/d
- (T4) Grazing + 60 g concentrate + 420 g lablab hay/h/d
- (T5) Grazing + 560 g lablab hay/h/d

All animals were allowed to feed on corresponding diets for 10 days during adaptation period. The actual experimental period was 100 days. The animals were allowed to graze as a single group for 8 hours daily according to the traditional grazing pattern of the area. The botanical composition of the natural pasture indicates that grasses are the dominant (96.1%) cover of Adami Tulu area of which *Pennisetum stramonium* has the largest share (86.8%). Legumes are found in a small quantity (3.9%).

The concentrate mixture had 69% wheat bran, 30% noug cake and 1% salt, and the lablab was cut, sundried and chopped into 1–2 cm pieces. The chemical composition of the feed stuff is presented in Table 1.

Concentrate was offered on a group basis at 7:00 AM daily and lablab was offered one and half hour after the concentrate. Refusals were recorded when the animals are out to graze. Water was available once during day time and at all time during the evening.

Data Collection

Quantities of feed offered and refused were recorded daily. Average daily feed intake per animal and per treatment was calculated from daily intake. Experimental animals were weighed every 7 days. Initial and final liveweights were calculated as a mean of three consecutive daily weights taken after depriving animals of water for approximately 16 hr.

Table 1: Chemical composition of experimental feed stuffs (% DM)

	*DM**	*N*	*CP*	*NDF*	*ADF*	*EE*
Lablab hay	92.1	2.7	16.8	42	36	-
Noug cake	93.1	5.68	35.5	33.3	28.2	12.5
Wheat bran	92.5	2.7	17.01	52.17	17.25	4.59

Source: Abule (1995) for lablab hay and Seyoum and Zinash (1989) for noug cake and wheat bran
DM, dry matter; N, nitrogen; CP, crude protien; NDF, nuetral detergent fiber; ADF, Acid detergent fiber;
EE, Ether extract

Data Analysis

The data were analyzed using SAS computer program. Variances were analyzed using one way ANOVA and the means were separated using Duncan's Multiple Range Test. The average daily weight gain over 100 experimental days was calculated by regressing liveweights of individual animals measured at work.

Results

Feed Intake

Performance of goats supplemented with lablab and concentrate is given in Table 1. Total DM and N intake reduced from 232 to 153 g/h and from 9.7-4.2 g/h, respectively, when the concentrate was substituted with more lablab hay. All concentrate which that offered to each group of animals was completely consumed regardless of the concentrate level. The intake of lablab hay ($p < 0.05$) increased from 98.5 g/d to 167 g/d as the level of concentrate was reduced from 125 g/d to zero.

Total DM and N intake per gram of liveweight gain reduced from 3.2 to 2.7 g/d and from 0.14 to 0.06 g/d, respectively, as the level of lablab supplementation increased from 0 to 560 g/h/d. The amount of N needed to support one gram of liveweight by supplementing grazing goats with lablab hay was ($p < 0.05$) less than that supplemented with concentrate only. That is, 0.14 g of N was needed from concentrate to obtain 1 g of liveweight gain, but to support the same unit of gain the amount of N needed from lablab was 0.06 g only.

Table 2. Feed intake of grazing goats supplemented with lablab hay and concentrate

Intake	Treatments					
	T1	T2	T3	T4	T5	SE
Aver. supplement (g/d)	-	250a	224ab	191bc	167c	17
Aver. concentrate (g/d)	-	250a	125b	60c	-	17
Aver. Lablab (g/d)	-	-	98.5b	131ab	167a	17
Total dry matter (g/d)	-	232a	207ab	176.7bc	153.8c	15
Total DM/gain (g/g)		3.2	3.2	2.7	2.7	-
Total N (g/d)	-	9.7	7.5	6.4	4.2	0.5
Total N/gain (g/g)	-	0.14	0.11	0.09	0.06	-

Weight Gain

All experimental animals including the control group gained liveweight (Table 2). Concentrate and/or lablab hay supplemented animals gained ($p < 0.05$) more than the control (grazing) group (51.2 g/d). Animals that were supplemented with 250 g concentrate only gained more value (71.8 g/h/d) and those supplemented with lablab only gained less (65.1 g/d).The difference in weight gain between animals supplemented with concentrate (T2) and lablab (T5) was not ($p > 0.05$) significant.

The weight gain obtained by supplementing grazing goats with lablab hay was 90.7% of the gain obtained by supplementing concentrate. This indicates that *Dolichos lablab* can partly replace concentrate.

Table 3. Weight gain and feed efficiency of grazing goats supplemented with lablab hay concentrate

	Treatments					
	T1	T2	T3	T4	T5	SE
Average weight gain (g/d)	51.2	71.8	65.4	66.0	65.1	4.8
Total DM intake (g/d)	-	232	207	176.7	153.8	15
Total DM intake/gain (g/g)	-	3.2	3.2	2.7	2.7	-
Gain/DM intake(g/g)	-	0.31	0.32	0.37	0.42	-

Discussion

Kiflewahid and Mosimanyana (1989) reported that mean daily DM intake of lablab (8.27 kg DM/d) supplemented to dairy cattle fed sorghum stover was lower than that of sorghum bran (10.21 kg DM/d). Similarly, in the present study the DM intake of lablab (153.8 g/d) was lower than the DM intake of concentrate mixture (232 g/d).

The gain of liveweight by goats in the different treatments including the control agrees with a recent report of Hailu and Ashenafi (1997) from the same study area. This indicates that goats by virtue of their small size and grazing habits, are efficient feed utilizers and capable of adapting to the dry ecology of the Mid-Rift Valley area.

Supplemented goats on average had 23.6% increase in liveweight gain when compared with goats in the un-supplemented diet. Increased liveweight gain following supplementation agrees with Adu et al. 1993. Kiflewahid and Mosimanyana (1989) reported that the dairy performance of Tswana cows supplemented with sorghum bran was not significantly different ($p > 0.05$) from that of cows supplemented with lablab. Similarly, Hailu and Ashenafi. (1997) reported in significant difference ($p < 0.05$) in liveweight gain between goats supplemented with leucaena (62.20 g/d) and those supplemented with concentrate (63.60 g/d). In our study the daily liveweight gain of goats supplemented with 250 g of concentrate mixture was not also significantly different ($p > 0.05$) from that of goats supplemented with 560 g lablab hay. This result agrees with Trung et al. (1983) in which daily weight gain of heifers fed 35% rice straw and 65% concentrate was not significant ($p > 0.05$) from those fed 35% straw, 45% leucaena and 25% concentrate. Snitweng et al. (1983) also reported that the weight gain obtained by supplementing Buffaloes with concentrate was not ($p > 0.05$) different from that supplemented with 60% of leucaena hay.

In addition to all the above positive agreements, in our study the weight gain obtained by supplementing grazing goats with lablab hay was 90.7% of the gain obtained by supplementing concentrate. This result indicates that *Dolichos lablab* can partly substitute for concentrate.

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PRELIMINARY OBSERVATION ON RELATIONSHIP OF DRY MATTER INTAKE BY SHEEP WITH FERMENTATION PARAMETERS, CHEMICAL COMPOSTION AND IN VIVO DIGESTIBILITY OF FORAGES

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ABSTRACT

The Pressure Transducer Technique (PTT) is based on measurement of gas production from fermentation of forages incubated with rumen inoculum buffered medium. Dry matter (DM) intake and in vivo digestibilities of six forage hays viz panicum, two cultivars of phalaris, Rhodes grass and natural pasture were determined using 36 (24 males and 12 females) local and cross bred (Menz x Awassi) Ethiopian highland sheep. Estimated parameters of gas production and in situ DM disappearances of the forages were determined and linear or multiple regression analyses were used to predict intake from estimated parameters obtained from PTT and Dacron bag methods and chemical compositions. The DM intake ($g/M^{0.75}.d$) ranged from 51.8 (Rhodes grass hay) to 60.8 (Phalaris hay1). The differences between the five forages was small (10 $g/M^{0.75}.d$). The in vivo DM digestibility of the forages varied from 54.2 (Rhodes grass hay) to 65.9 (Phalaris hay2) g /100 g DM. DM intake was significantly related to nuetral detergent fiber (NDF) content ($P < 0.05$, $R^2 = 0.62$), in vivo DM digestibility ($P < 0.05$, $R^2 = 0.66$) and the estimated parameters obtained from PTT ($P < 0.01$, $R^2 = 0.78$) and Dacron bag methods ($P < 0.01$, $R^2 = 0.78$). However, prediction of DM intake from the estimated parameters obtained from PTT and Dacron bag methods were more accurate ($P < 0.01$) than prediction from NDF content. Only effective gas production (EGAS) obtained from PTT could be used in predicting DM intake ($P < 0.01$). Of the estimated parameters obtained from Dacron bag method, rate of in situ DM disappearance was the most closely related to DM intake ($P < 0.01$). DM intake was not related ($P > 0.05$) with in situ rate and extent of DM disappearance parameters when used as factors in multiple linear regression. PTT can be used in ranking forages according to their ease of digestion and intake. However, the study used only six forages and the regression equations derived were based on data of low range of DM intake. More data are needed to asses whether PTT can be used in predicting intake of wide range of forages in Ethiopia.

Introduction

While in vivo trials are accepted methods for determining the nutritive value of forages for ruminants, the high cost involved limit their use in forage quality evaluation. For this reason, various laboratory methods have been developed. The main indirect methods of forage evaluation include fiber analysis (Goering and Van Soest 1970), two-stage in vitro digestibility of Tilley and Terry (1963), the Dacron bag rumen degradability method (Ørskov and McDonald 1979) and in vitro gas production method (Menke et al. 1979; Theodorou et al. 1991, 1994; Blümmel and Orskov 1993; Khazaal et al. 1993). Intake of forages can be predicted from the rate and extent of their fermentation parameters. The Dacron bag method can be used to estimate both the rate and extent of forage DM disappearances in the rumen. However, the method is incapable of handling large number of samples at a given time and is therefore of limited value for routine use in a forage screening program.

The Pressure Transducer Technique (PTT) described by Theodorou et al. (1993) is based on measurement of gas production from fermentation of forages incubated with rumen inoculum buffered medium. Gas production during microbial fermentation is an indirect measure of forage degradability (Menke and Steingass 1988). The method is the quickest and the cheapest in estimating the fermentation pattern of gas production. The potential of PTT method as compared with the Dacron method for ranking fermentation profiles of four groups of Ethiopian forages was studied (Zinash 1994). The forages studied were three groups of improved forages harvested at different cutting intervals and a fourth group of crop residues and their botanical compositions. The results indicated that the estimated parameters from PTT ranked the forages similar to the Dacron bag method.

The accuracy of any indirect method of forage evaluation relies on the ability of the method to provide results that are correlated to animal responses such as intake and digestibility. Hence, the objective of this study was to relate estimated values of parameters of forages obtained from PTT and Dacron bag methods to their intake using six forages.

Materials and Methods

Experimental Forages and Preparation

The study was conducted at Holetta Research Cenetr, IAR, Ethiopia. The forages used in the experiment were Panicum *(Panicum coloratum)* hay, hays from two cultivars of Phalaris (*Phalaris aquatica* "Sirroco"; *Phalaris aquatica* "Sirosa"), Rhodes grass (*Chloris gayana* Massaba) hay, hay from grazing pasture of mixed species and oat (*Avena sativa*) hay. Phalaris hay was harvested at 50% flowering stage; Panicum and Rhodes grass hays at full heading and oat at milk stage. Native grass hay was harvested in November 1992 from the permanent pasture area, usually reserved for hay making. Hay from grazing composed of mixed species. The major species were *Pennisetum adones* (23.4%), *Andropgen abyssunicus* (12.3%), *Eleucine flocifolia* (11%), *Hyparrhenia rufa* (9.4), *Pennisetum schimperi* (10.9%), native clover (2.5%), and others (30.5%) (Alemu Taddesse, pers. comm). The forages were baled and stored under open-sided barn.

Animals and Management

Thirty-six (24 males and 12 females) local and crossbred (Menz x Awassi) Ethiopian highland sheep were stratified based on weight and sex, and allotted to the six forages at random. Four males and two females were assigned to each hay diet. The sheep were individually rationed 1.0 kg/day and fed twice daily at about 9.00 and 15.00 hr. During weighing the forage on offer, sub-sample was taken and pooled for a week for DM determinations. The sheep had free access to water and mineral block. The mineral block was purchased from the Third Livestock Project, Ministry of Agriculture (Ethiopia); each block weighing about 3 kg. Each block contained molasses 125 g, limestone 125 g, bone meal 1 kg, $CuSO_4$ 24 g, $MnSO_4$ 7.5 g, $ZnSO_4$ 20 g, $CoSO_4$ 0.25 mg and NaCl 1.25 kg (Third Livestock Project, pers. comm.). Daily forage on offer and refusal from each sheep was recorded for 30 days. Daily refusal from each sheep was removed at 7.00 hr and weighed. Daily refusal from each sheep was sub-sampled and bulked for one week for DM determination. The intake trial lasted for 22 days.

