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The Private Sector in the Ethiopian Livestock Industry: Investment Opportunities and Challenges

Proceedings of the 22nd Annual Conference of the Ethiopian Society of Animal Production (ESAP) Held In Addis Ababa, Ethiopia, August 28-30, 2014

Ethiopian Society of Animal Production
P.O.Box 62863, Addis Ababa, Ethiopia

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Livestock Master Plan: Roadmaps for Growth and Transformation

His Excellency Dr. Gebreigzehaber Gebre Yohannes,
State Minister, Livestock Sector Development, MoA

The Livestock Master Plan was drawn by Livestock Resources Development Sector of MOA. This plan has its own vision and mission accompanied by a comprehensive strategy that can be adopted as a roadmap built on a factual baseline, realistic targets and priorities. LMP is unique in that it has involved relevant stakeholders during its preparation including investors all aspiring to work towards poverty reduction and economic growth.

The road map is based on Livestock Sector Model Analysis which acts as guiding documents -- until 2028 and possibly beyond. This road map has also provided a comprehensive national data baseline for the projection of GTP II in which both private and public entrepreneurs are expected to play their major roles. What is more important is that the road map is calibrated on the basis of the different production zones and sub systems in order to include dairy, red meat/ milk and poultry productions. It is important to note that formulation of the road map which is expected to stretch over a period 2015-20 has gone through several stages of development in order not to leave out the most important components of the roadmap. It is guided by a toolkit that has been field tested and reviewed in other countries. The toolkit enables in-depth and systematic quantitative analysis of major constraints facing the livestock sector. Moreover, the toolkit provides guidance for prioritizing investments according to their potential impacts on private and social development goals. There are three major stages:

1. The Livestock Sector Analysis (LSA) – 2013-2028
2. GTP II Projections & Targets (2015-2020)
3. The Livestock Master Plan Roadmaps (LMP) (2015-2020)

To enable investment scenario analysis the toolkit has also inbuilt mechanisms where by investors and the like are bound to gain confidence in working out their intervention investment returns as positive venture to arrive at favorable benefit/cost ratio. They could also work out their internal rate of return (IRR). The resulting LMP can also be taken as a series of 5-year development plan or roadmaps for the key livestock value chains and production systems within each value chain. There are nine value chain components of the road map which includes the following

1. *Live animals and red meat/milk - cattle, goats, sheep, camels*
2. *Cattle feedlots*
3. *Family dairy - cattle, goat, and camel*
4. *Specialized dairy*
5. *Family poultry*
6. *Specialized poultry – broilers and layers*
7. *Hides and skins (production and health issues)there are 9*

8. *Animal feed, health and genetics*
9. *Animal health*

The major livestock production zones and systems included in LMP are;

1. Mixed Crop-livestock Moisture Sufficient Zone (MRS) -- high altitude zone
2. Lowland Grazing zone:
3. Specialized Systems (small and medium scale – not tied to production zones)

If there is no investment made in raising livestock productivity, the Livestock Sector Analysis projections for 2028 show a deficit of 42% for meat and 23% for cow milk. This condition will further exacerbate the poverty level of the 11.4 million rural households. Thus, according to the Livestock Sector Analysis, successful investment in poultry improvement can result in an overall surplus of all meat production by 2028. This can be achieved by importing exotic crossbred chickens to be crossed with chickens of high genetic potential along with appropriate feeding and health regime.
The LMP identified fire areas of focus for investment interventions during GTP II. Includes,

1. Cattle
2. Poultry
3. Dairy development for domestic markets and export earnings
4. Traditional family meat/milk systems
5. Also combination of cattle and poultry can lower domestic meat prices, increase exports and foreign exchange earnings.

Key Note Address

Harnessing Science and Technologies for Public-Private Partnerships in Livestock Sector

Dr. Siboniso Moyo
Director General's Representative to Ethiopia, ILRI

The importance livestock sector in Africa including Ethiopia is that 20-40% of livestock products are significant contribution to the GDP of many countries. The fact that a true contribution of livestock to an economy also comes from by taking advantage of their Multi-functionality in order to realize the full contribution to an economy. Even though, it appears that demand for animal-sourced foods is estimated to be ''extraordinarily high'', there is still a big question to be asked and that is whether the Private Sector Investments can bring forth a sustainable solution through exploitation of such a huge number of livestock existing in Ethiopia and elsewhere in Africa just to meet the growing demand for livestock products. The reply to this question was a big "yes" in that both public and private sector can jointly work together to address this issue because llivestock production should be seen as a business that makes money, and thus managed as such for it to attract private sector investments.

In spite of raising livestock as a business activity, the trend here in Ethiopia is to give priority to investors to acquire lands for floriculture witch nowadays looked upon as an orthodox activity capable of fetching foreign currency. The partnership of public and private groups is essential. The public sector role could be to pave the way for private sector in areas like improvement of rural infrastructure; facilitating; business development, and even funding research and extension services. In case situations are favourable, the private sector can come in and provide expertise and experience in product development, marketing and delivery. All in all private sector can bring about innovative ideas and solutions through the application of modern technologies. Science and Technological advance offer opportunities for Private Sector Investments in the Livestock Sector such as:

1. Breeds, feeds and animal health
2. Feeds and feeding systems
3. Setting up seed production facilities
4. Recording schemes, data collection, identification and traceability schemes
5. Animal Health Issues
6. "Youth" engagement where a "Young farmer milks his way to wealth"

Other non-technological opportunities like:

Supporting information flow on markets
Provision of credit and finance

Creating a conducive enabling environment (appropriate policies and institutional arrangements)

Improving availability of livestock data and information to support decision making across the value chain.

Creating resilience of pastoralists through use of schemes like the Index based Livestock Insurance (IBLI) - under testing in Borana district where Insurance companies are involved.

Dairy In the Cross Roads: What Does It Cost To Transform Dairy in Ethiopia

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Sustainable Agribusiness Incubator, PCI/USAID

For the last many centuries, Ethiopia has been leading Africa in the number of livestock. Some important facts and other production parameters show that the Amhara, Oromia and the SNNPR regions are the three top leading regions with cow distribution of 44%, 42% and 6% respectively.

Whether it is in the highland mid-land or in the lowlands dairy production has been the country's tradition. However with advancing of time, four distinct production systems are prominent: Pastoral system, highland small holders, intra and per urban and large scale commercial dairy systems are widely practiced. 98% of the total milk production of the country comes from the pastoral/ agro-pastoral, smallholders and highland production systems. The total milk production of the country, 98% of the major dairy products come from the pastoral/ agro-pastoral, smallholders and from the farmers of the highlands. The household consumption by the peasant farmers of cheese, butter and fresh milk is in the order of 83.34%, 61.4% and 46.61% respectively. It appears that out of the ten regional states, the per capita milk consumption of Gambela and Afar led the way by 56.95% and 56.02% respectively in the year of 2011/12.

Even though exports of the dairy products are negligible, however, imports of long shelf-life have manifested a significant rise in recent years. This picture could be attributable to the fact that the domestic market accounts for 98% of milk product demand. However, five big import/export players in Africa have been identified as being Morocco, Egypt, the Sudan, South Africa and Kenya. With the growth in number of Ethiopian population, there appears to be a corresponding rise in demand for livestock products. This scenario renders a promising future for the livestock industry of the country. This scenario could also be attributed to emergence and promulgation of the free market economy of the country. Other factors also contributing to the rise in demand for dairy products include the emergence of middle income group.

As one could reflect back for some time, it is a paradoxical for livestock men that There was no high level portfolio for livestock resources in the Ministry of Agriculture for the last two decades (The state ministry for livestock resources was just a recent establishment). Moreover, there was no country strategy and development master plan for dairy (long overdue). GTP 1 had a clear target for live animals and meat. Poultry, sheep and goat were consider as important animals to meet the food security needs of the population, while Dairy was on the cross road there was no mention in the GTP 1. Now here comes, the paradox, that the Government gives priority to export commodities and Dairy was not therefore on the priority list. The beginning is to facilitate and cater for the provision of the necessary input for milk production followed by well streamlined milk collection and processing activities capable of passing over the baton to the process of distribution, marketing and sale in order to reach the consumers. Last but not least it is however, of paramount importance that incentives are provided in the process of stream lining the dairying activities.

Developing the Butter Value Chain in Ethiopia

Berhanu Gebremedihin (PhD), ILRI

The dairy sector in Ethiopia contributes about 13.7% to GDP while livestock contribute 39.4% to the GDP. The per capita milk consumption in 2009 was only about 16 kg/year, which was lower than African and the World per capita averages of 27 kg/year and 100 kg/year, respectively. In this paper the traditional versus modern butter making research work has been conducted. In order to determine the importance of the butter system for dairy farmers, and to investigate if there is spatial dimension as to where butter production is more important.

Analysis of LIVES baseline survey data conducted in 10 zones in the 4 major highland Regions of Ethiopia in 2013. The results of LIVES project at community level have been presented in which a total of 4032.6 tons of butter was produced by all LIVES project PAs in a year. Most of this butter is produced and sold by females in male- and female-headed households. The prices of butter and milk across the PAs averaged around Birr 112.75/kg and Birr 6.91/liter, respectively. In this project the presenter has come up with the result that the value of butter has appreciated by about 73% indicating the increasing importance of butter relative to milk in the LIVES targeted areas. In this study distance had a significant impact on the delivery of the milk and milk by products. According to the research result, it is interesting to note that average sales revenue of butter/sample PA in nearby PAs is in fact higher than the sales revenue from butter in the more distant PAs. In thus study, the key findings is that the crossbred cows of 6% of the total dairy cattle population, account for 33% of the total milk production.

The Demand - Supply for butter depends on various factors including season of the year, fasting, holidays, wedding season, and availability of cash crops. Since demand and supply of butter increases or decreases depending on the months of the year, most price fluctuations are seasonal. The seasonal price variation is linked to the volume of supply and demand in the respective woredas. In Dale woreda, a traditional butter group known as *shufo*. The use of improved and modern packages for traditional butter is not common in the visited woredas. Both sellers and buyers often use traditional butter quality indicators such as origin, color, smell, consistency and degree of adulteration with foreign materials. Yellow-red is preferable to white butter in most of the woredas.

Recommendations

It was important to increase fluid milk and thereby increase the quantity of butter
There is a need to work on genetic improvement of the animals.
As AI work is not dependable it is important to make use of mobile teams that synchronize the het period and go for mass insemination
Reduce burden on women

Introduce larger capacity butter churns
Improve infrastructure for the fluid milk to move faster to consumption area
Improving the availability and use of feed resources to improve milk yield and cow fertility
Maximize efforts by feeding cows using cut and carry system
Intensify extension messages.

Aspiration and Attitude of Graduating Students to Livestock Business: The Case of Wolaita Sodo University, Ethiopia

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Abstract

This study was conducted to assess career aspiration and attitude of agriculture graduate students in Wolaita Sodo University. Multi stage sampling procedure was used to categorize students into departments and the sample drawn with the proportion to sample size. The data were collected from these samples using questionnaire. All the data collected were analyzed using descriptive statistics and inferential statistics. The result obtained indicated that the career aspiration of students have relationship with , achievement, and educational aspiration. The study also indicated both favorable and unfavorable attitude toward agriculture or livestock farming as a future career. Student's socio-economic background and family educational status, occupation, and expectations have also a significant relation with the students' attitude towards the career in agriculture. Career and enterprise preferences of students toward livestock farming were lower than other given non livestock business activities.

Key words: *Attitude, Career Aspiration, livestock business*

Introduction

The livestock sector in developing countries contributes more than 33% to agricultural Gross Domestic Product (GDP), and is one of the fastest growing agricultural sub-sectors. The livestock sector has been experiencing what has been coined the "Livestock Revolution". Population growth, urbanization, and most importantly, increasing income have resulted in a rapid increase in demand for livestock products, which is likely to continue well into the future. Higher Education and training in Agriculture and Livestock sciences was begin in Ethiopia with the establishment of Agricultural schools and colleges six decades back. It was essential for young people to enter the labor market successfully. The institutions have played fundamental role in intellectual leadership and their contribution to learning and knowledge generation and adaptation of modern technology in livestock sector.

Now a day, the Higher education system in Agriculture and Livestock sciences is supplying the country with large numbers of new graduates. The traditional education system imparts the knowledge and attitudes needed for salaried employment in the public sector. This has created dependency of the young graduates on the government employment opportunity or their family income. However, the growth of employment opportunities in public institutions is becoming increasingly lower than the turn out of college graduates. Currently, it is observed that although higher education among labor force has risen significantly, there is stagnation in employment structure. On the other hand, self-employment and the small firms expected to have enormous potential for rapid generation of large numbers of new jobs. The government effort to expand employment creation schemes through small-scale enterprise development is not focusing mainly on young university graduates. The existing educational and employment system seems not responding as fast as the changes of the ground realities. Therefore, there is a need to substantially reorient Universities to promote self-employment and entrepreneurship.