In Vivo DM Digestibility

Total faeces were collected into canvas bags harnessed to four male sheep. Faeces collection was done at 7.00 hours before feeding the animals. Daily forage on offer and refusals were measured, and the refusals were sub-sampled from each sheep for DM determinations. Faecal samples, about 10% of the daily total collection from each sheep, were put in a fan draft oven (Gallenkamp, UK) on the same day and dried at 65 °C for 48 hr for DM determination. The digestibility trial lasted for eight days.

In Vitro Gas Measurement Using PTT

Gas production from the six forages was determined using the PTT as described in Zinash (1994). The rumen fluid was withdrawn from six fistulated steers fitted with permanent rumen canulae. The incubation was done for 120 hr. At the end of the incubation period, the residue in each serum bottle was filtered using previously weighed Gooch crucibles (porosity 2) and dried over night at 65 °C. The volume of gas produced per g DM loss (Y, ml/g DM loss) was calculated by dividing the gas pool obtained from the equation by the weight DM loss (g DM loss/g DM incubated).

In Situ Dm Disappearance Determination Using Dacron Bag Method

The nylon bags filled with the test forages were suspended in the rumen of fistulated steers for 6, 28, 48, 72, 96 and 120 hr. The diet of the steers consisted of grass hay offered ad libitum from native pasture and 3 kg of noug seed cake offered in two equal meals per day.

Each bag (inner size 7.5 x 10.5 cm; pore size = 50 u) was filled with 3 g of air dry sample and was suspended in the rumen just prior to the morning feeding (07.00 h). At the end of each incubation time, the bags were removed from the rumen, immediately rinsed with cold water and washed by hand under running water until the effluent became clear. The clean washed bags were dried at 65 °C or for 48 hr, and weighed. Zero time washing DM loss was determined by washing the bags containing without rumen incubation. Duplicate bags were used for each forage sample.

Chemical Analysis

Samples of the six forages were analysed for DM, OM, and N contents according to AOAC (1980) and fiber contents (NDF, ADF and permanganate lignin) according to the procedures described by Goering and Van Soest (1970).

Statistical Analyses

The model proposed by France et al. (1993) was fitted to the exponential profile to estimate the rate and extent of gas production of the forages. In the model, rate of gas production is expressed by two fractional rates. A combined rate of gas production was calculated. The model by France et al. (1993) provides an estimate of effective gas production (EGAS) by combining all the parameters in a single equation. EGAS is an estimate of the amount of gas production from the forage degraded in the rumen and was calculated with an assumed ruminal passage rate.

In the Dacron bag method, the DM degradation constants were obtained after fitting the data to the exponential model described by Orskov and McDonald (1979). Effective DM disappearance (EDMD) of the forages was calculated with a passage rate of 0.02/hr.

Linear and multiple regression analyses were made on the relationships between DM intake and the estimated parameters obtained from PTT and Dacron bag methods and chemical compositions (SAS 1985).

Results and Discussions

DM Intake and In Vivo DM Digestibility

Chemical analyses, DM intake (g/M$^{0.75}$.d) and in vivo digestibility of the six forages are shown in Table 1. The DM intake (g/M$^{0.75}$.d) ranged from 51.8 (Rhodes grass hay) to 60.8 (Phalaris hay1). The in vivo DM digestibility of the forages varied from 54.2 (Rhodes grass hay) to 65.9 (Phalaris hay2) g DMD/100 g DM (Table 1).

Prediction of DM intake from chemical compositions and estimated parameters obtained from PTT and Dacron bag methods The mean gas production (ml/g DM) at 24, 48 and 96 hr incubation time is shown in Table 2. Gas production from oat hay was higher than the gas production from the other forages.

Table 1. **Chemical composition (g/100 g DM), DM intake ($g/M^{0.75}.d$) and in vivo DM digestibility of the six forages**

Forage	DM (g/100 g)	*Chemical composition (g/100 g DM)* OM	N	NDF	ADF	$KmnO_4$	DM intake ($g/M^{0.75}$ .d)	In vivo DMD (g/100 g DM)
Panicum coloratum	97	90	1.3	66	43	8	53.9 ± 0.616	54.8 ± 0.60
Phalaris aquatica "Sirroco"	97	91	1.5	60	40	4	60.7 ± 0.509	65.9 ± 0.61
P. aquatica "Sirosa"	97	89	1.4	63	38	6	55.6 ± 0.584	61.0 ± 1.20
Rhodes grass hay	96	93	1.1	76	50	6	51.8 ± 0.696	54.2 ± 0.63
Hay from grazing pasture	96	93	1.5	71	43	8	53.9 ± 0.619	62.2 ± 0.75
Oat hay	96	92	1.4	74	44	8	54.2 ± 0.666	58.8 ± 0.6

Table 2. **Gas production of forages (ml/g DM) at different incubation time**

Forage	Gas production (ml/g DM[1]) at different incubation-times		
	24 hr	48 hr	120 hr
Panicum hay	143 ± 3.0	207 ± 2.9	244 ± 1.8
Phalaris hay1	69 ± 2.8	247 ± 3.0	289 ± 2.0
Phalaris hay2	75 ± 2.1	259 ± 2.2	308 ± 2.0
Rhodes grass hay	149 ± 2.6	207 ± 2.3	250 ± 1.9
Oat hay	198 ± 2.4	269 ± 2.3	309 ± 1.9
Native hay from grazing pasture	161 ± 2.3	238 ± 2.5	288 ± 2.0

[1] Mean of four serum bottles

The estimated parameters of gas production and in situ DM disappearance of the hays are shown in tables 3 and 4, respectively. The rate of gas production (m) ranged from 0.032 to 0.048. Linear or multiple regression equations and R^2 derived from the equations in predicting DM intake from in vivo DMD, NDF content and estimated parameters obtained from PTT and Dacron bag methods are given in Table 5.

DM intake was significantly related to NDF content ($P < 0.05$, $R^2 = 0.62$), in vivo DM digestibility ($P < 0.05$, $R^2 = 0.66$) and the estimated parameters obtained from PTT ($P < 0.05$, $R^2 = 0.78$) and Dacron bag methods ($P < 0.05$, $R^2 = 0.78$). However, prediction of DM intake from the estimated parameters obtained from PTT and Dacron bag methods was more accurate ($P < 0.05$), than prediction of intake from NDF content (Table 5).

Table 5 indicates that only EGAS obtained from PTT could be used in predicting DM intake ($P < 0.05$). The relationships between rate of gas production (m) and DM intake was not significant ($P > 0.05$). Of the estimated parameters obtained from Dacron bag method, rate of in situ DM disappearance was the most closely related to DM intake ($P < 0.05$). DM intake was not related ($P > 0.05$) with in situ DM disappearance parameters of A, B and c, when used as factors in multiple linear regression.

Table 3. Estimated parameters of gas production and SE of six grass hays measured for intake and digestibility

	Estimated and derived parameters						
Forages	Q[1]	Z[1]	Gas pool[1] (ml)	Lag-time[1] (h)	Combined rate of gas production (m (/h))[2]	Y (ml/g DM loss)[3]	EGAS (ml/100 ml)[4]
Panicum hay	0.958 ± 0.0071	1.020 ± 0.048	246 ± 4.0	1.5 ± 0.40	0.048	379	43
Phalaris hay[1]	0.952 ± 0.0076	1.083 ± 0.0545	291 ± 3.7	1.2 ± 0.81	0.043	383	48
Phalaris hay[2]	0.956 ± 0.0080	1.060 ± 0.0640	311 ± 4.6	0.5 ± 0.82	0.040	428	46
Rhodes grass hay	0.972 ± 0.0071	0.941 ± 0.0535	255 ± 3.8	1.1 ± 0.63	0.032	396	42
Oat hay	0.965 ± 0.0072	0.945 ± 0.0552	311 ± 3.5	1.2 ± 0.90	0.040	475	45
Hay from grazing pasture	0.961 ± 0.0071	1.032 ± 0.0570	291 ± 3.5	0.5 ± 0.30	0.037	423	43

[1] The parameters were estimated from the equation of France et al. (1993).

[2] Combined rate of gas production (m) at 48 h incubation period was calculated as m (/hr) = b_f+(c_f2Öt)

[3] Y (ml/DM loss) = A fraction of the parameter/DM loss (g DM loss/100 g DM). [4] EGAS calculated with an assumed passage rate of 0.02/hr

Table 4. In situ DM disappearance from the nylon bags after incubation time and estimated parameters for six grass hays

	In situ DM disappearance (g/100 g) by Incubation time (h)						Estimated parameters[1]					EDMD (g DM disappearance
Forages	6	28	48	72	96	120	A	B	c	a+b	RSD	/100 g DM disappearance)[2]
Panicum hay	32	54	65	70	73	74	22	53	0.034	75	1.8	56
Phalaris hay[1]	40	63	72	76	78	80	29	50	0.041	79	1.2	63
Phalaris hay[2]	40	61	69	74	75	78	30	46	0.038	76		61
Rhodes grass hay	24	50	61	70	73	74	12	63	0.032	75	1.3	51
Oat hay	33	52	62	65	68	69	24	45	0.035	69	1.6	53
Hay from grazing pasture	32	58	68	74	76	78	21	57	0.037	78	1.3	58

[1] Parameters were estimated from the equation of Ørskov and McDonald (1979). A is the washing loss and B the insoluble but fermentable matter, B = (a + b)-A.

[2] EDMD was calculated with an assumed passage rate of 0.02/h.

There is evidence about the variability associated in intake of forages with fermentation pattern of forages (gas and DM disappearances) (Blümmel and Ørskov 1993, Khazaal et al. 1993). Other reports (Van Soest 1967 and Rohweder et al. 1978) showed that DM intake of forages can be predicted more accurately from NDF content. However, the relationship between intake and DM disappearance parameters or between intake and chemical composition are not consistent over the forages studied in the different references. Rohweder et al (1978) emphasised that the prediction of intake from NDF content varies between species and between forages grown at different locations. For example, for forages grown in temperate regions, the accuracy of predicting intake from NDF content is better than for forages obtained from tropical regions (Zinash 1994).

Table 5. Linear and multiple regression equations in predicting DM intake (g DM/M$^{0.75}$.d) using estimated parameters from PTT and Dacron bag methods and chemical composition (N and NDF contents)

Parameter	Equation	R^2	Level of significance
Rate of gas production (m,(/hr)	28.0(± 9.40) + 690.2(±239.16) m	0.5944	0.0448
EGAS (ml/100 ml)	-1.2(± 13.03) + 1.3(± 0.29)EGAS	0.7793	0.0125
Rate of in situ DM disappearance (/hr) (c)	24.1(± 7.70) + 852.1(± 211.58)DM	0.7527	0.0158
EDMD (g DM disappearance/100 g DM disappearance)	23.7(± 9.75) + 0.5(± 0.17)EDMD	0.6524	0.0322
In situ DM parameters of A, B, c	24.1(± 20.50) -0.1A(± 0.86) -0.1 (± 0.50)B + 10008.0(± 1036.10) c	0.5124	0.2778
In vivo DMD (g/100 g DM)	20.5(± 10.53) + 0.6(± 0.18) DMD	0.6604	0.0307
NDF content (g/100 g DM)	83.2 ± (9.39) - 0.4(± 0.14) NDF	0.6180	0.0394
N content (g/100 g)	36.5(± 10.28) + 13.5(± 7.48) N	0.3119	0.1450

There were differences in digestibility of the forages at the same level of intake (Table 1). This could be responsible for low prediction of intake from DM digestibility of the forages. Other reports have also shown the same results (Milford and Minson 1966, Hovell et al. 1986 and Khazaal et al. 1993). Milford and Minson (1966) concluded that digestibility is not always a good predictor of intake of tropical grasses. This indicated that factors other than digestibility per se involved in diet voluntary intake of some of the forages.

From the data presented in literatures (Ørskov et al. 1988, Von Keyserlingk and Mathison 1989, Carro et al. 1991, Nandra et al. 1993, Khazaal et al. 1993, Blümmel and Ørskov 1993, Kibon and Ørskov 1993), regression analyses on the relationships between intake and estimated parameters obtained by PTT (EGAS) and Dacron bag method (EDMD) and chemical composition (N, NDF) were made. Based on the regression coefficient (R^2) obtained from the regression equation as well as the level of significance, prediction of intake using Dacron bag method was not consistent across the cited references. In agreement with the present results, Carro et al (1991) found that from the estimated parameters of DM disappearances, rate of in situ DM disappearance was the parameter from which the intake of the forages can be predicted. Other reports, however, showed significant relationships between potential DM disappearance (a + b) (Hovell et al. 1986) or in situ DM disappearance fitted of constants (Ørskov et al. 1988 and Khazaal et al 1993). It was suggested (Hovell et al. 1986, and Carro et al. (1991) that further research is required to examine whether different parameter are needed to predict intake of different forages.

Only few reports were available on prediction of intake of forages from their estimated parameters of gas production (Blümmel and Ørskov 1993, and Khazaal et al. 1993) or volume of gas production of forages after short incubation time (24 to 48 hr) (Kibon and Ørskov 1993). The EGAS calculated from the data of Blümmel and Ørskov (1993) and Khazaal et al. (1993) was significantly ($P < 0.01$) related to intake.

The relationships between EGAS and DM intake presented in this study are in agreement with other results (Blümmel and Ørskov 1993, and Khazaal et al. 1993). Blümmel and Ørskov

(1993) and Khazaal et al. (1993) did not use the parameter EGAS in predicting intake, but the data reported in these references were used to analyse the relationship between DM intake and EGAS (Zinash 1994). Kibon and Ørskov (1993) studied the relationship between intake and gas production and they reported that volume of gas production recorded between 24 to 48 hr explained 87% of the variation in intake of browse trees.

Conclusions

The present study only used six types of forages and the regression equations derived were based on data of low range of DM intake. However, bearing in the limited range of data, the results indicated the potential of PTT in predicting intake of forages. In addition, PTT can also be used in estimating in vivo DM digestibility of the forages 90% of the variation in in vivo DM digestibility of the six forages was explained by EGAS. PTT, therefore, has a distinct advantage over two-stage in vitro Tilley and Terry 1963 in that it is capable of predicting both intake and digestibility.

EGAS might be expected to rank the forages according to their ease of digestion and intake. More data are, however, needed to confirm whether EGAS can be used in predicting intake of wide range of forages in Ethiopia.

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EFFECT OF CULTIVAR AND FERTILIZER APPLICATION ON YIELD AND QUALITY OF BARLEY STRAW

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ABSTRACT

A total of 13 cultivars of barley land races and improved varieties consisting of 6 late maturing types at three sites and 7 early maturing ones at one site were established with and without fertilizer application to study the effect of cultivar and fertilizer application on yield and quality of barley straw. Site specific comparisons were made to detect the influences of the factors under study on yield, CP content and in vitro digestibility (IVOMD) of the straw and the association between grain yield and straw quality was quantified using correlation analysis. Cultivars were ranked from best to worst based on potential utility index (PUI). The cultivars varied significantly ($p < 0.01$) in CP content and IVOMD at all sites. Differences noted among cultivars varied from 6–9% in IVOMD, 0.0–0.16 t/ha in straw yield and 3–27% in PUI. Fertilization had a major influence on straw yield than straw quality and PUI. Ranking of cultivars using PUI was affected more by site than fertilizer application. Grain yield and straw quality (CP, IVOMD) were poorly ($r = -0.14-0.22$) related at all test sites. Consistencies in varietal differences and association between straw quality and agronomic merits need to be studied further.

Introduction

The use of straw as livestock feed has been recognized probably since the time when man started arable cropping. However, crop residues are still poorly utilized owing to their low nutrient density, low digestibility, low propionate fermentation pattern and low voluntary intake. Various strategies have been attempted to upgrade utilization of these abundant feed resources. Currently the emerging trend is the option to exploit varietal differences in straw quality. The effort made in this direction has produced variable results. Some authors (Orskov 1986 and White et al. 1981) have reported substantial differences while others (Kernan et al. 1979, Pearce 1983 and Seyoum and Zinash 1995) reported small or no differences at all. Under situation where substantial differences were reported, there was no strong association between grain yield and straw quality giving opportunity to select cultivar with higher straw quality without sacrificing grain yield.

In addition to genetic contribution, a number of environmental factors may affect quality of the straw through the morphological development of the plant by influencing rate of growth, the amounts of the various tissues produced and the time of maturation. The factors involved include soil fertility, fertilizer application, time of sowing, time of grain harvest, amount of rainfall, temperature range and incidence and severity of disease

(Pearce 1983). These factors have not been studied in detail in relation to the nutritive value of crop residues and therefore the nature of their possible effects are largely speculative.

Under local condition no attempt has been made to detect varietal differences among barley land races and the contribution of non-genetic factors to the yield and quality of the straw is not known. This report comprehensively describes varietal differences in straw yield and quality in the presence or absence of fertilizer application.

Materials and Methods

Data were collected from on-farm barley cultivar trial late set (Trial 1) sown at Robegebeya, Altufa and Adeberga and early set (Trial 2) sown at Degem during the 1995 cropping season. Trial 1 was composed of six cultivars of either land races or improved varieties including local check and Trail 2 included 7 cultivars of either land races or improved cultivars. The materials were planted on 3 replications with (F1) and without (F0) fertilizer application in a spilt plot design (fertilizer as main plot and cultivar as subplot) on farmers field using plot sizes of 3 m^2 (1.2 m 2.5 m, 6 rows at 20 cm spacing), seed rate of 85 kg/ha and fertilizer applied at the rate of 41/46 (N/P_2O_5/kg) per ha.

Above ground biomass yield data were taken and straw yield was calculated as a difference between biomass and grain yield. About 0.5 kg straw sample was taken upon threshing from each plot and prepared for lab analysis. Crude protein content was determined using the procedure of AOAC (1975) and IVOMD was determined according to the procedures of Tilley and Terry (1963). Site specific comparisons were made to detect cultivar differences and the influence of fertilizer application on the yield and quality of barley straw. Simple correlation analysis was performed to detect association between grain yield and straw quality.

Results and Discussion

Trial 1: Late Set

At Robegebeya, cultivar fertilizer interaction had significant ($p < 0.01$) effect on straw yield of barley straw (Table 1). Cultivar had significant ($p < 0.01$) effect on straw yield, crude protein (CP) content and in vitro digestibility (IVOMD) of straw. In the absence of fertilizer application, Baleme had the highest straw yield followed by local check and Senef kollo was the best in terms of CP. When fertilizer was applied, three cultivars HB-42, Baleme, and Luyita had higher straw yield than the local check. Three cultivars (Senefkollo, Luyita and 3336-20) had higher CP than the local check and the mean of all cultivars.

Table 1. Effect of cultivar and fertilizer on straw yield and quality of barley grown at Robegebeya (late set, 1995)

	Straw (t/ha)		CP (%)		IVOMD	
Cultivar	FO	F1	FO	F1	FO	F1
Luyita	0.49	1.32	4.5	4.6	50.01	49.44
Senef Kollo	0.34	0.55	5.1	5.3	49.72	47.99
Baleme	0.89	1.69	4.3	4.0	47.95	47.61
3336-20	0.56	1.10	4.4	4.6	50.06	49.98
HB-42	0.74	2.29	3.6	3.8	47.45	46.87
Local check	0.81	0.67	3.1	2.8	44.18	40.58
Mean	0.64	1.10	4.2	4.18	48.23	46.91
F-TEST PROBABILITIES						
Fetilizer		**		NS		**
Cultivar		***		**		***
Culltivar * Fertilizer		**		NS		NS

F0 = with out fertilizer
F1 = with fertilizer

Potential utility index and ranking of barley cultivars grown at Adeberga is given in Table 2. Under low input condition, the three best cultivars were Senef kollo, Luyita and Baleme while under high input condition cultivar 3336-20, Senef Kollo and Beleme were the best.

At Altufa, cultivar fertilizer interaction had significant effect on CP and IVOMD (Table 3). Under low input condition, improved cultivars HB-42 and 3336-20 had higher straw yield than land races. In terms of straw quality, Baleme had the highest IVOMD followed by local check. Under high input condition again, Baleme had the highest straw yield, IVOMD and CP content.

Potential utility index (PUI) and ranking of cultivars with and without fertilizer at Altufa is shown in Table 4. The three best cultivars without fertilizer application were Baleme, 3336-20 and local check while under fertilizer application the best ciltivars were Baleme, HB-42 and local check.

Table 2. Potential utility index (PUI) and ranking of barley cultivars with and without fertilizer application at Robegeya (late set, 1995)

	Without fertilizer		With fertilizer	
Cultivar	PUI	Rank	PUI	Rank
Luyita	60.3	2	62.3	4
Senef Kollo	63.3	1	64.1	2
Baleme	59.1	2	63.6	3
3336-20	54.1	5	67.4	1
HB-42	54.6	4	62.2	5
Local check	49.3	6	60.7	6
Mean	56.8		63.4	

Table 3. The effect of cultivar and fertilizer application on straw yield and quality of barley grown at Altufa (late set 1995)

	Straw (t/ha)		CP (%)		IVOMD	
	FO	F1	FO	F1	F1	FO
Luyita	3.84	8.09	3.1	3.3	40.87	40.24
Senef Kollo	4.28	8.74	3.1	3.0	42.88	41.20
Baleme	4.28	9.66	3.5	3.8	48.99	44.99
3336-20	4.46	8.97	3.0	3.3	42.81	42.85
HB-42	5.60	8.48	2.6	3.1	40.39	42.33
Local check	3.50	8.88	3.7	4.0	43.93	43.37
Mean	4.33	8.80	3.2	3.42	43.23	42.50
F-test probabilities		*		NS		NS
Feritlizer		NS		***		***
Cultivar		NS		*		*
Cultivar * Fertilizer						

Table 4. Potential utility index and ranking of barley cultivars with and without fertilizer application at Altufa (late set, 1995)

	Without fertilizer		With fertilizer	
Cultivar	PUI	Rank	PUI	Rank
Luyita	49.8	6	50.3	6
Senef Kollo	52.5	4	53.0	4
Baleme	60.1	1	55.8	1
3336-20	56.0	2	52.7	5
HB-42	51.3	5	54.8	2
Local check	54.5	3	54.5	3
Mean	54.0		53.5	

At Adeberga, culitivar had a significant effect on CP content of straw (Table 5). Under low input condition, local check had the highest straw yield followed by Luyita and Baleme. Under high input condition, the three best cultivars in terms of straw yield were cultivar 3336-20, Luyita and HB-42. Two cultivars (Luyita and Senef Kollo) had higher CP content than local check.

Trial 2. Early Set

At Degem, cultivar * fertilizer interaction had a significant ($p < 0.01$) effect on straw yield and IVOMD and the cultivars tested varied significantly ($p < 0.01$) in yield, CP content and IVOMD (Table 4). Under low input condition three cultivars (local check, Shasho and

HB-42 had) higher straw yield than the mean of all cultivars. In terms of straw quality the three best cultivars were Arusobale, local check and Aybogebs. Under high input condition, HB-42 had the highest straw yield followed by Shasho and 3336-20. In terms of straw quality Aruso Bale and Somie were the best cultivars followed by Shaso

Potential utility index and rankings of barley cultivars are shown in Table 7. Under low in put condition the best cultivar was Senef Kollo followed by Luyita and Baleme, while under high input condition 3336-20 was the best followed by Senef Kollo and Beleme.

Table 5. **The effect of cultivar and fertilizer level on the straw yield and quality of barley land races grown at Adeberga (late set, 1995)**

	Straw (t/ha)		*CP (%)*	
Cultivar	FO	F1	FO	F1
Luyita	1.44	3.41	3.8	4.1
Senef Kollo	1.00	2.27	5.3	4.8
Baleme	1.38	3.22	4.0	3.8
3336-20	1.28	3.48	3.5	3.6
HB-42	1.10	3.38	3.0	3.9
Local check	1.60	3.23	3.5	3.5
Mean	1.30	3.16	3.9	3.95
F-test probabilities				
Fertilizer		NS		NS
Cultivar		NS		***
Cultivar * Fertilizer		NS		NS

Table 6. **Effect of cultivar and fertilizer levels on straw yield and quality of barley grown at Degem (early set, 1995)**

	Straw (t/ha)		CP (%)		IVDM	
Cultivar	FO	F1	FO	F1	F1	FO
Local check	1.21	0.76	3.15	2.41	48.61	46.01
Aybo gebs	0.15	0.91	3.41	2.84	48.42	44.56
Arusobale	0.19	0.48	3.47	3.04	48.67	49.81
Somie	0.20	0.42	3.34	3.43	46.64	48.62
HB-42	0.97	2.04	2.91	2.35	42.37	42.39
3336-20	0.60	1.67	3.12	2.25	46.49	43.29
Shasho	1.07	1.72	3.44	3.57	46.96	46.68
Mean	0.63	1.14	3.26	2.84	46.88	45.78
F-TEST PROBABILITIES						
Fertilizer		NS		NS		NS
Cultivar		**		**		***
Cultivar * Fertilizer		NS		NS		**

Table 7. Potential utility index (PUI) and ranking of barley cultivars with and without fertilizer application at Degem, 1995

Cultivar	Straw (t/ha)		CP (%)	
	FO	F1	FO	F1
Local check	56.9	5	72.6	1
Aybo gebs	70.0	3	67.3	4
Arusobale	76.7	2	70.0	3
Somie	79.4	1	72.3	2
HB-42	52.1	7	51.0	6
3336-20	59.0	4	49.7	7
Shasho	54.0	6	56.4	5
Mean	64.0		62.8	

Consistencies in ranking of cultivars across locations and management type are given Table 8. Ranking of cultivars was inconsistent across locations and management type. Under low input condition at Adeberga, Luyita ranked second while the same cultivar ranked last at Altufa under similar management. The ranking position of cultivars like Senef Kollo and Baleme were not affected by management type while the ranking of 3336-20 was remarkably affected by management type.