Therefore, one might ask how universities could react to the unemployment situation of the day. What job requirements do we observe these days? What is higher education expected to "deliver", and how does it respond to the current changes? The departments of Animal sciences are experiencing serious problems; lack of interest among the students to enroll, the declining quality of research and teaching and high graduate unemployment rates are some among the problems. Lack of interest in enrollment could be due to misperceptions of students toward the subject. In contrast, there is huge potential for growth of the private livestock sector. It is also in need of specialized research and expertise. Regarding to the issues of livestock business, current education systems require fundamental reform to support the private sector development. As students are the future experts and decision makers, in addition to the current course work, specific attention should be paid to a few experiential learning opportunities, which can enhance their practical knowledge and attitude towards livestock farming. It may be difficult for a newly graduate to start own business in the field of livestock farming. This is because of the existing perception both in the society and the students already had in their minds. That is waiting the government for employment opportunity and looking agriculture or farming as the job of illiterate people and as a last resort where there was no other jobs. These problems may be behavioral factors related to attitudes and aspirations of the students among others. Therefore, the study was conducted to assess attitudes of agricultural students as well as perceived challenges that agricultural students are likely to face in their future career in livestock farming.

The current government of Ethiopia considers the livestock sector as the key factor that will ultimately determine the success or failure of its national development plan. Growth in the agricultural sector, in addition to meeting important targets such as achieving food security, is expected to provide the vital push the rest of the nation’s economy needs. This belief is also apparent in the ‘the Growth and Transformation Plan (GTP)’, The government considers improving agricultural skills, knowledge and productivity as another vital component of the agricultural development strategy and argues that not much can be achieved by trying to teach the older generation farmer who are illiterate and unable to acquire and adopt new, improved and scientific methods of farming. Various polices of the government emphasize a need to cultivate a new generation of literate farmers (who have preferably some post elementary school agricultural training or, at the very least, completed elementary school). Clearly, according to the policy, literate farmers are needed for improved agricultural innovation and output which in turn will allow young people to secure more productive and attractive employment in agriculture (MOFED, 2010).

Given that agriculture in general and small-scale farming in particular is the key to the country's economy both currently and in the foreseeable future, understanding aspirations of future generation of farmers (rural youth) and whether they are attracted to take up agriculture as a livelihood is critical for any future interventions on agriculture in Ethiopia. The existing aspiration and attitudinal problems of students toward careers in agriculture especially in farming necessitated this study. The study was undertaken on the Career Aspiration and Attitude of agricultural students of Wolaita Sodo University. Having the above in mind the study aims to assess the attitude of graduating students toward career in livestock agriculture busneses and to determine the perceived challenges and opportunities.

Materials and Method

Description of the Study Area

The study was undertaken in Wolaita Sodo University, which is located in the mid highlands of southern Ethiopia. The college of agriculture have different departments providing first degree in regular, extension and summer programs.

Sampling Technique

The sampling technique used for this study was multi stage sampling and the respondents from each department were selected in proportion to sample size using simple random sampling techniques. The departments under study are: Animal and Range Science, Natural Resource Management, Plant Science and Rural Development and Extension Department. The total number of agriculture graduate students is 239 and out of it 29 are female students.

Sample Size Determination

The sample frame was the list of graduate students of college of agriculture, which is obtained from the department of Animal and range science, the department of Plant science, the department of Natural resource and Management, and the departments of Rural development and agricultural extension. The sample size has been determined by considering the homogeneity of the population, the inadequacy of resource and time. The study applied the simplified formula provided by Yemane (1967) to determine the required sample size at 90% confidence level, margin of error 10%. Out of 239 graduate students of agriculture, 71 students were selected using the formula, but for the purpose of representativeness 100 students were selected which is higher than the minimum sample requirement.

$$n = \frac{N}{1+N(e)^2}$$

Where N = is total population Confidence level 90%and precision 95%
e = margin of error is 10%

Data Collection Method
Since the sample respondents are graduate students questionnaire were used to collect data having quantitative and qualitative nature. The questionnaire has been checked for its validity and pretested before conducting the formal survey. In case of qualitative data focus groups' discussion which consists of key informant interview. The questionnaires were distributed to the sample respondents and collected back after two weeks.

Data Analysis
The data were analyzed using descriptive statistics such as percentage, frequency, mean and correlation coefficients. Statistical package for social science (SPSS 20) were used for the purpose data processing and analysis.

Result and Discussion

Attitude toward livestock farming
Table 8 shows that the attitude of the respondents toward livestock farming, which was collected by five point Likert scale questions were analyzed in a multiple response. Accordingly, 50.6% and 20% of the respondents' attitude is above the neutral level, which is favorable toward had favorable attitude toward livestock farming. As well as 36.1% unfavorable and 13.3% of the respondents' attitude toward livestock business is neutral level. These findings indicate almost half of the respondent's attitude toward livestock business is low. As an agriculture students their attitude were expected to be high. This shows the need for improvement on the attitude of students toward the career in agriculture and taking farming as a future career.

Table 1: Attitude towards Livestock business

Category	N	Percent	Level
Agriculture	2124	56.8%	Favorable
	506	13.5%	Neutral
	1110	29.7%	Unfavorable
	Total	100%	
Livestock Business	6335	50.6%	Favorable
	1671	13.3%	Neutral
	4523	36.1%	Unfavorable
	Total	100%	

Correlation Analysis

Career aspiration is a product of socio-cultural and economic environment, and the person's self-concept was vitally important in that decision (Herr, 1970; Hewer, 1963; Super, 1957). The choice of a career is, therefore, not merely a decision of a moment: it is a complex and difficult process that spans a number of years (Ginsberg, Axelrod, &Herman, 1951), if not a lifetime.

Relation between students' attitude toward agriculture and living place

As shown in the appendix Table 9 there is significant negative relationship of (-0.234*, p 0.020) between the attitude of students toward livestock agriculture as an interesting field of occupation and their living place. Therefore, living place is negatively affecting their attitude toward the agriculture as an interesting field of occupation.

Table 2: Correlation between students' attitude toward livestock and other factors

Attitude		living place	mother education status	livestock farming is a traditional way of life	livestock agriculture is an interesting field of occupation
living place	Pearson Correlation	1	0.235*	0.169	-0.234*
	Sig. (2-tailed)		0.020	0.092	0.020
	N	100	98	100	99
mother education status	Pearson Correlation	0.235*	1	0.193	-0.103
	Sig. (2-tailed)	0.020		0.057	0.317
	N	98	98	98	97
livestock farming is a traditional way of life	Pearson Correlation	0.169	0.193	1	-0.327**
	Sig. (2-tailed)	0.092	0.057		0.001
	N	100	98	100	99
livestock agriculture is an interesting field of occupation	Pearson Correlation	-0.234*	-0.103	-0.327**	1
	Sig. (2-tailed)	0.020	0.317	0.001	
	N	99	97	99	99

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

There is also significant positive correlation at (0.169, p 0.092) between the students' attitude toward farming as a traditional way of life and their living place. Mothers' educational status has also positive correlation (0.193, p 0.057) with the attitude that farming is a traditional way of life. The result obtained from focused group discussions (FGDs) also confirms that not only students but also teachers agree that the current farming practice is traditional. But results showed high significant correlations between location of birth on agriculture, interest and attitude of respondents toward agriculture Movahedi (2003).For example, rural students who prefer to live close to their parents and those who prefer to live close to nature or natural environments are more likely to choose careers that can be achieved in their rural communities.

Relation between students' attitude and parent's educational status

Table 10 shows father educational status has negative correlation with the students attitude that farming has low prestige in community at significance level of (-0.160, p 0.115). Therefore, father educational status negatively affects the attitude toward farming as a prestigious job in the community. The reason may be the long term developed negative attitude of the society toward farming. Fathers' education level was found significant with the seniors' career aspiration in the 1996 study. This is consistent with other research that found that academic performance was closely correlated to the family's socio-economic status and occupation (Scott-Jones & Clark, 1986). Even though mothers' education level did not show a statistical relationship with the students' career aspiration, it was highly correlated with fathers' education level.

Table 3: Correlation between students' attitude and father educational status

Attitude		father educational status	livestock farming has low prestige in the community
father educational status	Pearson Correlation	1	-0.160
	Sig. (2-tailed)		0.115
	N	99	99
livestock farming has low prestige in the community	Pearson Correlation	-0.160	1
	Sig. (2-tailed)	0.115	
	N	99	100

Parents are the major role players in academic achievement (Alam et al., 2011)). In the teaching and learning process, family factors influence student success and school achievement. Parental expectation and aspiration, home environment and parental involvement in their child's education, such as creating conducive home environment and the consistent provision of assistance in their studies, are the main factors that could affect the student's academic achievement and the effects of home environment on learners' socio-emotional and cognitive development (Christenson et al., 1992). The author clearly showed that the family and school environments play important roles in learners socio-emotional and cognitive development.

Relation between students' livestock career preference and parent's education and occupational status

As shown in Table 11 Career preference of students has positive correlation with students' career preference toward poultry production and mother educational status at significance level of (0.006, p 0.954). This indicates that students' career choice or preference is in line with their field of agriculture which was their field of study. But their preference toward business in seep and goat were negatively correlated with father educational status at significance level of (-0.005, p 0.963). Therefore, student's career preferences toward business activity in relation to their field of study were indicating the gap that they may not have pre hand information on how to do business in their field of study. The response from focus group discussion asserts whether the curriculum is inspiring the students toward livestock business or not, the majority said it needs some modification, others said it is more detail but needs to be updated by incorporating agribusiness and entrepreneurship in each content beyond the science.

When they were asked whether the current learning environment makes the student toward job creation, half of them respond yes to some extent but the rest of them said not at all because the curriculum is not designed in that way. The question were raised whether the group members were joined the faculty of agriculture by choice or not, some of them said 'yes', but the majority said 'no' because it is based on the potential or capacity of the students.

Table 4: Correlation between livestock career preference, living place, family education and occupation status

Career Preference		living place	mother occupation	mother education	father occupation	father educational
Dairy	Pearson Correlation	-0.209	0.006	0.087	-0.157	-0.163
	Sig. (2-tailed)	0.038	0.954	0.394	0.124	0.108
	N	99	99	97	97	98
Poultry	Pearson Correlation	-0.110	0.038	0.081	-0.058	-0.042
	Sig. (2-tailed)	0.275	0.705	0.429	0.568	0.680
	N	100	100	98	98	99
sheep and goat	Pearson Correlation	-0.046	-0.128	0.018	-0.059	-0.005
	Sig. (2-tailed)	0.648	0.204	0.857	0.563	0.963
	N	100	100	98	98	99
beekeeping	Pearson Correlation	0.126	-0.091	-0.061	-0.064	-0.153
	Sig. (2-tailed)	0.211	0.366	0.551	0.530	0.130
	N	100	100	98	98	99
Fishery	Pearson Correlation	-.213	0.002	0.056	-0.315	0.000
	Sig. (2-tailed)	0.033	0.982	0.585	0.002	1.000
	N	100	100	98	98	99
fattening	Pearson Correlation	0.006	-0.150	0.027	-0.039	0.081
	Sig. (2-tailed)	0.955	0.137	0.795	0.706	0.423
	N	100	100	98	98	99

Relation between respondent, teachers and parent career expectations

As shown in the Table12 below the students expectation to be a leader has positive correlation with teachers at significance level of (0. 229, p 0.022) student's career expectation. This indicates the positive influence instructors had on students' career expectation. Accordingly fathers expectation has negative correlation with the students future career expectations of being a livestock farmer at significant level of (0.020, p = 0.842) It can be understood that parents' expectation has an influence on students' future career choice and expectations. Kritzinger's (2002) interviews with 17-19 year olds living on South African farms indicated that the aspirations and expectations of younger girls were likely to be thwarted by their social location and broader macroeconomic factors which structure their opportunities. For instance, although their parents also had high (educational) expectations for their children, they often put pressure on them (especially girls) to start working and contributing to the household.

Table 5: Correlation between students career expectation, teachers, parents, field of study and living place

Career expectation		teachers	mother	father	field of study	living place
Leader	Pearson Correlation	0.229	0.101	0.093	0.053	-0.102
	Sig. (2-tailed)	0.022	0.315	0.358	0.602	0.311
	N	100	100	100	100	100
employee	Pearson Correlation	0.261	0.022	-0.021	-0.009	-0.030
	Sig. (2-tailed)	0.009	0.829	0.838	0.929	0.765
	N	100	100	100	100	100
entrepreneur	Pearson Correlation	0.435	0.003	0.021	0.181	-0.111
	Sig. (2-tailed)	0.000	0.973	0.839	0.072	0.271
	N	100	100	100	100	100
livestock farmer	Pearson Correlation	-0.058	0.159	-0.020	-0.077	0.193
	Sig. (2-tailed)	0.567	0.114	0.842	0.447	0.054
	N	100	100	100	100	100

Perceived challenges and opportunities

Perceived challenges

Table 11 below shows the percentage of respondents perceived challenge and opportunities in relation to land ownership or access to agricultural land, lack of technical skill and knowledge, financial support, policy issues and business know how. Accordingly 83% of the respondents perceive shortage of land as a bottleneck for participating in livestock business career while 17% agree as there is no a problem of land to engage in livestock farming activities. As indicated above the majority of the respondents are perceiving shortage of land as a problem which prevents their participation in livestock business activity. The shortage of land is not only the perceived problems of the respondents or sample students but it is also the problem of farmers in the rural area of Ethiopia. The newly graduated students were expecting the government to provide them employment opportunity because the existing situation indicates as stated on the folk, shortage of land and other farming equipments. Since the majority of the respondents were from rural area they know the problems associated with land.

As the number of household increase the individuals share on the land will decrease and leads to the minimum amount of land will remain on the hands of individuals with decreasing fertility. In addition to this most uneducated rural youth were accommodated in the rural area seeking job in agriculture and remain on the farm but most of them have no access to cultivable land. Perceiving this problem the respondents consider shortage of land as a stumbling block to their employment and growth in agriculture business activities. The second challenge associated with lack of technical skill in livestock business practice according to 87% of the respondents and 13% of the respondents' consider lack of skill is not a problem to engage in livestock business activity. Accordingly response obtained from members of FGDs indicated that level of technical confidence is less among students while few of them revealed they have some technical knowledge but confident theoretically.

Table 6: Perceived challenge in percentage of responses

Perceived Challenges		Frequency	Percent
lack of land	Yes	83	83.0
	No	17	17.0
	Total	100	100.0
lack of technical skill	Yes	87	87.0
	No	13	13.0
	Total	100	100.0

Additionally the group discussion also reveals the perceived challenges graduate students likely to face in their future career such as attitudinal challenges, lack of initial capital, the risky nature of the science, lack of land and the outlook of the population expecting every graduate to be hired in government.

Perceived Opportunities

As indicated on Table 12 the respondents were asked what possible opportunities exist that can encourage their participation in the agricultural career as a sort of employment. Accordingly 82% of the respondents said the current economic policy and agricultural policy as one of the encouraging factor to engage in livestock and any other agricultural business activity, private agricultural extension service, vegetable exports, fruit and flower exports, coffee exporting. Accordingly 75% and 80% of the respondents know how to obtain financial support i.e. the existing credit access to start own business enterprise and have know how on business plan preparation. This indicates the presence of suitable policy to engage in agricultural production and rural financial services to support youth engagement in employment creation.

Table 7: Perceived opportunities in percentage

Perceived Opportunities	Response	Frequency	Percent
Policy	Yes	82	82.0
	No	18	18.0
	Total	100	100.0
Credit access	Yes	75	75.0
	No	25	25.0
	Total	100	100.0
business know how	Yes	80	80.0
	No	20	20.0
	Total	100	100.0

The current government of Ethiopia considers the agricultural sector as the key factor that will ultimately determine the success or failure of its national development plan based on the ADLI philosophy. Growth in the agricultural sector, in addition to meeting important targets such as achieving food security, is expected to provide the vital push the rest of the nation's economy needs in order to jump start. This belief is also apparent in the latest manifestation of the government's five year plan, dubbed "the Growth and Transformation Plan" where ensuring the agricultural sector is emphasized (as the second of eight pillars) to provide the massive push necessary for economic growth and industrialization (Ministry of Finance and Economic Development, 2010).

Conclusion

The findings this research also indicate that half of sample students have favorable attitude toward the career in agriculture and in livestock business in particular. However, nearly half of the student's attitude toward agriculture and livestock business is between the neutral and lower level. The mean value from twenty statements of the student's attitude toward agriculture and farming also indicate low level. The attitude of respondents has significant correlation with parent's occupation and educational status, the location where they lived for a long time by itself affects their attitude toward agriculture. In addition the expectation of their teachers and family also affects their attitude toward agriculture.

Recommendations

Based on the result obtained from the surveyed sample respondents the student's attitude toward agriculture is low. It is recommended that as an agricultural graduates the students' attitude toward livestock farming needs improvement through developing curriculums that encompasses more behavioral and entrepreneurial contents in order to make their attitude grow in relation to their field of study. Additionally, improving the attitude of students can be accomplished through continuous training and orientation toward the profession of agriculture.

The response obtained also indicates the perceived challenges graduate students likely to face in their future career as shortage of land and technical skill. This can be solved with the coordinated effort with the government bodies even by restructuring the policy framework related to the use of agricultural land and making it accessible to the rural unemployed youth and the newly graduates so as to create their job in their field of study. Even though the policy is favorable to agriculture, focus must be given to newly graduates and unemployed youth in order to increase job opportunity and exploit the knowledge and skills of educated personnel's in the field of agriculture. Since students were learned more theoretical part of agriculture science they lack some practical knowledge in the field. Lack of field experience and exposure makes them resilient to take an action. Therefore the University specifically College of Agriculture has to focus on strengthening the technical skills through extensive practical programs in relation to agriculture livestock business activities. It is highly recommended that allocation of students in the field of agriculture should be based on interest and choices of students.

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Animal Production

Carcass Quality of Cattle in Ethiopia Based on Standard (ES) System

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Abstract

This study was conducted with the aim to evaluate carcass quality of cattle in Ethiopia. The Ethiopian Standard (ES) system was used to classify carcasses which are a modification of the SEUROP system. About 10% of carcasses were collected from Adama, Hawassa, Mekelle and Kombolcha abattoirs between August 2013 and January 2014. The result from the study revealed that the average carcass weight of cattle slaughtered at local abattoirs was 135.83 ± 38.40 kg. Carcasses with superior, moderate and inferior conformations accounted for 30%, 33% and 36%, respectively, with mean carcass weights of 171.24 ± 31.70, 130.40 ± 20.01 and 111.48 ± 29.35 kg, respectively. About 67.5% of carcasses evaluated were of inferior quality with a mean carcass weight of 116.36 ± 31.83 kg. Castrated and intact bulls accounted for 64.64 % and 26.07% of cattle slaughtered with the average carcass weights of 136.17 ± 37.27 and 148.21 ± 38.06 kg, respectively. A relatively higher proportion of good quality carcasses was obtained from growing bulls (11.11%) compared to intact (8.33%) and castrated bulls (9.94%) with the mean carcass weights 138.00 ± 15.40, 189.17 ± 30.11 and 179.89 ± 23.55 kg, respectively. Relatively higher (p<0.001) carcass weight was observed in wet season (155.56 ± 26.59) compared to the dry season (119.42 ± 26.55). Moreover, higher proportion of superior quality carcasses was observed in the wet season (8.57%) with a mean carcass weight of 180.63 ± 27.37 kg compared to the dry season (0.36%) with a mean carcass weight of 176.00 ± 3.23kg. The average carcass weight at Adama, Hawassa, Mekelle and Kombolcha abattoirs were 161.26 ± 29.53, 143.92 ± 19.96, 134.11 ± 29.46 and 95.63 ± 12.45 kg, respectively. The proportion of superior quality carcasses in Adama, Hawassa and Mekelle abattoirs were 7.14, 1.43 and 0.36% with mean carcass weights of 182.15 ± 28.49, 173.00 ± 14.61 and 176.00 ± 7.89 kg, respectively. The relatively better quality and conformation of carcasses in the wet season compared to the dry season indicates the opportunities to improve the quality and yield of the carcasses through better feeding management.

Key words: carcass quality, carcass yield, Ethiopian standard, local abattoirs

Introduction

Evaluation of carcass and meat quality is an important practice in the meat marketing at national and international level (Lazzaroni, 2007). The tendency to pay beef producers based on weight of animals at slaughter and carcass quality is increasing. Age, sex, conformation and fat cover are the main parameters that determine the quality of carcasses (Lazzaroni and Biagini, 2009). The SEUROP grading system evaluates carcasses based on class, conformation grade (six levels) and fat grade (five levels) (Fisher, 2007). Different countries developed classification systems which suit the existing production system, relatively more accurate, simplicity, ease of application, cost and ease for monitoring or verification (Strydom, 2011). Similarly, Ethiopia has developed a beef carcass classification system in 2012 which is a modification of SEUROP classification system (ES, 2012). The classification system is structured per animal categories, conformation (three levels) and fat grade (three levels). The country has the largest cattle resource (53.4 million) in Africa (Negassa *et al.,* 2011). Very little research has been done concerning carcass quality of cattle in Ethiopia (Negassa *et al.,* 2008). The objective of this study was therefore to evaluate the quality of carcasses from cattle slaughtered at local abattoirs in Ethiopia using the ES classification system.

Material and Methods

Study abattoirs

The study was conducted in Adama, Hawassa, Kombolcha and Mekelle local abattoirs. These abattoirs are located in Oromiya, Southern People National and Nationalities (SPNN), Amhara and Tigry regional states which account for more than 95% of cattle population in the country. Adama, Hawassa and Mekelle are public abattoirs that supply hot carcasses to the butcheries in respective cities. Kombolcha abattoir is a private abattoir that process corned beef for local market. Each abattoirs slaughter about 150 cattle per a day for about 200 days a year. Abattoirs give service of slaughtering animals for butchers. Butchers purchase slaughter animal from local market and bring them to abattoirs to get slaughter services.

Data collection

Information on categories of cattle slaughtered, gender, hot carcass weight, conformation and fat grade were collected from the study abattoirs. Data was collected 7-10 days randomly from 10% cattle slaughtered in each abattoir in dry and wet season between August 2013 and January 2014. Conformation and fat scores were recorded by an inspector at all abattoirs studied to avoid subjective difference between evaluators. Half right side of whole carcasses were weight randomly using weighing scale sensitive at 100 gm. The weight of half right side was multiplied by two to estimate whole carcass weight. Carcasses were categorized in to cows, growing bulls, intact bulls and castrated bulls based on degree of ossification of cartilage of thoracic vertebrae, discs of intervertebral sacral vertebrae and sex of cattle slaughtered (ES, 2012).

ES classification system

Table 1 Characteristics and description of Ethiopian classification (ES) system for beef (ES, 2012)

Conformation	**Grade**
Carcasses with convex profiles and very well developed muscle	1
Carcasses with straight profiles and good muscle development	2
Carcasses with concave profiles and moderate muscle development	3
Fat	**Grade**
Carcasses with small or no fat coverage	1
Carcasses with fat visible on the whole body exception the hind leg and shoulder	2
Whole carcasses covered with fat and fat deposited in the thoracic cavity	3
Descriptions	**Categories**
Carcass of young bull or heifers that weight less than 70 kg	JB
Carcasses of grown up bulls (cartilage of the spine up to four thoracic vertebras show no sign of ossification and from fifth to ninth show sign of ossification; discs of inter-vertebral of sacral vertebrae show sign of ossification)	JM
Carcasses of mature intact bulls	M
Carcasses of castrated bulls	O
Carcasses of heifers	JF
Carcasses of cows	F

Statistical analysis

Data was analyzed using procedure of GLM of SAS 2011 software. Factors showing significant difference at probability level of $p<0.05$ were compared using Tukey pairwise comparison procedure. Carcass weight was analyzed using conformation, fat, category and abattoirs as fixed effects. The percentage of inferior, moderate and superior conformation and quality of carcasses was calculated as a ratio of carcasses in each category to the total carcasses evaluated.

Results

Conformations and qualities of carcasses

The mean conformation grade of carcasses at the studied abattoirs is presented in Table 2. About 3,080 carcasses were classified during the study period. The average carcass weight for all categories of conformation was 135.83 ± 38.40 kg. Carcasses with good, moderate and inferior conformations accounted for 30%, 33% and 36%, respectively, with mean carcass weights of 171.24 ± 31.70, 130.40 ± 20.01 and 111.48 ± 29.35 kg, respectively.

Table 2 Mean conformation grade of carcasses at studied abattoirs

Conformation grade[1]	Carcass number	Percentage of total	Mean weight (kg/ carcass)	S.D
1	924	30.00	171.24[a]	31.70
2	1,045	33.93	130.40[b]	20.01
3	1,111	36.07	111.48[c]	29.35
Total	3,080	100.00	135.83	38.40

[1]1-superior conformation, 2- moderate conformation, 3- inferior conformation
[a,b,c] with in column means with different superscript letter differ ($p<0.001$)

The mean quality of carcasses at studied abattoirs is shown in Table 3. Fat grade 1 represents inferior quality carcasses which accounted for 67.5% of carcasses graded with a mean carcass weight of 116.36 ± 31.83 kg. Fat grade 2 represents a medium quality grade which accounted for 23.21 % of the total carcasses classified with a mean carcass weight of 158.54 ± 25.87 kg. Fat grade 3 represents a superior quality grade which accounted for 9.29% of the total carcasses classified with a mean carcass weight of 180.72 ± 26.89 kg.