The association between straw yield and quality with grain yield is shown in Table 9. Straw yield was positively related to grain yield both at Robe gebeya and Altufa. Straw quality had no strong association with grain yield across sites.

The above findings suggest that varietal differences in straw yield, quality and puls are evident. Differences noted among cultivars varied from 6 to 9% in IVOMD, 0.0–1.6 t/ha in straw yield and 3–27% in PUI. Fertilizer application had a major influence on straw yield than straw quality and PUI. Improvement in straw yield was 81–143% as compared to unfertilized plots. Rankings of cultivars using PUI was affected by site than fertilizer application. Association of grain yield and straw yield and quality suggest that it is possible to select cultivar which can combine both grain yield, straw quality and yield. Consistencies of varietal differences and association between straw quality and agronomic merits need to be investigated further.

Table 8. Consistencies in ranking of cultivars across locations and management type

Cultivar	Straw (t/ha)		CP (%)	
	Adeberga	Altufa	Adeberga	Altufa
Luyita	2	6	4	6
Senef Kollo	1	4	2	4
Baleme	3	1	3	1
3336-20	5	2	1	5
HB-42	4	5	5	2
Local check	6	3	6	3

Table 9. Association (r) between straw yield and quality with grain yield of barley

Site	n	Parameter	r
Robe gebeya	12	Straw yield	0.86
		CP	-0.17
		IVOMD	-0.14
Altufa	12	Straw yield	0.94
		CP	0.14
		IVOMD	0.22

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FEEDLOT PERFORMANCE OF CROSSBRED BULL CALVES FEED ON DIFFERENT CONCENTRATE TO ROUGHAGE RATION

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ABSTRACT

A study on the feedlot performance of crossbred bull calves fed on three different rations of concentrate to roughage ratio ((75:25) Ration A, (50:50) Ration B, and 25:75) Ration C) was conducted using 8-month old crossbred bull calves. Final weight and average daily grain (ADG) significantly ($P < 0.01$) increased as the ration of concentrate in the ration increased: 184.8 ± 7.6, 172.2 ± 7.6, 153.2 ± 7.6 kg for the final weight, and 820 ± 5.6, 456 ± 5.6 g. for ADG, respectively. The feed conversion efficiency (FCE) was 6.1, 7.2, and 12 kg/kg of weight gain in the rations A, B, and C, respectively. Partial budget analysis showed that the net return per animal was higher for animals fed on Ration A (Birr 53.45) than Ration B (Birr 34.22), while the animals fed on Ration C had the negative return (Birr-22.80). Thus it is concluded that fattening crossbred bull calves in shorter period need to depend largely on increased level of concentrate feed and lower level of roughage in the ration both for biological and economic advantages.

Key words: crossbred, feedlot, bull calves.

Introduction

The fact that a great proportion of beef comes from overworked old oxen, culled cows, and few young bulls indicates that beef production in Ethiopia is lower both in quality and quantity. The lower production level can definitely have a negative impact on domestic beef consumption and foreign exchange earnings. Despite the huge livestock population of the country, the contribution of meat and meat products to Ethiopian economy is less than 1% compared to other commodities Zewdu et al. 1989). Among other constraints encountered in beef production in Ethiopia, lack of proper fattening and /or finishing system before marketing can be considered as the major one.

Several studies were conducted to evaluate the fattening or finishing performance of some local and their crosses with exotic breed under different feeding systems at the Institute of agricultural Research (O'Donovan et al. 1989, O'Donovan 1979, O'Donovan et al. 1978 and IAR 1976) and other institutions. In most cases the works dealt with steers, heifers and bulls. Fattening or finishing young culled bull calves from the dairy enterprise was not commonly practised in Ethiopia.

The general trend towards liberalization of domestic market, control in Ethiopia and the increased urbanisation are raising domestic milk market demand (Stall and Shapiro 1996). Consequently, high grade and crossbred cows are being well popularised in the urban and per-urban dairy production systems. In this system, more attention is paid to reserve female calves for replacement or rear them to sell for high price. Obviously male calves are the object of meat production. The situations in the urban and per-urban dairy production systems, such as limitations of feed and space are forcing producers to cull male calves at younger age and sell them at a very low price. But the growth potential of these animals could be exploited for increased good quality beef production if proper management interventions are made.

The objective of this work is to evaluate the feedlot performance of culled bull calves on different proportions of concentrate to roughage and to make preliminary observations on the economic aspects of finishing this category of animals before marketing.

Material and Methods

Animals and management. Eighteen crossbred male calves born from Borane cows (dam breed) and Friesian or Jersey (sire breed) at Holetta were used. During the pre-weaning period, calves were offered 3 kg/day colostrum for 4 days and 260 kg of whole milk for 94 days. They also had access to good native grass had adlibitum and some concentrate feed starting from two weeks after birth of adaptation to solid feed supplemented with 1 kg of concentrate feed consisting of wheat bran 30%, wheat middling 33%, noug cake 30%, bone meal 3%, meat meal 30%, and salt 1%. At the age of 8 months 7-9 calves were stratified according to their weight and were randomly assigned to one of three experimental diets (Table 1) composed of concentrate to roughage ratio of 75:25 (Ratio A); 50:50 (Ration B) and 25:75 (Ration C).

Table 1. Total feed offered, refused, and intake per feeding treatment

Ration: % of concentrate :hay	No. of animals	Concentrate (kg)			Hay (kg)			Total (kg)
		Offered	Refused	Intake	Offered	Refused	Intake	
(A) 75 : 25	6	439.4	75.0	364.4	147.7	25.1	122.6	487.0
(B) 50 : 50	6	239.9	12.2	227.7	239.9	98.3	204.6	432.3
(C) 25 : 75	6	143.2	0.9	142.3	426.6	122.8	303.8	446.1

Feed was offered at the rate 2% of their initial body weight as feed on individual feeding bases, and was adjusted every 15 days based on liveweight changes and the amount of feed refused during this period. If the total refusal was more than 10% of the total feed offered, no additional increment was made. But if the refusal was less than 10%, allowance of 10% was made for the next 15 days. The amount of hay for the day was divided into two half of the feed was offered in the morning and half in the afternoon. Feed refusal was measured and recorded every morning. The feed consumption during the experimental period is shown in Table 1. Body weight measurements were and recorded every fortnight. A rehearsal period of two weeks was allowed before the 90-day experimental period.

Economic Parameters

There farmers from Holetta area who were believed to have experience in the price of animals estimated the initial and final price of calves. Farmers evaluated the calves individually by looking at the condition of each calf. The average price estimated by the three farmers at the start of the experiment was considered as initial price of the calves and the same procedure was followed to estimate the selling price of the calves at the termination of the experiment.

The cost of feed (concentrate at the rate of Birr 0.70/kg and hay at Birr 0.35/kg) was calculated as the proportion of concentrate to roughage ration consumed. The labor cost was calculated at the rate of Birr 3.00/day paid for two daily laborers for 90 days. Medication was estimated as the price of drugs used to treat the animals during the experimental period only.

Statical Analysis

Least-squares procedure of Harvey (1990) was used. The model incorporated feeding treatments as class variable and weight of calves at the interval of 14 days as dependent variable. Average daily gain (ADG) was calculated as coefficient of regression over the weighing periods and was included in the model as dependent variable. Feed conversion efficiency (FCE) was calculated as the relationship of total feed consumed by individual animal for a kilogram weight gain and included in the model as dependent variable.

Results and Discussion

The final weight and the average daily gain (ADG) increased as the ration of concentrate in the ration was increased: 184.8 ± 7.6, 179.2 ± 7.6, 153.2 ± 7.6 kg final gain 820 ± 51, 733 ± 51, 456 ± 51 g average daily gain (ADG) for Ration A, Ration B, and Ration C, respectively (Table 2). The increased level of concentrate in the ration initiated better intake (Table 1) and the feed conversion efficiency (g of feed /g gain) was also improved (Table 2).

The comparatively lower growth performance of calves on Ration C could be due to the fact that they were not getting their protein requirement for faster growth as sufficient as those in groups A and B, because of lower concentrate level in the ration. The overall

ADG and feed conversion efficiency obtained in this study followed similar pattern of previous results obtained from fattening crossbred bulls (O'Donovan 1980 and O'Donovan 1979) on varying levels of concentrate and hay in the diet. Borane and Horro crossbred bulls fed on adlibitum hay and supplemented with 3–4 kg/day of concentrate gained 600–800 g/day (O'Donovan 1980).

Changes in the daily growth rate of calves due to differences in the ration were clearly observed at the fourth week of the beginning of the experimental period being highly pronounced starting from the tenth week. The variation of growth rate between the treatments at this period was also highly significant ($p < 0.001$) (Figure 1).

Table 2. **Least square means and standard errors of live weight, average daily gain, feed conversion efficiency and daily feed intake of bull calves.**

Trait	Ration A	Ration B	Ration C
Number of Animals	6	6	6
Initial weight (kg)	112.8 ± 4.8	112.8 ± 4.8	112.8 ± 4.8
Final weight (kg)	184.8 ± 7.6^{a}	179.2 ± 76 ^{a}	153.2 ± 7.6^{b}
Average daily gain (g)	820 ± 51^{a}	733 ± 51^{a}	456 ± 51^{b}
Feed conversion efficiency (kg feed/kg gain)	6.7 ± 1.1^{a}	7.2 ± 1.1^{a}	12.0 ± 1.1^{b}
Daily feed intake/calf			
Hay (kg)	1.3	2.1	3.4
Concentrate (kg)	3.4	2.8	1.4
Total (kg)	4.7	4.9	4.8

Within row means with different superscript are significantly different ($p < 0.01$)

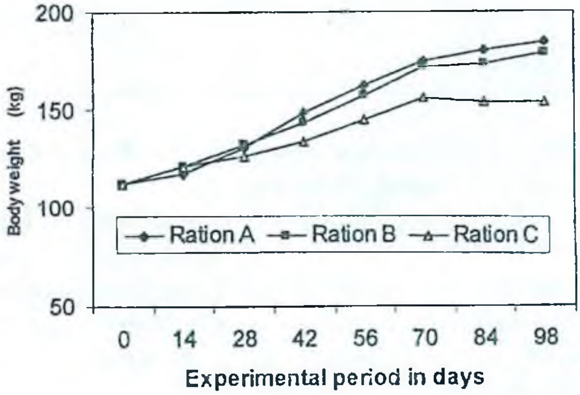

Figure 1. Change in body weight of calves feed on different rations

Simple economic analysis made to evaluate the three rations for fattening young bull calves showed that net return per animal was higher for the animals fed on ration A (Birr 53.45), followed by the net return from animals fed on ration B (Birr 32.22). The practice of feeding high proportion of roughage than concentrate ration to finish young bull calves (Ration C), was found to be a loss (Birr-22.80/animal) (Table 3). Obviously the differences in the net return per animal was the reflection of differences in the body condition of the animals expressed by the quality of feed at the period of the termination of the experiment. This influenced the estimation of the selling price of calves.

Table 3. Partial budget analysis of finishing bull calves on three different rations (in Ethiopian Birr)

Item	Ration A	Ration B	Ration C
Number of calves	6	6	6
Estimated initial total cost of calves	744.72	744.72	744.72
Average cost of one calf	124.12	124.12	124.12
OPERATIONS COST			
Feed	238.36	268.97	206.10
Labor	180.00	180.00	180.00
Medication	21.00	21.00	21.00
Total	484.36	469.97	407.10
Average selling price	258.30	236.37	169.17
Gross return	1549.80	1420.02	1015.02
Net return	1549.80	1420.02	1015.02
Gross return/animal	177.57	158.34	101.32
Net return/animal	53.45	34.22	-22.80
Marginal rate of return	3.20	3.02	2.49

As it has been reflected in the results of this study, finishing should largely depend on the high level of concentrate feeding, than roughage in the ration. The biological and economical feasibility of fattening or finishing young animals on higher proportions of roughage to concentrate feeding seems to be very low. Thus, in the urban or per-urban dairy production systems excess young culled male calves from the dairy enterprise can be successfully fattened or finished on 50:50 or higher concentrate level to roughage ration in the ration at the rate of 2% of their body weight in the subsequent growth rate for better biological and economic return.

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UTILIZATION OF ENSET *(Ensete Ventricosum)* PLANT AS LIVESTOCK FEED IN GURAGE ZONE

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ABSTRACT

Participatory rural appraisal based survey was carried out in five villages in Gurage Zone, southwest Shewa, that focused on enset varieties and use in the farming system. A total of 113 households were included in the survey. The survey mainly focused on the varieties, distribution, cultivation and utilization of enset in the area. A wealth ranking of the households based on the number of enset plants in the homestead, which was the measure used for wealth in the area, was carried out. There were 36 different varieties of enset found in the study area out of which 12 were commonly found in all the five villages. In all villages, though enset was primarily grown for human consumption, it also was used as feed for animals during the dry season, mainly the leaves but also the pseudostem. The size of the plot for enset and the number of enset plants owned by each household were very different between households. Very rich households had more than 800 enset plants, the greater part of which were older plants which are more valuable.

Keywords: enset, feed, food

Introduction

Enset (*Ensete ventricosum*), native to Ethiopia, is found in most or all farms in the south and southwest part of the country. It is considered as tolerant to drought (Taye and Asrat 1966, Shack 1966, Westphal 1975) and plays an important role in the cultural identity of the group of people who grow it. Hence, it has acquired a special place in the rain-fed areas due to its better tolerance of unfavorable soil moisture conditions.

At the present situation, this plant and activities related to it are being promoted by the government. This is with an understanding that the production of enset in the enset growing region and the adoption of such practise in other parts of the country will help to back-up the smallholder farmers during unfavorable environmental condition as is the livestock a principal buffer in time of crop failure. Non-equilibrium environmental circumstance (Behnke and Scoones 1991) is the case that occurs more frequently in this country.

Enset production has remained important in the enset growing regions for a number of generations and has a cultural importance to serve as source of food for humans. That is, an on time value as source of food for humans, particularly for the household. It is no wonder, then, that enset has a special place in the socio-cultural structure of the society, besides being an important resource. These values have brought the consideration for enset to be one national commodity crop in the newly structured Ethiopian Agricultural Research Organization (EARO).

Enset is primarily processed by women. The male farmers involve only in the land preparation, weeding and occasional transplanting of the plant at different ages within the plot. The propagation in enset is vegetative.

Thought early studies on the enset have already established its high-yielding potential which has stimulated the interest of this study, the study was conducted with the following objectives:

- to investigate and describe the present utilization of enset in the area
- to make a varietal mapping
- to observe the importance of enset as an animal feed and for human uses, i.e., to describe the alternative uses of enset.

Materials and Methods

Site Characteristics

This survey was conducted in the Gurage Zone at Asinawra Kebele, 225 km southwest of the capital. This kebele has ten villages. Akuban, Asinawra, Daya, Dien, Gebabo, Gedelo, Kibo, Anshat, Geza and Yimauj. Asinawra kebele has an average altitude of 2963 m (Figure 1). According to the classification given by Westphal (1975), the study area can be categorized as 'daga' and the area have a diversified vegetation: tuber, enset (the major crop) and potato; pulses , peas and beans; cereals, barley and wheat; tree, eucalyptus and pit trees; vegetable, the Ethiopian cabbage cultivated by the inhabitants. In general the landscape is undulated in the enset growing region, as do the Ethiopian plateau (Westphal 1975).

The predominant language is Guraghigna (Guragic), and to some extent Amharic is spoken by few people. The only institution that is found in the Kebele is a small primary school. All the inhabitants are Christians that follow the Ethiopian Orthodox Church denomination.

Site Selection

Selection of the site was started in the Gurage Zone which consists of eleven weredas. Sodo, Meskan and Mareko, Lanfero, silti, Kokir, Dalocha, Gumer, Eza and Wolene, Goro, Cheha, and Inemor and Eaner. From these weredas Eza and Wolene were selected. Within the wereda there are three distinct groups. Eza, Moher and Wolene. From these distinct groups, Moher was selected. In Moher, there are sixty-one kebeles. Out of these kebeles, Asinawra kebele was selected as the final experimental site for the experiment to make an observation on the different components of the study. Selection was done randomly.

Village Mapping

Mapping was done by the local people composed of two groups (farmers: male and female, and primary school students and teachers). It was as sort of competition between the groups. In both cases, the map (Figure 1) was first drawn on the ground, then redrawn on paper.

Village Walk

This was done to make a talk with some farmers at the spot of their farm. This was helpful to get practical information and more appropriate to talk about practical problem of the farms in the area.

Figure 1. Map showing area and altitude of the study villages

Varietal Mapping

It was done, by listing the commonly available enset variety in the respective village, by the local farmer (Table 1). Then the verietal map was fitted to the village map and shown to the villagers in order to get comments and to comment one over the other village by using the map.

Regarding the present utilization of enset, observation was made on:

- the present use of the enset crop as feed for ruminant animals in combination with, when and how different feed resources available. Also the different use pattens.
- the amount given and amendments made for lactating cows, non-lactating cows, young ruminants and working animals, especially oxen. This was done by scoring.
- the part of the plant (fraction of the plant) used for ruminants and that for human, etc., as a competing use component.

This was done by raising questions and by making observation on time. This was done equally by interaction with the female and male farmers plus the family members participation.

Results and Discussion

A number of different varieties of enset were grown in the farms to satisfy the demand for quality and quantity of enset products for human food, medicinal value and livestock feed. A total of thirty-six different varieties of enset were fund in the surveyed villages. The local name and their rank of relative abundance is presented in Table 1.

Table 1. **The relative abundance of the different varieties of enset and their local names**

Variety	Ranking based on abundance
Agade, Badedate, Lemat	*****
Ankefuye, Ferezye, Ginjiwe, Ginbwe	****
Guarye, Kanchwe, Terye, Yedibrye, Zubre	***
Ashatye, Benezye, Derye, Imerye, Kewerety, Kibnar, Nechwe Sinwe, Yekeswe, Yeshra-frye	**
Arat, Astara, Boseretye, Dem-awraj, Derwetye, Gezwet Goje-mura, Inba, Key-amoratye, Mishrat, Sebara, Tikur-amoratye, Yiregye, Yeshia-kinke	*

***** indicates the highly abundant varieties, whereas * indicates the least occurring varieties

Among the varieties listed in the Table 1, 12 were present in all the surveyed villages in common.

Distribution and age structure of enset

The age structure of the enset plants in an enset plot and the average number of enset plants per household in each village are presented in Table 2.

Table 2. Age structure of enset plantation in five villages in Asinawra keble, Gurage Zone

Village	Average number of enset plants in different age (years) group							Total	Sample no.
	0–2	2–4	4–5	5–6	6–7	7–8	>/= 8		
Akuban	52	45	51	50	62	76	133	469	25
Anshat	54	42	55	53	39	76	88	407	26
Asinawra	84	40	59	64	50	68	59	424	11
Geza	110	63	57	40	64	309	207	850	26
Yimuaj	125	105	76	57	26	27	58	474	25

The wealth ranking based on the number of enset plants owned by each household is shown in Table 3. Farmers with more than 800 enset plants were considered to be very rich. On the other hand, farmers with less than 200 enset plants were considered to be poor. The age structure of enset plants also followed the ranking with wealth and the number of enset holdings (Table 4.)

Table 3. Wealth ranking by enset plant holding in five villages in Asinawka Kebele, Gurage Zone

Wealth group	No. of plants in enset holding	No. of samples
Very rich	>/= 800	15
Rich	500–800	26
Medium	200–500	58
Poor	< 200	14

Table 4. The age structure of enset plantation in five surveyed villages based on wealth rank

	Average number of ensete plants in different age (years) groups						
Wealth rank	0–2	2–4	4–5	5–6	6–7	7–8	>/= 8
Very rich	155	97	103	85	91	254	272
Rich	103	87	69	61	56	198	143
Medium	71	50	53	46	40	80	58
Poor	25	25	21	20	18	23	37

Rich farmers had a higher proportion of old enset plants as compared to poor farmers. This indicates that the number of enset plants and their age structure in each household depend on the financial capacity of the farmers. The rich has more chance to choose and to use the older enset plant for consumption and to get a higher supply of their staple food. The older the plant is the higher the yield of the starch component for human consumption, and the longer the life time of the enset plants the more leaves for livestock feed per plant. This is in agreement with the result of MoA (1987) which reported that the output enset is determined by the age of the plant, older enset plants giving higher production.

Utilization of Enset

In one way or the other, all the plant parts of this crop are useful. The fresh leaves are used for wrapping food, wrapping dough while baking, chopped for feeding cattle. The fiber obtained after scrapping the pseudostem sheath, when the plant is processed for making 'kocho', is used for making carpets, sacks, bags, ropes, etc. the storage root or the corm is usually boiled and eaten. This can be considered as an indication for the incredible value and uses of enset as food for human, feed for the animal and other household uses.

Enset as Feed for Ruminants

Integrated crop and livestock production is the ancient tradition in Ethiopia. However, the more important changes occurring include progressively declining average farm sizes in response to the rising rural population. In this area also the availability of natural grass and legume pasture for grazing is determined by the highly increasing human population, the intensity of annual cropping and the area sown to coffee, enset and chat. Therefore, these factors increase the relative dependence of farmers' livestock upon enset leaf to large extent and cereal-crop residues. During the dry season enset leaf which is fed after chopping is the largest component of the livestock diet in this area. Crop residues such as cereal straws from barley and wheat, pulse-crop residues from horse beans and peas which is stocked after threshing are also used (Table 5). The utilization and combination of the crop residues with enset part and also the period in which they are used are shown in Table 5.

As shown in Table 5, the farm animals are more or less dependent on the enset parts, crop residue and natural grass. In the long dry period the farmers used to feed their livestock with enset leaf after chooping which is found green all over the year, if available crop residues such as barley or wheat straw, peas and natural grass as hay and/or for grazing. Whereas, in the rainy season since there is sufficient moisture for the growth of green feed, the use of the dry season feeds decline.

This indicates that the utilization of enset as ruminant feed depends on the rain distribution in the area. The rainfall pattern in the area where the experiment conducted is a bimodal type with the short rains that occur from January to April and the main rain season from June to October (The terms "short rain season' and 'main rain season' reflect the general trends in the weather, but they are not very exact, in particular for the period January to April).

Table 5. Use of enset as feed for ruminants in combination with crop residues and map of different use patterns

			Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
CROP RESIDUE						*?	*?	*?	*?	*?	*?	*?		
ENSET														
	Leaf				*!	*!	*!	*!	*!	*!	*!	*!		
	Stem													
	Corm													
GRASS														
	Dry													
		Hay												
		Graze				*?	*?	*?	*?	*?	*?	*?		
	Green					d	d	d	d	d	d	d		
		Graze	d	d	d								d	d
		Cut	*!	*!	*!								*!	*!

The corm and stem of enset is used rarely (i.e., in severe dry period) for animals near to die in order to recover and maintain life.

*, feeds that are provided to animals at night time in the house

?, feeds that are available to a lesser extent

!, feeds that are more available and offered

d, day time activity

Amount of enset given and amendments

As far as there is an increase number of human population in the area, farmers in future will have smaller quantities of crop residues available per farm and be less able to augment these cereal products by pasture grazing or hay. The areas under pasture are being reduced and average socking rates are increasing. The amount of enset given for different classes of livestock in the survey area are given, on ranking basis, in (Table 6). The working animals during the working period of the year are given more attention. They are allowed to graze in the morning hours before the other animals are released for grazing. Mostly, they have relatively preserved grazing areas.

For the case of amendment, all animals are provided with chopped enset leaf if it is available. Any animal gets its share according to the ranking shown in Table 6. No animal will be ignored by pardon. This is because all animals are kept in the same house tied in its own place. Therefore, as a culture no one animal will be ignored, but provided in different amounts depending on the importance of the individual animal for the farm.

Table 6. Amount of enset given for different classes of livestock by rank

Livestock class	Ranking
Lactating	****
Non-lactating	****
Heifers	****
Calves	**
Working animal: oxen	*****

Competing uses of enset

As it is mentioned, all parts of this crop has several uses, i.e., right from the top part (the leaf) to the root (the corm). Therefore, all the plant parts (botanical factions) have value as human food, such as kocho, bulla and amicho; as animal feed, such as the leaf, pseudostem or the corm depending on the decision of individual farmers on which part to use; and for home utilities, such as the leaf, the fiber extract and the dead pseudostem sheath.

Since the areas under pasture are being in reduced as there is an increase in the human population in the area and also the average stocking rates are relatively increasing, farmers in the future will have smaller quantities of feeds like crop residues available per animal per farm. The use of enset for feeding shows that the farmers are using already their available resources to tackle the feed shortage.

The use of enset, either the whole plant or the leaf, for feeding could however be increased since the plants are nor exploited to their full potential at present. However, to be able to give advice about feeding of enset leaves and pseudostem, a better knowledge of the nutritive value and the possible level of consumption in necessary.

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GENERAL DISCUSSION and RECOMMENDATIONS

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SYNOPSIS AND RECOMMENDATIONS ON WOMEN AND ANIMAL PRODUCTION

The Sixth ESAP Conference made a general discussion on the theme of the assembly, women and animal production, and other business topics of the society. The discussion held on the lead theme and the recommendations passed regarding the prevailing challenges of women as related to animal production in particular agricultural research, development and policy agenda in general are briefly summarized as below.