Table 3 Mean qualities of carcasses at studied abattoirs

Fat grade[1]	Conformation grade[2]	Carcass number	Percentage of total	Mean weight (kg/ carcass)	S.D
	1	198	6.43	153.97	39.24
1	2	891	28.93	126.93	26.85
	3	990	32.14	108.18	27.58
	Total	2079	67.50	116.36[a]	31.83
	1	506	16.43	171.58	24.93
2	2	132	4.29	146.13	24.46
	3	77	2.50	135.63	32.46
	Total	715	23.21	158.54[b]	25.87
	1	220	7.14	186.00	29.70
3	2	20	0.65	176.50	7.68
	3	35	1.14	146.00	8.29
	Total	286	9.29	180.72[c]	26.89

[1]1- inferior quality carcasses, 2- moderate quality carcasses, 3- superior quality carcasses
[2]1-superior conformation, 2- moderate conformation, 3- inferior conformation
[a,b,c] with in column means with different superscript letter differ ($p<0.001$)

Categories of cattle and carcass quality

Categories of cattle slaughtered in study abattoirs and conformation grade are shown in Table 4. More than 64% of cattle slaughtered at local abattoirs were castrated bulls (O). Matured intact bulls (M), cows (F) and growing bulls (JM) accounted for 26.01%, 5.36% and 3.93%, respectively of all cattle slaughtered. Intact bulls had relatively higher mean carcass weight (148.21 ± 38.06 kg carcass^{-1}) compared to castrated bulls (136.17 ± 37.27 kg carcass^{-1}), growing bulls (133.69 ± 34.39 kg carcass^{-1}) and cows (121.08 ± 28.81 kg carcass^{-1}).

Table 4 *Categories of cattle slaughtered in study abattoirs and conformation grade*

Categories[1]	Conformation grade[2]	Number	Percentage	Mean carcass weight (kg/ carcass)	SD
	1	21	0.68	142.25	14.07
F	2	12	0.39	126.00	10.21
	3	132	4.29	95.00	25.79
	Total	165	5.36	121.08[a]	28.81
	1	56	1.82	150.40	18.74
JM	2	42	1.36	121.50	40.69
	3	23	0.75	115.25	13.02
	Total	121	3.93	133.69[b]	34.39
	1	308	10.00	176.98	33.17
M	2	286	9.29	139.35	24.45
	3	209	6.79	128.29	37.93
	Total	803	26.07	148.21[c]	38.06
	1	539	17.50	171.35	30.53
O	2	704	22.86	127.77	29.10
	3	748	24.29	109.40	23.85
	Total	1991	64.64	136.17[b]	37.27

[1]JM (carcass of grown up bull), M (carcass of mature intact bulls), O (carcass of castrated bulls), F (carcass of cows).

[2]1-superior conformation, 2- moderate conformation, 3- inferior conformation

[a,b,c] with in column means with different superscript letter differ ($p<0.001$)

Qualities of carcasses per categories of cattle slaughtered in study abattoirs are shown in Table 5. Fat grade 1 carcasses were produced from 85.71% of cows, 66.66% growing bulls, 62.50% mature intact bulls and 67.96% castrated bulls. The average carcass weights of these categories of cattle were 96.37 ± 24.32, 130.39 ± 24.99, 136.40 ± 30.85 and 116.77 ± 26.35 kg, respectively. Fat grade 2 carcasses were produced from 14.29% cows, 22.22% growing bulls, 29.17% intact bulls and 22.10% castrated bulls. Mean carcass weights of these categories were 136.00 ± 21.48, 154.00 ± 25.46, 172.45 ± 24.44 and 160.29 ± 23.27 kg, respectively. Fat grade 3 carcasses were produced from 11.11% growing bulls, 8.33% intact bulls and 9.94% castrated bulls. Mean carcass weights of categories of these cattle were 138.00 ± 15.40, 189.17 ± 30.11 and 179.89 ± 23.55 kg, respectively.

Table 5 Qualities of carcasses per categories of cattle slaughtered in study abattoirs

Categories[1]	Fat grade[2]	Conformation grade[3]	Number	Percentage	Carcass weight (kg/ carcass)	SD
		1	10	6.50	126.50	12.56
	1	2	12	7.78	126.00	10.70
		3	110	71.43	90.40	26.12
		Total	132	85.71	96.37	24.32
		1	11	7.14	154.00	20.34
F	2	2	0	0.00	0.00	0.00
		3	11	7.14	118.00	22.63
		Total	22	14.29	136.00	21.48
		1	0	0.00	0.00	0.00
	3	2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	0	0.00	0.00	0.00
		1	23	23.23	153.00	21.49
	1	2	20	20.20	121.50	41.45
		3	23	23.23	115.50	13.02
		Total	66	66.67	130.39	24.99
		1	22	22.22	154.00	25.46
JM	2	2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	22	22.22	154.00	25.46
		1	11	11.11	138.00	15.40
	3	2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	11	11.11	138.00	15.40
		1	66	8.33	153.83	37.99
	1	2	264	33.33	141.50	23.64
		3	165	20.83	121.28	36.87
		Total	495	62.50	136.40	30.85
		1	187	23.61	179.03	26.28
M	2	2	22	2.78	175.50	3.58
		3	22	2.78	113.50	18.94
		Total	231	29.17	172.45	24.44
		1	55	6.94	197.80	32.08
	3	2	0	0.00	0.00	0.00
		3	11	1.39	146.0	15.23
		Total	66	8.33	189.17	30.11
		1	99	4.97	157.33	44.07
	1	2	572	28.73	121.12	26.66
		3	682	34.25	107.24	22.39
		Total	1353	67.96	116.77	26.35
		1	286	14.36	168.74	23.35
O	2	2	110	5.52	152.65	19.80
		3	44	2.21	124.50	29.93
		Total	440	22.10	160.29	23.27
		1	154	7.73	185.21	26.14
	3	2	20	1.00	176.50	7.69
		3	24	1.21	146.00	10.26
		Total	198	9.94	179.89	23.55

[1]JM (carcass of grown up bull), M (carcass of mature intact bulls), O (carcass of castrated bulls), F (carcass of cows)

[2]1- inferior quality carcasses, 2- moderate quality carcasses, 3- superior quality carcasses

[3]1-superior conformation, 2- moderate conformation, 3- inferior conformation

Conformation and quality of carcasses in wet and dry seasons

Conformation of carcasses in wet and dry seasons is shown in Table 6. The average weights of carcasses in wet and dry season were 155.56 ± 26.59 and 119.42 ± 26.55, respectively. More numbers of carcasses had relatively superior conformation in wet season (43.41%) with heavier carcass weight of 173.91 ± 29.67 kg compared to the dry season (18.54%) which had an average carcass weight of 165.90 ± 34.38 kg. In the other word, more number of carcasses had inferior conformation in dry season (48.34%) with the average carcass weight of 99.38 ± 19.78 kg compared to the wet season (21.71%) with the average carcass weight of 138.98 ± 22.50 kg. The proportion of moderate quality conformation of wet (34.88%) and dry (33.11) seasons was comparable with the average carcass weight of 143.04 ± 26.14 and 122.67 ± 29.93 kg, respectively.

Table 6 Conformation of carcasses in wet and dry seasons

Seasons	Conformation grade[1]	Carcass number	Percentage of Total	Mean weight (kg/ carcass)	SD
Wet	1	616	43.41	173.91	29.67
	2	495	34.88	143.04	26.14
	3	308	21.71	138.98	22.50
	Total	1419	100.00	155.56[a]	26.59
Dry	1	308	18.54	165.90	34.38
	2	550	33.11	122.67	29.93
	3	803	48.34	99.38	19.78
	Total	1661	100.00	119.42[b]	26.55

[1]1-superior conformation, 2- moderate conformation, 3- inferior conformation

[a,b,c] with in column means with different superscript letter differ ($p<0.001$)

A quality of carcasses in wet and dry seasons is shown in Table 7. A relatively smaller proportion of poor quality carcasses was observed in the wet season (22.14%) with a mean carcass weight of 144.19 ± 26.16kg compared to the dry season (45.36%) with a mean carcass weight of 109.48 ± 23.91 kg. Relatively higher proportion of medium quality carcasses was observed in wet season (15.36%) compared to the dry season (8.21%). Moreover, a higher proportion of superior quality carcass was observed in the wet season (8.57%) compared to the dry season (0.36%) with mean carcass weights of 180.63 ± 27.37 and 176.00 ± 3.23 kg, respectively.

Table 7 Qualities of carcasses in wet and dry seasons

Season	Fat grade[1]	Conformation grade[2]	Carcass number	Percentage of total	Mean weight (kg/ carcass)	SD
		1	77	2.50	172.29	41.64
	1	2	396	12.86	141.74	26.62
		3	209	6.79	138.50	21.67
		Total	682	22.14	144.19	26.16
		1	330	10.71	166.30	22.39
Wet	2	2	77	2.50	145.67	30.14
		3	66	2.14	130.71	18.87
		Total	473	15.36	157.98	23.11
		1	209	6.79	186.53	30.38
	3	2	20	0.65	176.50	7.68
		3	35	1.14	146.00	8.29
		Total	264	8.57	180.63	27.37
		1	121	3.93	142.32	32.82
	1	2	495	16.07	117.67	27.02
		3	781	25.36	99.20	19.83
		Total	1397	45.36	109.48	23.91
		1	176	5.71	181.48	26.45
Dry	2	2	55	1.79	167.70	11.72
		3	22	0.71	105.50	16.89
		Total	253	8.21	171.87	23.31
		1	11	0.36	176.00	3.23
	3	2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	11	0.36	176.00	3.23

[1] 1- inferior quality carcasses, 2- moderate quality carcasses, 3- superior quality carcasses
[2] 1-superior conformation, 2- moderate conformation, 3- inferior conformation

Conformation and qualities of carcasses in Adama, Hawassa, Mekelle and Kombolcha *abattoirs*

Carcass conformations of cattle slaughtered in Adama, Hawassa, Mekelle and Kombolcha abattoirs is shown in Table 8. The average carcass weight at Adama, Hawassa, Mekelle and Kombolcha abattoirs were 161.26 $\pm$ 29.53, 143.92 $\pm$ 19.96, 134.11 $\pm$ 29.46 and 95.63 $\pm$ 12.45 kg, respectively. A relatively higher proportion of carcass with superior conformation was observed in Adama local abattoirs (57.84%) compared to Hawassa (35.90%) and Mekelle (16.18%) with mean carcass weights of 176.32 $\pm$ 30.26, 157.79 $\pm$ 16.32 and 148.49 $\pm$ 43.43 kg, respectively. No carcasses with superior conformation were found at Kombolcha abattoir.

Table 8 Carcass conformations of cattle slaughtered in Adama, Hawassa, Mekelle and Kombolcha abattoirs

Abattoir	Conformation Grade*	Carcass number	Percentage of total	Mean weight (kg/ carcass)	SD
	1	649	57.84	176.32	30.26
Adama	2	253	22.55	151.89	23.90
	3	220	19.61	127.58	33.01
	Total	1122	100.00	161.26[a]	29.53
	1	154	35.90	157.79	16.32
Hawassaa	2	198	46.15	138.14	25.81
	3	77	17.95	131.06	19.93
	Total	429	100.00	143.92[b]	19.96
	1	121	16.18	148.49	43.43
Mekelle	2	330	44.12	137.60	23.49
	3	297	39.71	124.37	28.41
	Total	748	100.00	134.11[b]	29.46
	1	0	0.00	0.00	0.00
Kombolcha	2	264	33.80	100.29	11.38
	3	517	66.20	93.26	12.97
	Total	781	100.00	95.63[c]	12.45

[1]1-superior conformation, 2- moderate conformation, 3- inferior conformation

[a,b,c] with in column means with different superscript letter differ ($p<0.001$)

Carcass qualities of cattle slaughtered in Adama, Hawassa, Mekelle and Kombolcha abattoirs is shown in Table 9. A relatively lower proportion of inferior quality carcasses were observed at Adama (10.36%) and Hawassa (8.57%) compared to Mekelle (23.21%) and Kombolcha (25.36%) abattoirs with the mean carcass weights of 139.52 ± 31.01, 133.83 ± 19.67, 134.49 ± 30.01 and 95.63 ± 12.45 kg, respectively. The proportion of medium quality carcasses at Adama, Hawassa, Mekelle abattoirs were 18.93, 3.93 and 0.71% with mean carcass weights of 165.28 ± 25.78, 169.97 ± 19.12 and 170.00 ± 8.91 kg, respectively. The proportion of superior quality carcasses at Adama, Hawassa, Mekelle abattoirs accounted for 7.14, 1.43 and 0.36% with mean carcass weights of 182.15 ± 28.49, 173.00 ± 14.61 and 176.00 ± 7.89 kg, respectively. No carcasses with medium and superior quality were found at Kombolcha abattoir during the study period.