Highlights of the Prevailing Scenario

Animal husbandry make high demands on their environments and thus on the people who keep them. Women constitute the dominant force in animal production. They are often responsible for rearing and tending animals and own large and small livestock themselves; yet they are not considered on an equal footing with men. The prevailing scenario is outlined as follows.

- The role of women in animal production is not adequately enumerated. Basic data on the role of women in the different farming systems is lacking. Women's unpaid labor on family holdings, off-farm micro-enterprises and domestic labor are normally excluded from national statistical data
- Research and development efforts have failed to address exclusive needs of women in animal production.
- Prevailing strategies of research do not differentiate gender analysis in setting agenda and implementation of research results
- Women are left or marginalized by the introduction of new agricultural technologies due to socio-economic and legal barriers
- Policies on poverty alleviation, agricultural development and land tenure reform, and other efforts lack vision of equally treating men and women needs
- Any change or improvement in agriculture affects both the household and the family. A socially acceptable rise in efficiency is only feasible if the overall system (household, farms, work flows, income) is analyzed and considered.

- Women's technical skills in animal production is invisible

- Direct access to government loans and credits are more difficult to women. Loans are generally awarded to heads of household. Due to lack of land or animal ownership, banks often consider women not to be credit worthy. Women cannot afford some inputs such as seed, farming equipment and breeding stock and thus excluded from many improvement schemes.

Recommendations

In view of these prevailing situations, consolidated efforts are needed to enhance the contribution of women in animal production and the agricultural sector at large. To accomplish these the conference participants have come up with the following recommendations.

- Efforts should be placed in generating data based on the dynamic role of women in the different agricultural production systems

- Research and development efforts should base on client orientation which female farmers should be regarded as one of the target groups. Gender-oriented approach in projects is vital to increase efficiency and, above all, sustainability

- Attempt should be made on generating technologies that ease high labor demand from women

- Policy efforts should be exerted in providing women access to productive resources and decision power, training women, access to training and extension. Efforts should be made to provide adequate training to women at all levels.

- Identification of efforts is needed to build upon the different opportunities available for each distinct group in agro-ecological, socio-economic and cultural context (e.g., self-help action).

Women's Producer Group

Organizing women's producer group is a vital component of agricultural development schemes. Self-help is a major promotion strategy in livestock production. Promotion of self-help requires

- Participation of all interested parties at all levels and in all phases of project cycle management

- Provision of extension package and services, appropriate to socio-cultural context and to the tasks carried out by the sub-group

Training

- Provide training for women farmers
- Look for possibilities of upgrading women qualification in professional areas
- Organize supplementary training's in animal production processing, marketing for female extension workers along with the other sectors
- Incorporate the gender and development issue in the training and upgrading of extension personnel
- Identify of support (resources, services) that needs to be made available to women to enable them improve their livelihoods, productivity, efficiency and their capacity to manage resources in a sustainable manner
- Equip implementers of animal production projects using gender-oriented approach with high level of know-how and skills, and sensitize them to the situation

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ESAP PRESIDENT REPORT AND VOTE OF THANKS

Zinash Sileshi (Dr.)

Mr Chairman,
Dear Participants

I would like to thank all chair persons and secretaries who led proceedings of the different sessions of the conference and all other members for your enthusiastic participation in enriching the discussion on each presentation.

It is now a year since the Third Executive Committee was elected during the fifth annual conference of EASP. The first task of the committee was to select the theme and soliciting funds from various organization. Over 120 letters were distributed to Government, Non-Government organizations, Institutions, Embassies and even to Institution outside Ethiopia. Only 11 organizations responded positively to our request and the Executive committee is very grateful to them.

The success story of any society depends on the dedication of its members. It is with regret that we note that most of our membership did not fulfill their responsibility of settling membership fee. Again the Executive Committee would like to request the cooperation of all members to pay their membership. The financial status of our Society is in bad situation and this should be taken seriously by the general assembly. The general trend is that members pay their fees during the annual conference. It would be useful if members can also send their dues through the Society's account and submit or send their receipt to ESAP office. ESAP will send acknowledgment receipts to their respective address.

The Ethiopian Agricultural Congress is going to be legally established and it is anticipated that the First Congress meeting will be held in 2000. It is hoped that the congress will strengthen the links between societies and assist in articulating the objectives of agricultural societies. Such coordination might help in decreasing the cost of organizing the future annual conferences.

Organization of annual conferences such as this is time demanding and also requires full participation of the members of the Executive Committee. The other big challenges faced by the Executive Committee within the one year office tenure is in getting the Executive Committee members to attend the regular meetings scheduled to be conducted every month. Most of the elected members are located far from Addis Ababa. One of the members living in Addis could not even attend the regular meetings continuously for four months; the situation is further exacerbated as two of the executive committee members left Ethiopia for trainings. This made three positions vacant, the Executive committee elected Ato Zewdu Sisay to fill one of the three vacancies. These circumstances made well-timed planning and decisions making difficult. Quite often the activities were put on the shoulder of few Executive Committee members. This should be given serious attention in the future in electing Executive Committee members and the elected members should feel the responsibility entrusted on them by the General Assembly.

In spite of these problems, as seen in the last two days the 6th Conference was successful and my sincere thanks and gratitude goes to all those who made this conference possible. I would like to commend the members of the Executive Committee for their tireless efforts in the realization of this conference.

The Society is grateful to ILCA/ILRI for their continuous promotion and support of its activities including sponsoring the publication of the proceeding of the Fifth ESAP annual conference. I wish to acknowledge, also, the generous financial assistance of FINNDA, Pan Africa Rinderpest Campaign, Small Scale Dairy Development Project, SG 2000, Alemaya University of Agricultural, Awassa College of Agriculture, Mekele College of Agriculture and Science and Technology Commission.

A lot of thanks goes for the usual superb logistic support of EARO. I am extremely grateful for the continued support of the staff of Information Services and Training sections of EARO. The encouragement and effort of Dr. B.I. Shapiro in looking funds for the publication of the proceeding of the Fifth Annual Conference is highly acknowledged. The Executive Committee of ESAP gratefully acknowledges with profound gratitude the receipt of one Elonex Computer donated by Department for International Development, British Embassy.

I would like to thank with appreciation the cooperation of EARO, SDDP, Awassa College of Agriculture, Faculity of Veterinary Medicine, Addis Ababa University and Oromia Agricultural Development bureau for availing their staff time for assisting in the Executive Committee. My special thanks also go to ESAP members who assisted us in reviewing papers submitted for the conference.

I also wish to thank all participants for devoting their time to attend this conference. We hope that members who do not attend this conference will come and share their experiences and ideas in our subsequent annual conferences. ESAP has provided an excellent opportunity for sharing information, exchanging views and becoming better acquainted with one another. It is my sincere hope that the enthusiasm, dedication and friendships developed so far will be maintained and renewed.

Finally, looking back to our previous record shows us that Dr. Alemu G/Wold has served as president of Steering Committee of the four NLIC and ESAP Executive Committee in organizing the Second and Third annual conferences. He has rendered dedicated efforts and services for 9 consecutive years; from 1986 to 1995. On behalf of the Executive Committee I kindly request the General Assembly to acknowledge such endurance's and unwavering commitment by providing Dr. Alemu G/wold a status of life time membership to the Society as per 4.2.6. of the Society's constitution.

I wish you success and happiness in all your endeavor. Hope to see you in our next annual Conference.

I thank you all.

WHO

IS

WHO

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WHO IS WHO IN NLIC AND ESAP

National Livestock Improvement Conference (NLIC)

FIRST–Fourth Executive Committee Members (1986–1991)

1st EXECUTIVE COMMITTEE (May 1986–April 1987)	POSITION	2nd EXECUTIVE COMMITTEE (June 1987–May 1988)
Dr. Alemu Gebrewold	← CHAIRMAN →	Dr. Alemu Gebrewold
Ato Luleseged Gebrehiwot	← SECRETARY →	Ato Lulesedged Gebrehiwot
Dr. Feseha Gebreab	← MEMBER →	Dr. Feseha Gebreab
Dr. Beyene Chichaibelu	← MEMBER →	Dr. Beyene Chichaibelu
Dr. Teketel Forsido	← MEMBER →	Dr. Teketel Forsido
Ato Tefera Gebremeskel	← MEMBER →	Ato Tefera Gebremeskel
Ato Adane Feyisa	← MEMBER →	Dr. Zegeye Yigezu
Ato Belete Adinew	← MEMBER →	—

3rd EXECUTIVE COMMITTE (June 1988–May 1989)		4th EXECUTIVE COMMITTEE (June 1990–May 1991)
Dr. Alemu Gebrewold	← CHAIRMAN →	Dr. Alemu Gebrewold
Ato Kassahun Awgichew	← SECRETARY →	Ato Beruk Yemane
Dr. Fesseha Tareke	← MEMBER →	Ato Mesfin Alemu
Dr. Goshu Mekonnen	← MEMBER →	Dr. Teketel Forsido
Dr. Teketel Forsido	← MEMBER →	Dr. Zegeye Yigezu
Ato Mesfin Alemu	← MEMBER →	Dr. Goshu Mekonnen
Ato Beruk Yemane	← MEMBER →	Dr. Fesseha Tareke
Dr. Zegeye Yigezu	← MEMBER →	—
Dr. Solomon Mekonnen	← MEMBER →	—

Ethiopian Society of Animal Production (ESAP)

FIRST–THIRD Executive Committee Members (1991–now)

1st EXECUTIVE COMMITTEE (June 1991–May 1993)	POSITION	2nd EXECUTIVE COMMITTEE (June 1993–May 1995)
Dr. Alemu Gebrewold	← PRESIDENT →	Dr. Alemu Gebrewold
Dr. Feseha GebreAb	← VICE PRESIDENT →	Ato Sentayehu G/Mariam
Ato Sentayehu G/Mariam	← SECRETARY →	Dr. Tafesse Mesfin
Ato Beruk Yemane	←ASSIS. SECRETARY→	Ato Tesfaye Kumsa
W/rt. Mebrat Alem	← TREASURER →	W/rt. Mebrat Alem
Dr. Zegeye Yigezu	← ACCOUNTANT →	Dr. Abebe Wondimu
Dr. Goshu Mekonnen	← EDITOR-IN-CHIEF →	Ato Biruk Yemane
Dr. Azage Tegegne	← ASSiS. EDITOR→	Ato Abaye Tedla
Ato Zewdu Kebede	← EDITOR →	Ato Getachew Feleke
Ato Mesfin Alemu	←PR OFFICER→	Ato Zelalem Alemayehu

3rd EXECUTIVE COMMITTEE (June 1995–May 1997)		4th EXECUTIVE COMMITTEE (May 1997–now)
Ato Tesfaye Kumsa	← PRESIDENT →	Dr Zinash Sileshi
Ato Asfaw Yimegnuhal	← VICE PRESIDENT →	Dr Alemu Yami
Ato Hassen Ali	← SECRETARY →	Dr Girma Abebe
Ato Hadera Gebru	←ASSIS. SECRETARY→	Ato Zewdu Sisay
W/ro Tsehaye Reda	← TREASURER →	Ato Abule Ebro
Ato Aschalew Tsegahun	← ACCOUNTANT →	W/ro Tsehay Redda
Ato Seyoum Bedeye	← EDITOR-IN-CHIEF →	Ato Sendros Demeke
Ato Sendros Demeke	← ASSIS. EDITOR →	Dr Tsige Yohannes Habte
Ato Hizkias Ketema	← AUDITOR →	Ato Teferra
Ato Zelalem Alemayehu	← PUBLIC RELATIONS OFFICER →	

Profile of NLIS and ESAP Executive Committee Members

Abaye Tedla

Ato Abaye earned his MSc in Animal Sciences from Oklahoma State University U.S.A. in August 1969 and his BSc in Animal Sciences from Alemaya Agricultural College, Haile Selassie I. University in July 1966. Ato Abaye served as expert in livestock production and development planning in the farmer Livestock and Meat Board from 1966 to 1977. He was senior expert and team leader of the Animal Feeds and Nutrition Division, MoA during 1978–1985. Ato Abaye was also manager and Coordinator of the Dairy Rehabilitation and Development and Selale peasant Dairy Development Projects in 1985–1990. In 1991–1993 he was Coordinator of the Ethio-Italian Tana Beles project, Team leader of the Animal Breeding Division (1983–1994), and Senior Expert in the Livestock production Division of MoA (1994–1996). Since 1996 Ato Abaye has been working as Freelance Consultant. Ato Abaye was born in 1942. He is married.