Table 9 Carcass qualities of cattle slaughtered in Adama, Hawassa, Mekelle and Kombolcha abattoirs

Abattoirs	Fat grade[1]	Conformation grade[2]	Carcass number	Percentage of total	Mean weight (kg/ carcass)	SD
Adama	1	1	89	2.89	154.06	29.66
		2	120	3.90	146.55	26.47
		3	110	3.57	120.17	36.27
		Total	319	10.36	139.52	31.01
	2	1	396	12.86	175.52	26.08
		2	110	3.57	152.85	19.58
		3	77	2.50	130.43	31.42
		Total	583	18.93	165.28	25.78
	3	1	165	5.36	190.13	32.45
		2	22	0.71	176.50	7.68
		3	33	1.07	146.00	8.29
		Total	220	7.14	182.15	28.49
Hawassa	1	1	22	0.71	141.50	9.72
		2	176	5.71	133.38	18.98
		3	66	2.14	132.50	23.51
		Total	264	8.57	133.83	19.67
	2	1	88	2.86	172.00	22.31
		2	21	0.68	154.25	11.96
		3	12	0.39	112.50	17.91
		Total	121	3.93	169.97	19.12
	3	1	44	1.43	173.00	14.61
		2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	44	1.43	173.00	14.61
Mekelle	1	1	88	2.86	157.00	50.35
		2	330	10.71	137.60	23.49
		3	297	9.64	124.37	28.41
		Total	715	23.21	134.49	30.01
	2	1	22	0.71	170.00	8.91
		2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	22	0.71	170.00	8.91
	3	1	11	0.36	176.00	7.89
		2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	11	0.36	176.00	7.89
Kombolcha	1	1	0	0.00	0.00	0.00
		2	264	8.57	100.29	11.38
		3	517	16.79	93.26	12.97
		Total	781	25.36	95.63	12.45
	2	1	0	0.00	0.00	0.00
		2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	0	0.00	0.00	0.00
	3	1	0	0.00	0.00	0.00
		2	0	0.00	0.00	0.00
		3	0	0.00	0.00	0.00
		Total	0	0.00	0.00	0.00

[1]1- inferior quality carcasses, 2- moderate quality carcasses, 3- superior quality carcasses
[2]1-superior conformation, 2- moderate conformation, 3- inferior conformation

Discussions

The average carcass weight of cattle slaughtered in the study abattoirs was relatively less than the carcass weight reported for Ogaden bulls (163-182 kg) at fattening center at Haramaya University, Ethiopia (Mekasha et al., 2011). However, it was relatively higher than the carcass weight of WASH, Sanga and Sed cattle breed in Gana (Teye and Sunkwa, 2010). Similar proportions of superior, moderate and inferior conformation of carcasses were found in the present study. However, the proportion of inferior conformation carcasses from local abattoirs in the present study was less than that reported for carcasses from Romania in 2008 (96%) using the EUROP classification system (Petroman *et al.,* 2009). Moreover, the proportion of superior conformation carcass in the present study was more than that reported in Mexico in 2004-2005 which was about 17.8% (Mendez *et al.,* 2009). However, it comparable to excellent conformation (28.92%) reported by Lazzaroni and Biagini (2009) in slaughterhouse of North-West of Italy.

The quality of carcasses was generally inferior in the present study. In contrary to the present finding, Lazzaroni and Biagini (2009) reported 8.43% carcasses was grade 1 in its fat content and 86.35% of carcasses were grade 2 in its fat content in slaughterhouse of North-West of Italy. However, the proportion of superior quality carcasses in the present study was more than that reported in Romania which was 0.7% (Petroman *et al.,* 2009). Moreover, the proportion of superior quality carcass in the present study was comparable to the carcass quality evaluated using USDA grading system in the northern part of Ethiopia which was 14.46% (Kumar *et al.,* 2010). The higher proportion of inferior quality carcass in the present study might be associated with poor body condition of cattle prior slaughter. There is no specialized production system rearing cattle specifically for beef purpose in Ethiopia. Beef is a by-product of draft in the mixed crop-livestock production system as cattle are primarily kept for traction purposes. Cattle are usually sold when they are too old for draft purpose and in poor body condition. Moreover, beef is a by product of dairy in pastoral production system as the cattle are kept primarily for milk purpose. Cattle are usually sold when they are culled from dairy purpose at old age and with poor body condition. This two production systems account for more than 99% of cattle production system practiced in the country (Negassa *et al.,* 2011). Feed shortage was often reported as a major constraint to livestock production system in Ethiopia. Natural pasture is the main source of feed for most livestock, complemented by fodder and crop residues during the dry season. Productivity of the range land was about 0.15 ton per hectare (Halderman, 2004).

The higher proportion of carcasses from castrated and intact mature bulls might be due to the higher proportion of cattle between 3 and 10 years of age which accounted for 62.8% of cattle population in Ethiopia (Negassa *et al.,* 2011). The proportion of intact bulls slaughtered at local abattoirs in the present study was less than the proportion reported in Poland which was about 47% (Weglarz, 2010). No carcasses from immature bulls and heifers were encountered during the study period. This is in contrast to the carcasses produced in USA namely 87.3% bulls and heifers less than 2 years of age (Savell *et al.,* 2011). Moreover, In contrary to the present finding Lazzaroni and Biagini (2009) reported the slaughter of 46.46% uncastrated young males, 24.69% cows, 15.16% veal calves and 13.04% other females in slaughterhouse of North-West of Italy.

Intact bulls had relatively higher carcass weight compared to castrated bulls and cows. Castrated bulls and cows were used for beef purpose after they were culled from the draft and milking services usually in old age and a very poor body conditions. This might be the reason for these groups of cattle for yielding a lower carcass weight compared to the intact bulls which are usually slaughtered at a young age. Higher carcass weights from intact bulls compared to castrated bulls and cows in present study were similar to that reported for Hanwoo cattle in Korean (Park *et al.,* 2002). Relatively more proportion of carcasses of growing bulls had better quality than proportion of carcasses of castrated and mature intact bulls in the present study. This confirms the general fact that young animals have relatively better carcass quality than matured once (Minchin *et al.,* 2009). No carcass was categorized as superior quality from cows during the study period. This might be due to the slaughter of culled cows which were old in age and poor body conditions. Higher age at slaughter was reported as one of the reason for poor quality of carcass from cows (Zaujec *et al.,* 2012). Even though intact mature bulls had shown higher carcass weight compared to castrated bulls, the latter exhibits more proportion of superior quality than the former. The relative better quality of carcass from castrated bulls compared to intact bulls was similarly reported for Hanwoo cattle in Korean (Park *et al.,* 2002).

There was relatively higher proportion of superior conformation and quality beef in wet season compared to the dry season in the present study. The better conformation and quality of carcass in wet season might be due to the availability of feed and water which made the cattle finished in good body condition and relatively better slaughter weight. Marked seasonal variation in availability and quality of natural pasture because of variability of rainfall distribution was reported for livestock production system in Ethiopia (Tolera and Abebe, 2007). Carcass conformation and qualities showed marked difference between abattoirs studied. More number of carcasses had superior conformation in Adama compared to Hawassa and Mekelle local abattoir. However, no carcass with best conformation was encountered in Kombolcha abattoir during the study period. Relatively higher proportions of superior quality carcasses was observed in Adama abattoir compared to the other abattoirs studied. The higher proportion of superior quality carcass and conformation in one compared to the other abattoirs in the present study might be due to the difference in genetic and environment in which cattle was managed prior to slaughter. Large proportions of fattening center are found in and around Adama (Little *et al.,* 2010) which serve as source of cattle for the Adama abattoir. Most cattle slaughtered at Hawassa abattoir comes from pastoral and agro-pastoral production system. Most of cattle used in Mekelle and Kombolcha abattoirs come from mixed production system after serving draft purpose for long period of time. All these factors might have contributed to the difference in degree of conformation and quality of carcass between abattoirs studied.

Conclusion

Even though Ethiopia has a large cattle population, most of the carcasses produced were graded as inferior in quality. The relatively better quality of carcasses in the wet season compared to the dry season indicates the opportunities for the improvement of the carcasses through better feeding management.

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Assessment of Processing and Value Addition of Milk and Milk Products around Nekemte Town, Oromia

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Abstracts

*The study was conducted in East wollega zone, in and around Nekemete town with the objectives of to assess traditional production, handling and processing and traditional milk post-harvest loss mitigation system in small-scale dairying. Based on semi-structured questionnaire forty five milk producers were interviewed. The data were analyzed using Statistical Procedures for Social Sciences (SPSS) version 13. Indices were calculated to rank purpose keeping, sale and plant materials as first, second and third by respondents as important according to the formula: The index for a particular attribute was derived as ((3*proportion of respondents that ranked as first + 2*proportion of respondents that ranked as second + 1*proportion of respondents that ranked as third for a particular attribute)/sum of (3*proportion of respondents that ranked a trait as first + 2*proportion of respondents that ranked a trait as second + 1*proportion of respondents that ranked a trait as third for all variables in question)). The average household size was 5.4±0.34. The priority ranking of the dairy animals' purpose of keeping was as follows: milk production 1st, income generation 2nd, manure 3rd and draft power 4th, respectively. In present findings were revealed that dairy animals provides for multiple purpose for economic success and risk managements. Daily milk yield were determined by breeds, seasons and stage of lactation. The average quantity of daily milk produced per day, consumed per day, processed per week and sold per week were 9.5±2.1, 3.9±2.1, 22.6±7.3 and 78.5±26.3 liters, in respectively. The plant materials used for fumigation milk and milk products containers were Watto, Dabaqqaa, Ejersaa, Kefoo and Kusaayee, respectively. More than half of the respondents fumigate the milk and milk products containers to improve flavor impartation while other to increase shelf. Constraints of milk production in the areas reported unavailable breed (80%) shortage of feeds (83%) and diseases (72%). More than 60% respondents were suggested to improve dairy production, handling, consumption and marketing we should have access to improved breeding, efficient AI services, veterinary services, improved forage, developed infrastructure, credit, trained on milk production and handling, concentrate mix, cooperative and marketing in our locality. Therefore, future work will be focus on these interventions.*

***Key Words*:** Milk, Milk products, Value addition and Processing

Introduction

Milk spoilage is a major problem of the dairy sector in tropical countries. The high temperature coupled with the absence of cooling facilities and adequate transportation means hasten the spoilage of the milk produced in this area (O'Mahoney and Peters, 1987). In Ethiopia the rural milk production system accounts for about 97% of the total milk production in the country where it is difficult to transport the raw milk to the market areas or to the processing plants due to poor infrastructure (Staal and Shapiro, 1996). Only about 5 % of the milk will be reached to the market areas and the rest of the milk will be processed at the farm into different dairy products. A significant amount of milk is spoiled due to the absence of cold storage facility such as refrigeration. To mitigate post-harvest milk losses different methods have been practiced by small scale milk producing households. Milk processing is one of the mitigation systems used to minimize the loss of raw milk especially in areas where infrastructure is underdeveloped to sale raw milk. Assessment of the quality of traded milk and milk products has shown that value addition through small-scale processing is important for income generation and reduction of post-harvest losses (Lusato, 2006). Fumigation of milk handling equipments using different herbs is another alternative for minimizing post-harvest losses. On the other hand, adding plant materials directly to the milk products is also used by small scale milk producers and processors in order to alleviate the problem of milk and milk products spoilage before consumption. However, there are other means of post harvest milk loss mitigation systems which should be studied, documented and introduced to other parts of the country, hence, the proportion of milk spoiled due to several reasons is not studied well and documented at Nekemte. Therefore, the objectives of the present study are to assess traditional production, handling and processing of milk and milk products.

Materials and Methods

The study was conducted in and around Nekemete town of in east Wollega zone. Forty five smallholder milk producers were selected with the assistance of the staff of office of agriculture and interviewed using semi-structured questionnaire. Only smallholder farmers having one more milking cows or those who have good experience in milk production were purposively selected. Data collected were mainly focused on milk production and utilization, milk handling and processing methods , risk factors associated with production, transportation and consumption, traditional standards used by smallholder milk producers, retailers and consumers, status of standardized dairy products consumption, challenges in maintaining and consuming standardized dairy food, consumers views and preferences, post-harvest loss mitigation systems and preservation methods.

Statistical Analysis

Descriptive statistics were employed using the Statistical Package for Social Sciences (SPSS) version 13.0 for qualitative data. Indices were calculated to rank purposes of keeping, sale and plant materials used to clean milking and milk storage materials as first, second and third by respondents as deemed necessary following Duguma *et al*. (2011) and Mirkena *et al*. (2011). The index for a particular attribute was derived as ((3*proportion of respondents that ranked as first +

2*proportion of respondents that ranked as second + 1*proportion of respondents that ranked as third for a particular attribute)/sum of (3*proportion of respondents that ranked a trait as first + 2*proportion of respondents that ranked a trait as second + 1*proportion of respondents that ranked a trait as third for all variables in question)).

Results and Discussion

Production and utilization of milk and milk product

The average quantity of daily milk produced per day, consumed per day, processed per week and sold per week were 9.5±2.1, 3.9±2.1, 22.6±7.3 and 78.5±26.3 liters, respectively. The use of milk for household consumption was reported to be one of the major reasons for the limited supply of milk to the market (Asfaw *et al*, 2012). For instance, about 48.9% of the respondents reported that they give whole fresh milk to family members for nutrition purposes. Family members were given priority of consumption of whole fresh milk to children (57.4%) and husband in male headed households), (6.4%). About 19.1, 17.1, 17.1 and 14.1% of fermented milk, butter milk, cottage types of cheese, butter/traditional ghee and whey are used for children in the family members. However, 21.1, 2.1 2.1 and 2.1 % of fermented milk, butter milk, cottage types of cheese and butter/traditional ghee were consumed by husbands, while 8.5, 2.1, 2.1 and 10.4% of fermented milk, butter milk, cottage types of cheese and butter/traditional ghee were used by wife (figure 3 and 4). Similarly, Asfaw *et al* (2012) reported that only surpluses, after satisfying the requirement of calves and that needed for household consumption, are sold. A study conducted in southern Ethiopia, indicated that fresh milk consumption is mainly limited to children (Fekadu, 1994). The present results were in agreement with the previous work of Alganesh (2002) that first priority was given for children in the consumption of the whole fresh milk. Asfaw et al. (1997) also reported that milk is the major food for children.

Table 1. Priority of ranking for different milk products for sale

Product	Prioritize ranking (N=45)						Sum	Index	Rank
	1st	2nd	3rd	4th	5th	6th			
Whole fresh milk	61.7	8.5					412.7	0.386	1
Fermented milk		19.1	29.8	4.1			227	0.212	2
Butter milk		12.8	4.3	2.1	21.3		130.1	0.122	4
Cottage types cheese		2.1	4.3	29.8	4.3		125.7	0.118	5
Butter/traditional ghee	10.6	12.6	6.4	2.1	2.1	10.6	173.3	0.162	3
Whey		2.1				19.1	29.6	0.028	6

About 61.7 % of the smallholder farmers ranked whole fresh milk as their first and fermented milk as their second priority (Table 2) for sale. It is observed from the current study that cottage type cheese is not sold in and around Nekemte, and it is in agreement with Alganesh (2002). Butter is the most important market items among the different dairy products in the study area likely due to its shelf life and easy handling compared to whole fresh milk and sour milk. In some areas like Guto wayu (Nekemte) and Bila Sayo districts of east Welloga Zone the smallholders farmers do not sell fresh milk due to small daily production, cultural barrier, lack of demand to buy fresh whole milk and preferred to process milk into butter or cheese (Aleganesh,2002).

Milk and milk products handling and processing

The interviewed households used different milking equipment for milk, fermentation, churning storing and transporting. The majority of respondents (72.3%) used plastic bucket for milking while clay pot were used for storing milk (10.6%) and Ayib making (40.4%). Yilama (2010) reported that 81% and 3.4% of the respondents from ten dairy potential areas in the Ethiopia highlands used plastic jars and stainless equipment's, respectively, while 6.6% of them used clay spot. Abebe *et al*., (2013) reported that equipment used for milking. Processing and storage determines the quality of milk and milk products. The authors concluded that pay particular attention to the type as well as cleanliness of milk equipments and aluminum and stainless steel more preferred for milking and storage of milk.

Table 2. Materials used for dairy purpose

Milking equipment's	milking		Fermentation		churning		Storing milk		Ayib making		Storing ayib		Storing butter		Transporting milk		Transporting butter	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Clay pot	2	4.3	4	8.5	1	2.1	5	10.6	19	40.4								
Stainless steel	7	14.9	10	21.3	3	6.4	5	10.6	5	10.6	9	19.1	13	27				
Plastic bucket	34	72.3	23	48.9			21	44.7	7	14.9	12	25.5	15	31.9	10	21.3	14	29.8
Wooden container	4	8.5	2	4.3	8	17	4	8.5										
Metallic container	1	2.1	2	4.3	1	2.1												
Calabash (Qil)	5	10.6	4	8.5	30	63.8	10	21.3	3	6.4	7	14.9	5	10.6				

More than half of the respondents fumigate the milk and milk products containers to improve flavor while others do so to increase shelf life. The major plant materials used for fumigation of the milk and milk products containers were *Watto, Dabaqqaa, Ejersaa Kefoo and Kusaayee.* The majority of respondents (46.8%) store milk in a cool and dry air. Some also store under shade (19.1%), and in a refrigerator.

Table 3.Amount of production, sale, processing and consumption of milk and its products

Purpose of milk	N	Minimum	Maximum	Mean	SE
Milk used for calf rearing per day in liter	31	0	4	1.94	0.15
Start milking cows for household use after parturition	45	6	12	9	0.29
Milk produced per day (Litter)	44	.50	150	12.60	3.8
Milk rejected from sale per week (liter)	1	4	4	4.0	.0
Milk donated to neighbors per week (liter)	4	0.50	35	10.3	8.3
Milk processed per week (liter)	32	1.50	56	14.1	2.4
Fermented milk produced per week (Litter)	24	1	42	13.7	2.1
Fermented milk processed per week (Litter)	16	2	35	11.9	2.05
Volume of fermented milk churned at a time (Litter	17	3	35	10.47	2.07
Fermented milk used to produced 1 kg of milk (Litter)	18	1	21	13.8	1.2
Butter milk used to produce 1 kg of cottage cheese (Litter)	12	1	20	10.7	1.3
Butter produced per week in kg (Litter)	12	1	4	2	0.33
cottage type cheese produced per week (Kg)	10	1	20	5.3	1.87
Milk consumed per week (Litter)	29	0.50	56	8.2	2.1
Fermented milk consumed per week (Litter)	22		20	6.5	1.1
Butter consumed per week (Kg)	14	0	10	2.2	0.9
Cottage type cheese consumed per week (Litter)	14	1	15	4.1	0.9
Buttermilk consumed per week (Litter)	6	3	10	4.8	1.1
Whey milk consumed per week (litter)	1	7	7	7	.
Milk sold per day (Litter)	19	2	150	26	8.6
Fermented milk sold per week (Litter)	2	1	7	4	3
Butter sold per week (kg)	7	0	2	1.7	0.27
Cottage type cheese sold per week (kg)	2	1	2	1.5	0.5

Constraints of milk production, marketing, processing and consumption

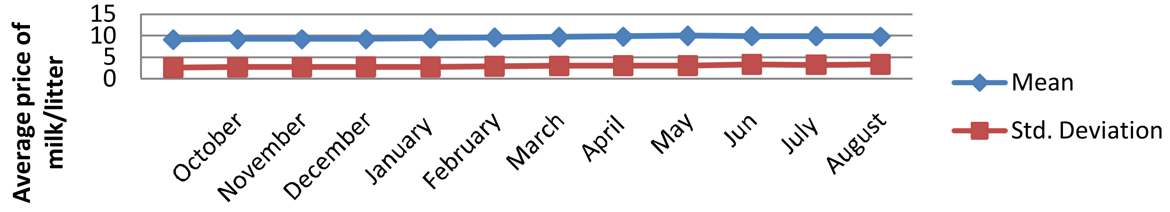
Table 4. The constraints associated with milk production, marketing, processing and consumption

No	Constraints	Production	Marketing	Processing	Consumption
1	Low milk yield (%)	61.7	40.4	34	48.9
2	Poor quality of feeds (%)	89.4	21.3	10.6	25.5
3	Feed shortage (%)	83	25.5	8.5	23.4
4	Low price of milk (%)	10.5	44.7	23.4	12.8
5	Poor market infrastructure (%)	12.8	55.3	27.7	12.8
6	Labor shortage (%)	46.8	38.3	34	17
7	Low milk quality/rejection (%)	14.9	38.3	27.7	25.5
8	Availability of small scale milk processing equipment's (%)	34	40.4	55.3	19.1
9	Higher price of milk products (%)	21.3	27.7	23.4	29.8
10	Unavailability of breeds (%)	80.9	25.5	17	36.2
12	Disease/health problem (%)	72.3	21.3	12.8	38.3
13	Cultural/religious taboo (%)	23.4	4.3	6.4	19.1

Milk and milk products transportation and Marketing

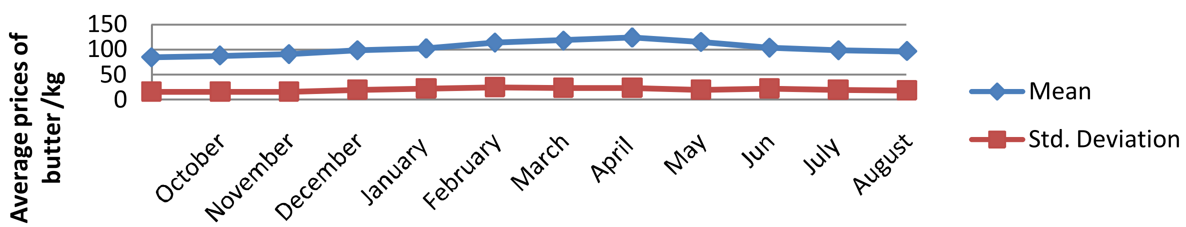
About 51.1% respondents reported that they sale milk at different palaces. For instance, 21.3% at farm gate, 21.3% to restaurants and 14.8% to hotels. The average price of milk is varies throughout the years (figure 5). The milk prices were high from March to May of the years. This implies that the milk prices in areas determined by availability feeding the areas.

Figure 5. The average milk price in 2003 E.C



The milk price were determined in local by customer (17%, n=8), producer (61.7%, n=29), processors (2.1%, n=1) and retailer (12.8%, n=6), but in the present report about 93.6% (n=44) respondents there is no interference government authorities. The factors determined the price of butter at market were availability (63.8%, n=30), quality (40.4%, n=19), original sources (31.9%, n=15), big festival (53.2%, n=25), market demand (36.2%, n=17) and number seller in the market (27.7%, n=13).The parameter used to determine good quality butter in market was freshness/age of butter (odor/rancidity) (70.2%,n=33),color and texture of butter (72.3, n=34), consistency/uniformity of butter (25.5%,n=12),cleanliness of butter (51.1% n= 24) and development of mould on the surface of butte (25.5%, n=12). The color of good quality butter indicators were 91.5% (n=43) respondent revealed yellowish and 2.1% (n=1) white and yellowish white, respectively. About 51.1% (n=24) confirmed that there is the price difference between fresh and rancid butter, fresh butter higher prices (55.3%, n=26). The average price of butter is varies throughout the years (figure 6). The prices of butter were ranges from 40-150 birr/kg. The milk prices were high from March to May of the years. This implies that the butter prices in areas determined by availability feeding the areas.

Figure 6.The average butter price in 2003 E.C



About 48.9% of respondent's sale butter by using traditional butter packaging materials. Those local butter packing materials are leaves like'*kobakital',* plastic containers, bottle gourd*, Birchiko, sini,*plastic cups*, Nikel* and metal containers, 21.3%,21.3%,6.4%,27.7%,51.1%, 34%, 6.4% and 12.8%, respectively.

Milk Transportation, rejection and loss

Milks were transported to marketing places on foot (70.2%), by cart, bicycle, and by public transports. About 93.6% and 74.5% of smallholders do not use any kind of additive to preserve milk and butter during transportation to market places, respectively. According to respondents (66%), the spillage of milk during production is very low.. About 83% of respondents reported that milk loss due to mastitis was high. Repoendents indicated that infected udder is treated traditionally (4.3%), by veterinary services (76.6%) and both (8.5%). About 55.3% of the respondents indicated that they dispose milk from infected teats, 21.3% reported that they use to feed other animals, and about 10.8% use for human consumption either after processing or without processing.

Standardized dairy products

Most respondents (93.6%) have no knowledge of standardized dairy products. They have no information about milk quality parameters utilized for the standardized dairy products. About 48.9% of respondents followed proper standard during milking: such as cleaning of barn, using of separate milking places, keeping clean milking environments and the cleanliness of milkers. About 44.7% respondents do have knowledge about good manufacturing process. Moreover more than 90% respondents reported that there are not know Hazard analysis critical control point system (HACCP). More than 60% respondents were suggested to improve dairy production, handling, consumption and marketing we should have access to improved breeding, efficient AI services, veterinary services, improved forage, developed infrastructure, credit, trained on milk production and handling, concentrate mix, cooperative and marketing in our locality. Greater than 80% of the respondent dairy producers are not observed the kind of diseases or pathogens (Anthrax, tuberculosis, mastitis and brucellosis) can be transmitted from cattle or milk to humans. Family members are more vulnerable to dairy food borne illness were babies (0-3 years) (93.6%), pregnant women (40.4%), children (4-12 years) (36.2%), elderly (17%) and youngsters (2.1%), respectively. The milk safety risks for vulnerable groups from different sources of contamination were reported that babies (0-3), children (4-12 years), pregnant women and elder very risky by microbial, chemical and physical contamination of dairy products compared with youngsters. Accordingly 63.8% agree and 29.8 strongly agree that necessary to provide the extra-safe milk with a special label, which will distinguish it from the other products. About 68.1% respondents revealed to definitely buy extra-safe milk with the price set by producers.

Conclusion and recommendation

From the present results was revealed that dairy production, handling, consumption and marketing we should have improved through improved breeding, efficient AI services, veterinary services, improved forage, developed infrastructure, credit, trained on milk production and handling, concentrate mix, cooperative and marketing. Therefore, future work will be focus on these interventions.