Abebe Wondimu (Dr)

Abule Ebro

Ato Abule Ebro earned a diploma from Centralized School of Nursing, Addis Ababa, in 1980. He, then, obtained his first and second degrees from Alemaya University of Agriculture in Animal Sciences. After his graduation with a B.Sc., he was assisgned to serve in the Regional Planning Office for Northern Ethiopia, Asmara (3 years) as a junior expert in Statistics and Research Department. Then, joined the Institute of Agricultural Research in 1987 and worked for three years at Adami Tulu Research Center in animal production research division. Soon after obtaining an M.Sc., Ato Abule was assigned as Manager of the center. Ato Abule is currently engaged in beef research and he is also Coordinator of the National Beef Research Program. Ato Abule also coordinates the livestock early warning project at Adami Tulu. Ato Abule has authored/co-authored 12 papers most of them in nutrition and management.

Adane Ferssa

Alemu Gebre Wold (Dr.)

Dr. Alemu Gebre Wold is an Animal Scientist specialized in Animal Physiology and Animal Production. He has three decades experience in Livestock Research, extension and teaching. Dr. Alemu has played a vital role in Institutional, National, Societal and regional initiatives in Livestock research establishment and developmental schemes. Much of Dr. Alemu's research focused on crossbred dairy cattle management, especially on calf, heifer and milking cows, fattening of male crossbred under different agro-ecologies using different feed types. In addition lately Dr. Alemu has been engaged in a collaborative study in Animal Draught research mainly on the use of crossbred F_1 cows for traction and dairy purposes. Dr.

Alemu has authored/co authored over, 40 professional and scientific activates in the area of dairy cattle, beef and animal traction. Dr. Alemu Gebre Wold joined the than IAR/EARO at the Department of Animal Science at Bako Research Center in 1969 as a junior research wilth BSc. degree in Animal Science. After three years service at Bako, he was awarded FAO fellowship (1972-1974) to peruse his MSc. degree in the field of Animal Production at the University of Aberdeen in Scotland, U.K. Upon his return he continued his research at Bako. In 1975 he was transferred to Holetta Research Center to coordinate crossbred dairy project study at four centers. In 1979 he was awarded German Academic Exchange Scholarship for Ph.D studies at Justus Leibig University in Giessen, Western Germany and completed his Ph.D in 1984 in Animal physiology. Dr. Alemu Gebre Wold upon his post graduate studies rejoined the Holetta Research Center and resumed his research in dairy cattle management. Since 1988 Dr. Alemu's research interest includes draught animals - mainly crossbred dairy cows and local oxen, to maximize utilization of available feed resources and improve productivity in term of power output, milk yield and reproduction. The draught animal power research studies focuses on development of alternative power sources for smallholder producers. Dr. Alemu since his employment at IAR/EARO as livestock researcher, alongside he has contributed to research coordination leadership at various levels as Section Head, Division Head, Department Coordinator, several projects leader and currently Dairy Commodity Programme Coordinator. In addition Dr. Alemu has participated in research management committee policy development, workshop organizes and in founding/ co-foundng role. Dr. Alemu has born at Deder town in Harerege in 1945. He completed his elementary education at Deder Mennonite Mission School and his secondary education at the Bible Academy at Nazareth, Shewa. Currently Dr. Alemu holds Senior Research post at EARO and in based at Holetta Research Center where he coordinate the National Dairy Research. Dr. Alemu is Married and a father of two daughters, Rahel (23 years) and Bethlhem (17 years).

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Alemu Yami (Dr.)

Dr. Alemu was born on March 26, 1955 in Addis Ababa. He earned his Bsc from Alemaya College of Agriculture, (1978, distinction) in animal science his MSc from same college (1981) in Animal Production and his PhD from University of Goettingen, Germany (1987) in Animal Nutrition. Currently he is associate professor of Animal Nutrition at the Alemaya University of Agriculture (AUA) stationed at the Debre Zeit Agricultural Research Center. He served at various administrative positions including as Dean of the school of graduate studies and head

of the Department of Animal Science at AUA. Currently he is coordinator of the national poultry commodity research program. Dr. Alemu Travelled to a number of foreign countries at various capacities including as visiting scholar at Langston University, USA (6 months); visiting scientist at University of Giessin, Germany (3 months) and university of Gothinen, Germany (3 months); traince at University of Reading, UK (3 months). He authored or co-aouthored about 20 scientific articles. He also supervised or co-supervised 21 MSc students in Animal Production.

Aschalew Tsegahun

Ato Aschalew Tsegahun was born in Addis Ababa in June 1949 EC. Ato Aschalew obtained his BSc in Animal Science from Addis Ababa University/ Alemaya College of Agriculture (1970–1973) and his MSc in Animal Production from alemaya University of Agriculture (1980–1984 EC). He also attended short term training in Animal Production at Reading University, U.K, during October 1986–March 1986 EC. He joined then Institute of Agricultural Research (IAR) in 1973 EC, and was assigned at melka Werer Research Center in the Feeds and Nutrition Division as assistant research officer. He was transferred to Sheno Research Center in 1984 EC. Ato Aschalew has produced more than 17 scientific articles. He has served at various leadership positions: as Head of Pasture and Forage section (1973–1978 EC), Head of Feeds and Nutrition Division (1978–1980 EC), Manager of Sheno Research Center (1984–1986 EC) and Head of Feeds and Nutrition Division (Since 1987 EC). Ato Ashalew has also participated in several technical committees: as member of the central committee for organizing the Ethiopian Feed Resource Network (1985–1990 EC), Executive Committee member of the Ethiopian Society of Animal Production (1987–1989 EC), Executive Committee member of the Ethiopian Feed resource Network (since 1990) and Sheep and Goat Program leader (Since September 1991 EC).

Asfaw Yimegnuhal

Ato Asfaw, is a senior research technologist at ILRI with more than 23 years experience in integrated agricultural development work in the highland and lowlant areas of Ethiopia. He has contributed immensely in research into the production of animal feeds for smallscale farming systems. This work included improved forages, legumes, pasture and crop residues for animal feeding. Ato Asfaw was also involved in generating appropriate technologies for the efficient utilization of Vertisols. At the moment he is working in developing feeding systems for dairy cattle, draught oxen, sheep and calves. Before joining ILRI, asaw prepared several

agricultural development projects with professionals in ODA, World Bank and Swiss Corporation (Helvetas) for government and non-government organizations. Asfaw has authored and co-authored more than 15 documents and scientific papers in development, socio-economics, feeding management and nutrition. Asfaw worked for Agri Service-Ethiopia, an NGO, during which time he was involved in translating agricultural pamphlets from English to Amharic extension. These were later distributed to progressive adult farmers that were organized by him. At the end of his service with Agri Service-Ethiopia, Asfaw joined Wollaita Agricultural Development Unit (WADU) which was sponsored by the World Bank. He worked in the capacity of Training Agent and was upgraded to the level of Training Officer of the Agricultural Training Center of WADU. After four years service, he was sent to complete his BSc degree in Plant Sciences at the Alemaya Agricultural College (now Alemaya University of Agriculture) and upon return, he was appointed the Deputy Department Head of Agricultural Extension and Training. He worked extensively in the preparation of project documents, project development and evaluation and project expansion to other Awrajas (provinces) together with the World Bank team. He liaised with national and international institutions to promote WADU's agricultural extension and training programs. In late 1978 he was transferred to the Ministry of State Farms on official request to head the farm in Nura Era that had an area of 10,000 ha of citrus, tobacco and cotton with a personnel strength of 5000 employees. While with the State Farms, he was involved in the management, planning and extension of the farm and upgrading of the agricultural sector to an agro-industry complex. After his two years service with the State Farms, Asfaw was assigned to work with the Swiss Association for Technical Assistance (SATA) as Co-Project Manager of the pilot integrated agricultural development project which was launched in Ambasei Woreda, Wollo Region. Prior to the implementation of the project, socioeconomic studies of the Woreda was carried out by him with the assistance of other team of experts. After identification of the major constraints of the Woreda, he implemented the Project as envisaged from the support donated by Helvetas. While working with SATA, he assisted as a consultant and interim Project Manager for the World Vision International, Ethiopia, to prepare a project proposal and launch an irrigated agriculture project to Semi-nomadic people around Omo Valley. In the mid 1984, Asfaw was employed as Research Assistant by the International Livestock Research Institute (ILRI), formerly the International Livesock Centre for Africa (ILCA), and was later promoted to a senior research assistant responsible for Debre Zeit Vertisol Project carried out in Dembi, Hidi, Dukem, Denkaka, Udea and Algae peasant associations. As Senior Research Technologist, he prepares, coordinates, participates and supervises the implementation of various research programs to improve cattle milk, meat and draught power utilization in mixed crop–livesock production systems. He is routinely involved in collecting, validating and analyzing data and write-up of working documents and research papers. Ato Asfaw was born on 27 August 1947 in Addis Ababa. He is married and has three children.

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Azage Tegegne (Dr.)

Dr Azage, is an Animal Scientist with specialization in Animal Breeding and Reproductive Physiology and Management. He has over 20 years experience in university teaching, research and extension activities. Dr. Azage has authored/co-authored over 60 professional and scientific articles in the area of cattle (dairy and beef) production, management and reproduction. Much of his research activities focus on development of feeding and management systems for calf and heifer reating, cattle reproductive physiology (both female and male), management options for reduction of reproductive wastage and the application of biotechnological toois such as oestrus synchronization, embryo transfer and associated techniques to improve cattle production and reproduction in the tropics. He has also been involved in the feeding, reproductive and productive management of small ruminants. After graduating with a BSc degree in Animal Sciences in 1977, Azage served the Department of Animal Sciences at the Alemaya College of Agriculture, Ethiopia. He subsequently completed his MSc Degree in 1981 in Animal Production specializing in Animal Breeding at the School of Graduate Studies of the Addis Ababa University and continued to teach and undertake research activities in the Department of Animal Sciences at Alemaya. He also served as Assistant Dean for Academic Affairs for four years at the Alemaya College of Agriculture, currently Alemaya University of Agriculture. His main responsibility during this period was to direct the degree and diploma programs of the College. After eight years of service at the Alemaya College, he was awarded a United Naticns Development Programme (UNDP) fellowship and completed his PhD studies in 1989 in Animal Reproduction at the Graduate School of Tropical Veterinary Science and Agriculture, James Cook University, Australia.

Dr. Azage Tegegne was a Graduate Research Fellow (1986–1988) and a Post Doctoral Research Fellow (1990–1991) at the International Livestock Centre for Africa (ILCA). Currently, he is working as an animal scientist at ILRI and is involved in a number of research activities on zebu and crossbred cattle reproduction and management. The main empasis of his work in Ethiopia is aimed at improving milk and meat production in cattle under smallholder and commercial production systems and includes studies on nutrition x reproduction interaction in zebu and crossbred cattle and the application of biotechnology to improve reproductive efficiency in zebu and crossbred cattle and to conserve African livestock germplasm. His studies on nutrition x reproduction interaction focus on the effects of strategic nutritional intervention on reproductive development and function of zebu and crossbred heifers, postpartum cow and breeding bulls and on the patterns of nutrient partitioning in zebu and crossbred dairy cows for body reserve, milk production and reproductive functions. He is also involved in multi-disciplinary and inter-institutional research program on the impact of diseases of intensification and reproductive wastage on smallholder peri-urban milk production systems and alternative source of draught power: use of crossbred cows for milk production and traction under smallholder farm conditions. He is also involved in examining the effect of feeding multi-purpose trees on the growth, development and reproductive functions of sheep and goats. The other areas of his research interest include the application of reproductive technologies in reproductive management of zebu and crossbred cows to optimize utilization of available feed resources and improve reproductive performance and the application of embryo transfer and associated techniques in zebu and crossbred cattle for research purposes, genetic conservation and improvement and multiplication of desirable animals.

Besides his full-time research work, Dr. Azage has been supervising DVM, MSc and PhD student. He has also served as external examines to DVM students at the Faculty of Veterinary medicine and graduate students at Alemaya University of Agriculture. Dr. Azage was born in Harer town, eastern Ethiopia, in 1956. Dr. Azage is currently working as an Animal Scientist at the International Livestock Research Institute (ILRI). He is married and has two children.

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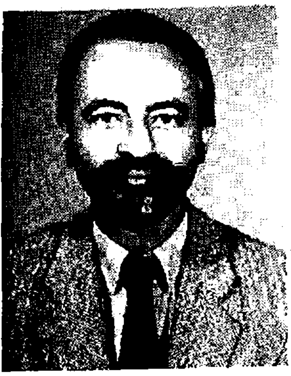
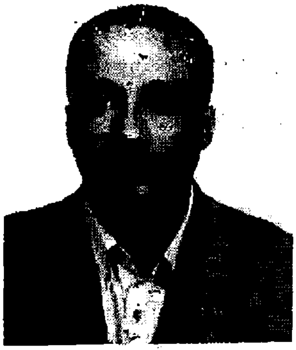


Beruk Yemane



Ato Beruk earned his MSc in Range Science from New Mexico State University (1982–1984). New mexico, U.S.A., and his BSc in Animal Science (1975–1979) from Addis Ababa University, College of Agriculture, Alemaya, Ethiopia. Ato Beruk has been working as a Senior Range management expert, in the Extension Department of MoA, since 1995. He was also Head of National Artificial Insemination Center of the Ministry (1987–1995). During 1983–1987 he was Expert in the Range management and Livestock Production, Project Preparation and Evaluation Center, Early Warning and planning Department. In addition, he was team leader of the Pastoralist Rehabilitation Study jointly sponsored by FAO and the Relief and Rehabilitation Commission. He was Division head of the Livestock Production and Veterinary Service and expert in Range Management. In 1981–1982 he was section head in the Livestock Production Relief and Rehabilitation Commission. Ato Beruk was born on 17 February 1954. He is married.