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Estimation of Slaughter Parameters for Ethiopian Arsi Cattle

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Abstract

This study was conducted in 2011 on 72 live animals and carcass samples of Arsi breed cattle slaughtered in Adama city's municipality abattoir with objective to estimate slaughter parameters i.e., heart girth (HG), slaughter weight (SW), carcass weight (CW) and dressing percentage (DP). Breed and production system and age were identified by phenotypic traits and dentition development, respectively. HG, SW and CW were significantly different across age groups ($P < 0.05$) but significant difference was not observed due to production system differences ($P > 0.05$). Experimental animals had mean HG, SW, CW and DP of 164.87±9.03cm, 308.64±44.32kg, 163.13±29.09kg and 53.15±5.75% respectively. There was strong and weak positive correlation between carcass weight and heart girth ($r = 0.67$) and between slaughter weight and dressing percentage ($r = 0.17$,) respectively. Further studies maybe needed to confirm the present findings.

Keywords: Heart girth; slaughter weight; carcass weight

Introduction

Ethiopia has huge cattle resource and CSA (2012) inventory indicates 52.13million head of cattle being owned by sedentary population. These livestock resource is playing important role by contributing to the national economy (Ayele et al. 2003; Nell 2006). According to MoFED (2010) report agriculture has a contribution of 43.17% to the national GDP. Animal agriculture has 26.6% of total agricultural GDP and 11.48% of total national GDP. Livestock sector of Ethiopia is expected to continue growing given the large potential for increasing meat production, the expected growth in income, increased urbanization and improved policy environment (MoFED 2010). In recent years feedlot firms are flourishing and getting engaged in the export of processed meat and live animals. These firms are exporting live animals and processed carcasses to various countries in close proximity of Ethiopia *i.e.,* Africa and the Middle East and absorbing in foreign currency from international markets. The Middle East and North African (MENA) countries prefer live animals and carcass produced from lowland areas. As a result, about 90% of live animals exported to the MENA countries are collected from lowland areas (Mohammed 2007). Studying the reason behind this preference would help to know the variation in meat quality if affected by altitude and the value addition work needed that can satisfy consumers. In addition to this, studying the effect of age and production system on slaughter parameters can indicate variation in meat quality. Beside preference, due to other reason the amount of live animals and processed carcass that Ethiopian firms export is too small in the international market when compared to Botswana and South Africa (OECD/FAO 2007). In MENA meat market, Brazilians, Argentines and Australians exporters takes the bigger share by exporting world class quality meat products and live animals. These leading exporters have already well-developed facilities and follow stringent quality control systems to maintain their prestige and secure their share (Ross and Keeping 2008). Ethiopian beef exporters claim the lack of quality animal supply, limited processing, packaging facilities and limited application of sanitary and quality standards and others as main challenge to exploit the sector. Therefore, this study was carried out to estimate some of slaughter parameters for Arsi cattle across different ages and production systems.

Materials and Methods

The Study Area

This study was conducted in Adama municipality's slaughterhouse. Adama city, which is one of the biggest cities in Oromia Regional State (in Ethiopia) is situated on 100km South-East of Addis Ababa, the capital city of Ethiopia. Adama city has an average altitude of 1666m above sea level (Google Earth 2012). The Adama municipality has one abattoir that gives service to cities' community. The abattoir is semi-modern that operates with services featuring cattle, sheep and goat slaughtering. The annual average minimum and maximum temperatures of Adama city are 18 and 32 degree Celsius (Zoover 2011). The specific geographical location of the abattoir is on the geographic coordinates of 8° 33' 05.79''N and 39° 15' 34.83''E.

Animal sampling, age and production systems determination

Arsi cattle were the main target of this study. Breed identification was done using the phenotypic traits that distinguishes the breed. The typical phenotypic traits used to distinguish Arsi cattle are combinations of Coat color (typically red, black, roan, white and combinations) Muzzle color (Red or black), Dewlap structure (prominent but thin of skin), Ear type (erect), Horn type (small, usually crescent-shaped) and Hump type (usually medium size). In addition to these traits, East Shoa administrative zone is one of the zones where almost fully Arsi cattle are predominantly found (DAGRIS 2007). Arsi breed cattle are reared in Arsi, West Arsi, Bale and East Shoa administrative zones and can be found in zones adjacent to Arsi, West Arsi, Bale and East Shoa administrative zones. These Arsi cattle are reared in both lowland and highland areas of the zones and it is mainly used for draught, meat and milk (MoARD 2007).

Production system was categorized based on agro-ecology of the areas under which the farmers produce cattle. Thus cattle production systems were categorized as highland and lowland production system (FAO 1996). To differentiate the animal under which production system (as highland or lowland origin) it was raised the phenotypic observations such as coat hair and fur structure was used (MoARD 2007). The highland cattle are distinguished by thick hair and the lowland cattle having short and lustering fur. For example, highland cattle are larger in body frame whereas lowland cattle are shorter and slender with predominantly faun color. The highland cattle are usually healthy and hardy as they are exploited in plow. The ages of the sampled animals were estimated according to CABSESP (2009) Age Verification Guideline.

Accordingly, the production system, breed (Arsi cattle) and age of cattle were identified and marked as the animals randomly entered the abattoir premise. A total of 72 animals were randomly sampled in the abattoir. According to classification based on production system, out of 72 animals sampled 42 were from lowland and 30 were from highland. Age of animals sampled ranges from 4 to 13years and categorically animals were distributed over the age considered by this study. Since the animals were taken randomly, the animal distribution across age and production systems treatment was unequal. The parameters evaluated were heart girth, slaughter weight, carcass weight and dressing percentage. The sampled animals were also measured for heart girth (with tape meter) and slaughter weight and carcass weight (with digital balance).

Digital cattle weighing scale (Model number = MTI500WB that has sensitivity of 500 gram) was used to measure slaughter weight and hot carcass weight. Heart girth and slaughter weight were measured before slaughter. Heart girth was measured by surrounding the thorax (chest, breast) with a tape meter, exactly behind the shoulder (magnitude in cm). After slaughtering, hot carcasses were weighed with digital balance and hot carcass dressing percentage was determined by dividing the carcass to slaughter weight, multiplied by 100%.

Experimental design

The experimental design of the slaughter parameters study was 2^8 Factorial in a Completely Randomized Designed (Factorial-CRD). The age has eight levels and production systems factor has two levels. The slaughter parameters that were estimated with this study are slaughter weight, heart girth, carcass weight and dressing percentage. The general linear model procedure of SAS (2008) was employed to analyse the effect of age and the production system on the slaughter parameters. Mean separation was done by DMRT when the F-test was significant ($P \leq 0.05$). The model was:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_k + e_{ijk}$$

Where; Y_{ijk} = the response variable

μ = the overall Mean

α_i = the effect of Age

βj = the effect of Production System

$\alpha\beta_k$ = the effect of interaction of Age with Production System

e_{ijk} = Random error

Results and Discussion

Slaughter parameters.

The least square means of carcass parameters are given on Table 1. The overall f-test for effect of age, production system and interaction of age by production system on slaughter parameters (heart girth, slaughter weight, carcass weight and carcass dressing percentage) of Arsi cattle slaughtered in Adama was significant ($P < 0.05$) and this is in agreement with Bures et al. (2007) that reported the slaughter weight varies significantly across ages and breeds. Heart girth, slaughter weight and carcass weight were significantly different across different ages ($P < 0.05$) but not significantly different due to production system differences. The interaction of age by production systems has also significant effect on heart girth, slaughter weight and carcass weight ($P < 0.05$). Bures et al. (2007) and Bures and Barton (2012) also reported that slaughter weight, hot carcass yield and dressing percentage significantly varies between sex, breeds and ages.

The average Arsi cattle's heart girth, slaughter weight, carcass weight and dressing percentage at the abattoir are given in Table 2. The hot carcass weight and dressing percentage of Arsi cattle that were slaughtered at Adama abattoir was 163.13 ± 29.09kg and 53.15 ± 5.75% respectively were found to be higher than 125.07 ± 21.47 kg and 47.78 ± 2.82% reported by Haryoko and Suparman (2009) for PO cattle and 47.49% for Borana and 44.93% for Kereyu breeds (Mohammed et al., 2008) that were grouped in the same Small East African Zebu with Arsi cattle. The dressing percentage of hot carcass for Arsi cattle is comparable with 59.36% reported by Melton et al. (1974) for mature Herford and 55.15-56.87% reported by Bures and Barton (2012) for 14-18 months crosses of Charolais and Simmental bulls and heifers. But hot carcass yield of Arsi cattle is far less than 233kg reported by Abdelhadi et al. (2011) for Baggara breed (zebu cattle). This large disparity in carcass yield and dressing percentage between Arsi breed and compared close breeds could be attributed to the effect of inbreeding that long existed in Arsi cattle. This suggestion conforms to the findings of Asimwe and Kifaro (2007).

Table 1. Least Square Means of Carcass Parameters by different ages and production systems

Variable	HG(cm) ± SE	SW(kg) ± SE	CW(kg) ± SE	DP(%)± SE
Age	*	**	*	Ns
5-6yr	168.5^{ba} ±3.51	349.2^{ba} ±16.58	187.8^{ba} ±11.40	53.8 ±2.55
6-7yr	169.1^{ba} ±3.72	323.8^{bac} ±17.58	169.6^{bac} ±13.96	53.3 ±3.12
7-8yr	164.3^{b} ±2.39	299.6^{bc} ±11.33	163.3^{bac} ±7.79	54.5 ±1.74
8-9yr	161.5^{a} ±2.26	303.9^{bc} ±10.70	157.8^{bac} ±8.18	52.9 ±1.83
9-10yr	174.7^{b} ±3.28	354.8^{a} ±15.51	188.7^{a} ±10.66	53.1 ±2.38
10-11yr	164.7^{b} ±3.39	293.1^{c} ±16.05	146.6^{c} ±11.04	50.4 ±2.47
11-12yr	162.4^{b} ±3.72	285.8^{c} ±17.59	152.0^{bc} ±12.09	52.9 ±2.70
12-13yr	162.8^{b} ±3.51	291.2^{c} ±16.58	158.2^{bac} ±11.40	54.5 ±2.55
Prod	Ns	Ns	Ns	Ns
Highland	165.6 ±1.83	309.5 ±8.64	166.3 ±5.97	53.9 ±1.33
Lowland	166.5 ±1.41	315.9 ±6.69	164.7 ±4.96	52.5 ±1.11
Age* Prod	*	**	*	Ns

Yr = year, prod =production system, age = different age groups, Age*Prod = interaction of age by production system, HG = Heart Girth; SW = Slaughter Weight; CW = Carcass Weight; DP = Dressing Percentage' SE = Standard Error of means

Table 2. Means of slaughter parameters of Arsi cattle that were slaughtered at Adama abattoir (n = 72)

Variables	Mean	S.D
HG (cm)	164.87	9.03
SW (kg)	308.64	44.32
CW (kg)	163.13	29.09
DP (%)	53.15	5.75

S.D = standard deviation, N = number of samples

Carcass weight estimator

Carcass yield estimation models for Arsi cattle slaughtered in Adama are given in Table 3. Best fitting model was selected by model selecting tool of SAS (2008) with relatively smaller conceptual predictive (cp) criteria, higher R^2, smallest Akaike information criterion (AIC) than other independent variable combinations. Accordingly the following two models were selected. Y_1 estimator can be used to estimate the expected carcass yield or weight at constant dressing percentage which would be more helpful for butcher to estimate how much carcass would be produced from a given Arsi bulls. Y_2 model can be used to estimate the expected carcass weight at varying dressing percentage which would only be fitted to the analyzed data of this paper.

Table 3. Carcass weight (CW) estimation model for Adama abattoir cattle samples (n = 72)

Variable	Model	Adj.R^2
CW(y_1)	$66.3+0.003(HG*SW)-0.0015\ (HG^2)$	0.62
CW(y_2)	$-168.65 + 3.166\ (HG) + 0.53\ (SW)$	0.99

Relationship among carcass parameters

The degrees of correlations among carcass parameters are given Table 4. The heart girth and slaughter (live) weight of the animals were strongly correlated (r = 0.78). There is significantly strong positive correlation between carcass weight and heart girth for Arsi cattle (r = 0.67). There is positive but weak relationship between slaughter weight and dressing percentage (P > 0.05, r = 0.17) and this in agreement with Chladek and Ingr (2003) report of a non-significant (r = 0.04) correlation. The slaughter weight and carcass weight have strong positive relationship (r = 0.77) and this is also in agreement with Chladek and Ingr (2003) report (r = 0.98) and Wheeler et al. (2005) report (r = 0.95) of correlations between slaughter weight (live weight at slaughter) and hot carcass weight. There is strong relationship between carcass weight and carcass dressing percentage (r = 0.8).