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Dr. Beyene Chichaibelu, Professor Emeritus of Animal Nutrition at Alemaya University of Agriculture, obtained his BSc degree from Imperial Ethiopian College of Agriculture and Mechanical Arts (1957–1961) in Animal Science. He obtained his MSc (Animal Science, 1962–1964) and PhD (Animal Nutrition, 1972–1975) from Cornell University, U.S.A. Dr. Beyene has worked for over thiry-six years as university professor, extension specialist and researcher in animal nutrition. He has also held different university, ministerial and research management positions in Ethiopia. He has produced over fourteen research papers in different journals and conference proceedings. Dr. Beyene was a recipient of outstanding student leadership and service awards (Ethiopian College of Agriculture and Mechanical Arts, 1961), USAID Scholarships and Fellowships awards (to Cornell University, U.S.A., in 1962–1965 and 1972–1975) and outstanding service award to academic profession (Alemaya University of Agriculture, 1992). He is member/ex-member of twenty technical committees and boards and six scientific and professional societies. Dr. Beyene was born in Gursum, Harerge, Ethiopia, in June 1934. He is married and has four children. He can spead and/or write four Ethiopian languages, English and Italian.

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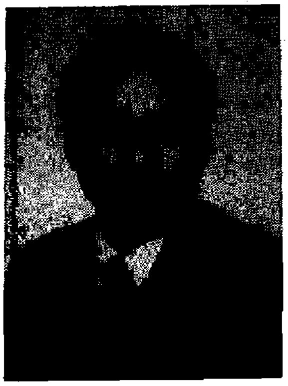
Feseha Gebreab (Dr.)

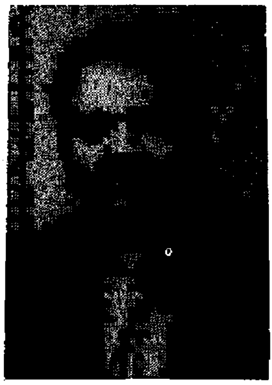
Dr. Feseha Gebreab, Associate Professor, Faculty of Veterinary Medicine, Addis Ababa University, was born in Shoa, Ethiopia, in July of 1941. Elementary and secondary school education was completed at Kokebe Tsebah school in Addis Ababa. Tertiary level was done at the Alemaya University of Agriculture in Ethiopia, Warsaw University of Agriculture in Poland and the National School of Veterinary medicine in Toulouse, France, obtaining and degrees of BSc, DVM and M.V.S.C. Professional career embraces work as an extension supervisor in Gonder, provincial veterinary officer in Tigray, lecturer in anatomy and physiology of domestic animals in the School for Animal Health Assistants, researcher in veterinary parasitology at the National Veterinary Institute, head of the Shola Veterinary Disease Investigation Laboratory, founding dean (1979–1988) of the Faculty of Veterinary medicine, Addis Ababa University and chairman (1994–1997) of the National Agricultural Research Council. Main preoccupation over the past twenty years is in the undergraduate and graduate academic programmes of the faculty of veterinary medicine. Substantial contribution has also been made to the graduate programmes of the faculty of science of AAU and faculty of agriculture of the Alemaya University. Research undertaking has been and continues in veterinary parasitology, zoonosis, veterinary education, equids in general and donkey biology, pathology and general welfare in particular.

Fisseha Tareke (Dr.)



Fisseha Tareke Mengesha was born on October 1, 1942 in Axum, Tigray. He obtained his BSc from Addis Ababa Univerisity (1963–1966) in Biology, from Nairobi University (Kenya) 1970–1973 in Veterinary Medicine and his MSc from University of Ediaburgh (1984–1985) in Tropical Veterinary Science. He has served in various positions: in Ministry of Education (Teaching), 1961–1962; Ministry of Health (Research Assistonship), 1966–1969; Ministry of Agriculture (Provincial Vertinary Officer); Commission for Higher Education (C.H.E), 1973–1979; Dean of Animal Health School and Jimma Agricultural College, 1980–1984; C.H.E. (Coordinator of Agricultural Education, 1985–1988; and at Addis Ababa University (Faculty of Veterinary Medicine-Dean), 1988–1991. Currently he is Assistant Professor and Instructor in Veterinary Mecrobiology at the Faculty of Veterinary Medicine.

Getachew Feleke



Ato Getachew obtained his MSc in 1977 from College of Agriculture, Addis Ababa University, Alemaya, Ethiopia, in Animal science and his MSc in 1986 from Scool of Agriculture, University of Aberdeen, Scotland in Animal Production, Dairy. Ato Getachew worked in the Animal and Fisharies Resources Development Authority during 1977–1979, where he was a Junior Livestock Development Officer and Later liaison Officer of the Food and Nutrition Surveillance Programme and Early Warning System. Ato Getachew moved to the Ministry of Agriculture as of 1979. There he worked as Senior Livestock Production Specialist (1979–1982), Chief Dairy Officer of Dairy Rehabilitation and Development Project. (DRDP) (1985–1990) and Manager of Dairy Rehabilitation and Development Project (1990–1997). As of 1997 he is Senior Livestock breeding Expert.

Sendros Demeke

Ato Sendros Demeke is an animal scientist with specialization in Animal Breeding. He has over 15 years of work experience in livestock research activities. Sendros has authored and co-authored over fifteen professional and scientific articles in the area of dairy cattle breeding and management and in sheep breeding and management. Much of his work focused on development of breeding and management strategy suitable for dairy cattle and sheep production for small scale farming situation. After graduating with a B.Sc. degree in Animal Sciences in 1982, Sendros joined the Institute of Agricultural Research (IAR), Department of Animal Sciences, Forage and Pasture at Holetta Research Station, Ethiopia. He was assigned to work as an assistant research officer to the coordinated dairy cattle crossbreeding program designed to develop breeding strategy suitable to varied - agro-ecological condition of the country. The first six years of his work was focused on organization and management of performance data collected form four participating stations and participating on calf rearing, heifer and cow management researches at Holetta. In 1988 Sendros was assigned to work on sheep breeding and management research at Sheno Research Station. He subsequently completed his M.Sc. Degree in 1993 specializing in Animal Breeding at the School of Graduate Studies of the Alemaya University with a thesis work of evaluating the performance of Exotic x Indigenous sheep for reproduction, growth, wool and carcass traits.

Following his graduation in 1994 he was re-assigned to work on dairy cattle breeding research. He was then involved in restructuring of long term crossbreeding research program based on the achievements of past evaluation results. With the assignment from the Federal Democratic Ethiopia, Prim Minster Office he is also participated in the preparation of the breeding part of the National Development Strategy of Ruminant animals. Currently his research work deal with the development of mating and breeding strategy that stabilizes the crossbreed dairy cattle performance under smallholder production situation. He is also participating in indigenous animal genetic resources characterization for sustainable utilization and conservation. The other area of his research interest includes development of simple performance measurement and recording techniques and development of suitable breeding structure and programs that integrate pure-breeding of indigenous animals with crossbreeding applicable to smallholder production system. Ato Sendros Demeke was born in Wolyta Soddo, Southern Ethiopia in 1959. He completed his elementary and secondary schools at Soddo and Nifas Selke Secondary School Addis Ababa, respectively. He is married and has two children.

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Seyoum Bediye

Ato Seyoum Bediye is an Animal Nutritionist with 16 years of research experience in Ruminant Nutrition. Ato Seyoum has authored /co-authored over 30 professional and scientific articles in the area of ruminant nutrition and related fields. Much of his research activities were in the area of feed evaluation and development of feeding system for cattle and small ruminant in the tropics. Ato Seyoum was born in Arsi administrative region in the town of Robe in 1965. He completed his elementary school in the same town and joined the Addis Ababa University, Alemaya college currently Alemaya University of Agriculture. After Graduating with B.Sc. Degree in Animal Sciences in 1982, Seyoum served as a research officer in Animal Nutrition at Holetta Research Center under the Institute of Agricultural Research currently the Ethiopian Agricultural Research Organization (EARO). He completed his MSc degree in the 1994 in Animal Production specializing in Animal Nutrition at the school of graduate studies of the Alemaya University of Agriculture. His M.Sc. thesis examined nutritional characteristics of local protein sources (oil seed cakes, herbaceous legumes and multi-purpose trees) and application of mathematical models in describing digestion kinetics of these feed resources. He then joined the department of Animal sciences at Holetta Research Center and continued his research in Animal Nutrition. The main emphasis of his work were on feed characterization, development of feeding system, nutrition-reproduction interaction in cattle, on-farm monitoring and evaluation of nutritional intervention.

Ato Seyoum has been involved as a chief scientific investigator or a research scientist in planning and implementation of externally funded research projects in animal nutrition. In a series of two technical cooperation projects sponsored by the International Atomic Energy Agency (IAEA), he served as research scientist and developed the capacity and capability of animal nutrition research program in the national research system. In a coordinated research project on development of feed supplementation strategies for small holder dairy in Africa sponsored by the IAEA, Seyoum served as a chief scientific investigator and developed dry season supplementation strategy for peri-urban dairy. In a multi-location trial on napier and pennisetum hybrid sponsored by the African Feeds Resources Net Work (AFERNET), Seyoum servs as a project leader and best bet accessions of pennisetum for the Ethiopian highlands have been identified to develop pennisetum based feeding system for smallholder dairy. He has also served as a research scientist in oxen traction project in the highlands of Ethiopia funded by the EU and his involvment was development of feeding system for draft oxen. Apart from technical duties and responsibilities, Seyoum rendered service for professional society and networks. He served as an editor in-chief of ESAP (1995-1997), secretary of the Ethiopian Network on Animal Power and Chairman of The Ethiopian Network on Feed Resources and Nutrition.

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diploma and DVM students, and he does research and extension activities in animal production sciences with more interest/work in animal nutrition. He is also a participant, as a lecturer and examiner in animal production/nutrition, in the Joint (Addis Ababa University–free University of Berlin) Postgraduate Programme in Tropical Veterinary Epidemiology, Berlin, Germany. Zewdu is an active participant in professional/non-professional activities. Among others, he is member of the Academic Commission and Secretary of the Research and Publications Committee of the Faculty;/Secretary of the Ethiopian Society of Animal Production (ESAP); Founding Member and Editor in-Chief of the Ethiopian Feed Resources and Animal Nutrition Network (EFRANU). Ato Zewdu is married and has a daughter.

Zinash Sileshi (Dr.)

Dr Zinash Sileshi is an Animal Scientist with particular specialisation in Animal Nutrition. After graduating with a B.Sc. Degree in Animal Science in 1979, she joined IAR where her professional career began with research in Animal Production, specifically on Livestock Breeding and worked for 2 and half years. She then joined the School of Graduate Studies of Addis Ababa University at Alemaya for her M.Sc. and graduate in 1985. She also has obtained her PhD in Animal Nutrition from University of Reading, United Kingdom, in 1995. In addition to training for higher degrees, Dr Zinash has taken part in and benefited from various short-term training courses organised by international organisations on subjects tailored to meet her specialities including Ruminant Nutrition, Forage Analysis and Use of Isotope-Aided Techniques in ruminant Nutrition. Since 1985, Dr Zinash has been working in different capacities in Animal Sciences Department of the same organisation: Research Officer and Head of Feeds and Nutrition Research Division and on various aspects of feed resource evaluation and animal nutrition research. Dr Zinash has played leading roles in designing, implementing and analysing various multinational collaborative research projects: Worked for more than 8 years in implementing research projects assisted by the International Atomic Energy Agency (IAEA). Currently, she is working as project co-ordinator of the East Africa Regional Livestock Early Warning System, as part of the Global Livestock CRSP program, a USAID funded project to Texas A & M University System (TAMU). Dr Zinash has authored/co-authored over 28 scientific papers, which were published in proceedings and/or journals. Most of her work focused on nutritional characterisation of feed resources, development of feeding strategies and development of tropical feed evaluation techniques. Dr Zinash is the current President of the Ethiopian Society of Animal Production (the first lady President of a professional association) and Vice-president of the Ethiopian Congress of Agricultural Science. Since June 1998, Dr. Zinash is serving the Ethiopian Agricultural Research Organisation (EARO) as a Director of Livestock Research. Dr. Zinash is married and a mother of three children.

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