Table 4. Correlation matrix between slaughter parameters (n = 72)

Variables	CW	HG	SW	DP
CW	1	0.67^{***}	0.77^{***}	0.58^{***}
HG		1	0.78^{***}	0.07^{Ns}
SW			1	0.06^{Ns}
DP				1

Ns for p > 0.05, * for p < 0.05, ** for p < 0.001, *** for p < 0.0001

Conclusion

As this study showed, heart girth, slaughter weight and carcass weight were significantly varied across different ages (P < 0.05) but not across different production systems (P > 0.05). This implies that age can significantly result in variation on slaughter parameters (heart girth, slaughter weight and carcass weight) than production system (lowland and highland). The mean figures of slaughter parameters (heart girth, slaughter weight and carcass weight, 164.8±9.03cm, 308.6±44.32kg and 163.1±29.09kg respectively) also showed that Arsi breed cattle are one of short framed African breeds. There is strong positive relationship between carcass weight and carcass dressing percentage (r = 0.8), between heart girth and slaughter weight (r = 0.78), and between slaughter weight and carcass weight (r = 0.77). Therefore, the regression model developed from these slaughter parameters *i.e.,* heart girth, slaughter weight and dressing percentage can better estimate carcass to be harvested from an animal. Further studies maybe needed to confirm the present findings.

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Effect of Honeybee (Apis mellifera) Pollination on Seed Yield and Quality of Guizotia Abyssinica (L.f.)

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Abstract

A flower of Guizotia abyssinica (L.F.) opens and liberates pollen early in the morning, the style emerges about midday and the plant is thus basically self-sterile. Hence G. abyssinica is a cross pollinated crop with cross pollination percentage ranging from 0 to 100 percent. Locally the role of honeybees' pollination however is still poorly understood and up to now not sufficiently appreciated. Hence, this experiment was carried out to evaluate the effect of the honeybee pollination on seed yield and quality of G. abyssinica. The study was conducted in a complete randomized block design (RCBD) with three treatments and four replications at Mekelle Agricultural Research Center farm. The treatments were crops caged with honeybee, caged without honeybee and open pollinated. The obtained data related to seed yield and quality were statistically analyzed using one way ANOVA using Genstat 14th version statistical software and least significant difference (LSD) was calculated to identify significant difference among the treatments mean. The highest seed yield/ha was found in crops caged with honeybees (16.7quintal) followed by open pollinated crops (13.3quintal), while crops excluded from insects had the lowest yield (9.6 quintal). So the study investigated that honeybees and other insect pollination had a significant effect on seed yield of G.abyssinica. Therefore, it is recommended to keep sufficient number of honeybee colonies in the vicinity of G.abyssinica fields during its flowering period to increase the pollination efficiency and thereby enhance seed productivity and quality.

Key words: *Guizotia abyssinica, honey bee, pollination, seed yield*

Introduction

Guizotia abyssinica (L.f.) is one of the indigenous and important oil crops both for domestic and commercial uses to Ethiopia (Weiss, 2000; Ethiopian Ministry of Agriculture, 2011). It is commonly known as Ramtil, Kalatil, Gurellu, Tilangi, Neuk, Noog and Nug (Dhurve, 2008). *Guizotia abyssinica* has the highest share and contributes up to 50% of the Ethiopian oil seed crop production (Weiss, 2000; Ethiopian Ministry of Agriculture, 2011). It is also one of the major honeybee plants of Northern Ethiopia (Haftom *et al.,* 2011). Honeybees visit its flowers for collection pollen and/or nectar (Haftom *et al.,* 2014b), which in turn results into florets get cross pollination (Dhurve, 2008). A flower of *G. abyssinica* opens and liberates pollen early in the morning, while the style emerges about midday and the plant is thus basically self-sterile, although self-pollination has been recorded (Weiss, 2000). *G. abyssinica* is a cross pollinated crop with cross pollination percentage ranging from 0 to 100% depending on the genotype and other environmental factors (Subhas, 2005). However, as a cross pollinated crop, the effect of insect foragers more particularly honeybees have not so far been exclusively studied locally. Even honeybee pollination is important in crop production as water or fertilizer (Jacobs *et al.,* 2006), local farmers keep honeybees for honey and/or wax uses only (Gidey and Mekonen, 2010). Moreover, the role of honeybees for pollination of the local farming systems is still poorly understood and up to now not sufficiently appreciated (Jacobs *et al.,* 2006). Despite local knowledge on the economic importance of honeybee pollination, it is also common to see insecticide application when honeybees are at high traffic (Haftom *et al.,* 2014b). Hence, this study was designed to determine the effect of honeybee pollination on yield and quality of *G. abyssinica* seeds.

Materials and methods

Description of study areas

The study was conducted during the 2013 cropping season at Mekelle Agricultural Research Center, Illala site (Fig 1). It is located North East of Mekelle at an elevation of 2012 meters and at N13031'21. 2" latitude and E39030'14. 7" longitude.

Experimental setup

For this experiment plants were grown with the recommended agronomic package practices. The crop was planted with a seed rate of 10kg/ha, 40cm distance spacing between rows and 10cm distance between plants. DAP and Urea were applied immediately after sowing and tinning of seedlings at a rate of 100kg/ha, respectively. Tinning of seedlings was done two weeks after sowing. The study was conducted in a complete randomized block design (RCBD) with three treatments and four replications in an experimental plot size of 3m×3m. The treatments were crops caged with honeybee (one colony of five combs), caged without honeybee and open pollinated (exposed to all insects including honeybees). The cages were put immediately before the beginning of blossom and colony transferring was done at 5-10% flowering stage of the plant.

Figure 2: The treatments: crops caged with honeybee, caged without honeybee and open pollinated

Number of head flowers, plant height and flowering period

The total number of flowers/plant was determined by counting the total number of head flowers. The height of the plant was measured from ground level to the tip of the longest branch with the help of a measuring tape. The flowering period of the plant was determined by recording the flower starting and ending date of the plants. To study the number of head flowers/plant, plant height and flowering period/plant a sample of ten, ten and nine plants were selected randomly from each plot, respectively.

Number of pods and seeds per plant and seeds per pod

Seeds were measured after drying the plants. The seed yield/ha was obtained by tacking the weighing of clean grains collected in the central area of each net plot (1m by 1.2m) in all treatments. To obtain the average number of pods per plant samples were taken from five randomly selected plants from each plot. The number of seeds per pod was determined by taking five seed pods/plant from a total of five plants per plot. The evaluation of average weight of seeds was made through weights of 1000 seeds. To know the total number of seeds/plant, the seeds were separated and counted manually.

Germination rate and oil content

To determine the germination rate of *G.abyssinica* seeds, 50 seeds from each plot were taken and placed on germination paper and kept in a Petridish at room temperature. The germination count was made after 6 days and then the obtained data were converted to a percentage. The oil content of *G.abyssinica* seeds was analyzed using Soxhlet method (AOAC, 2007). For this purpose a sample of 100g of seeds was taken from each plot and the obtained oil content was converted to a percentage.

Harvesting time

Date of harvest was investigated by recording the number of days starting from its time of sowing to its time of harvesting. Time of harvest was identified by looking plants that start to shatter their seeds or plants open their seed pods. The harvesting was made immediately after the seeds start to shatter.

Statistical Analysis

The obtained data related to seed yield and quality parameters were statistically analyzed using one way ANOVA analysis of variance and least significant difference /LSD/ was calculated to identify the significant differences among the treatments means. The data for the number of seeds/pod, head flowers/plant and seeds/plant were subjected to ANOVA after data transformed using *log (base10)*. The data were analyzed using Genstat 14^{th} version statistical software.

Result and Discussion

Number of head flowers, flowering period and plant height

Flowering period and number of head flowers of *G.abyssinica* were significantly affected by the mode of pollination. Plants caged without honeybees had the highest number of head flowers/plant, while plants caged with honeybees had the smallest number (Table 1). Crops caged without insects had also the longest flowering period (28.8 days), whereas open pollinated crops had the smallest flowering period (20.6 days). Similarly, Oz *et al.,* (2009b) revealed as flowering period and number of flowers/plant affected by the mode of pollination and the longest flowering period was reported in canola crops caged without bees followed by open pollinated crops. This might be the reason for the early maturation of the plants exposed to insects, i.e. open pollinated crop was harvested 8 days earlier than plants caged without insects. This may indicate mode of pollination had a great contribution for early maturation of seeds.

Plant height was not significantly affected by the mode of pollination (Table 1). Plants caged without honeybees and caged with honeybee had 108.9cm, and 106.0cm height, respectively. In Faba bean (*Vicia faba* L.) also self-pollinated crops had higher height than plants pollinated by bees (Musallam *et al.,* 2004).

Table 1: Number of head flowers, flowering period and plant height

Treatment	Number of head flowers	Height (cm)	Flowering period (days)
Open pollinated	52.6 (1.71) ^{b}	106.0	20.6^{c}
Caged with honeybees	48.3 (1.67) ^{b}	108.4	24.6^{b}
Caged without insects	64.8 (1.79) ^{a}	108.9	28.8^{a}
LSD	0.04		1.99
P value	<0.001	0.559	<0.001

Figures in the parentheses are head flowers per plant Log (base10) transformed values. Column means with different superscript letters are significantly different (P<0.05)

Number of pod, seed per pod and seed per plant

Significant variation was observed in number of seeds/pod among the treatments (Table 2). Plots caged with honeybees had the highest number of seeds/pod (30.9), while the plants caged without insects had the least number of seeds/pod (7.8). Sattigi *et al.,* (2004) also found the highest (33.0) and the least number of seeds/pod (17.8) in crops caged with bees and without honeybees, respectively. In sunflower, crops caged with honeybees increased significantly the percentage of seed setting, number of filling seeds/ head, compared with crops caged without honeybees (Oz *et al.,* 2009a). As indicated in Table 2, the highest number of seeds/plant (1089.7) were found in plants caged with honeybee followed by open pollinated plants (702.2), whereas the least number of seeds/plant was found in plants caged without insects (656.4). However, the number of pods /plant was not affected by the mode of pollination and non-significant difference was noticed among the treatments (Table 2).

Table 2: Number of seed pod, seed/pod and seed/plant

Treatment	Number of pod/plant	Number of seeds /pod	Number of seeds /plant
Open pollinated	47.3	18.2 (4.0)^{b}	702.2 (25.3)^{b}
Caged with honeybees	51.8	30.9 (5.5)^{a}	1089.7(32.4)^{a}
Caged without Insects	62.0	7.8 (2.6)^{c}	656.4 (24.4)^{cb}
LSD		0.74	4.50
P value	0.052	<0.001	0.001

Figures in the parentheses are number of seeds/pod Log (base10) transformed values. Column means with different superscript letters are significantly different (P<0.05)

Seed yield/ plant, weight of 1000 seeds and seed yield/ plot

Significant variation was observed among the treatments regarding seed yield/plant and seed yield/ha (Table 4). Plant caged with honeybees had the highest seed yield/plant (5.7g), while plants caged without honeybees had the lowest yield (2.9g). Related to 1000 seed weight, plants caged with honeybees and plants caged without honeybees had 5.1g and 5.0g, respectively, while open pollinated had 4.9g. However, non-significant variation was observed among the treatments related to 1000 seed weight. In *G.abyssinica* Dhurve (2008) was not also found a significant difference among the three modes of pollination related to 1000 seed weight.

Mode of pollination had a significant effect on the seed yield/ha (Table 3). The highest seed yield/hectare was obtained from crops caged with honeybees (16.7 quintal) followed by open pollinated plots (13.3 quintal), whereas crops excluded from insects had the lowest yield (9.6 quintal). The higher yield of crops caged with honeybees might be due to the higher pollination efficiency of the honeybees inside the cage. Rao and Suryanarayana (1990) also reported three times higher yield in plots caged with honeybees as compared with plots caged without honeybees. Dhurve (2008) also found higher yield in crops caged with honeybees than crops caged without insects.

Table 3: 1000 seed weight and seed yield per plant and plot

Treatment	1000 seed weight (g)	Seed yield / plant (g)	Seed yield / net plot (g)	Seed yield /hectare (quintal)
Open pollinated	4.9	3.0 (1.7)^{b}	159^{ba}	13.3^{ba}
Caged with honeybees	5.1	5.7 (2.3)^{a}	200^{a}	16.7^{a}
Caged without Insects	5.0	2.9 (1.6)^{cb}	115^{cb}	9.6^{cb}
LSD		0.30	57.1	4.8
P value	0.76	< 0.001	0.035	0.035

Figures in the parentheses are seed yield/plant (Log (base10) transformed values ; Column means with different superscript letters are significantly different (P<0.05)

Germination rate and oil contents

The mode of pollination had also significant effect on germination rate of *G.abyssinica* seeds (Table 4). The highest germination rate (86.2%) was found in plants caged with honeybees followed by open pollinated (79%), while the lowest germination rate (60.5%) was found in plants excluded from insects. Dhurve (2008) revealed that *G.abyssinica* crop caged with bees had a 19.79% increase in germination rate over crop caged without bees. In onion seed, Adel *et al.,* (2013) also reported as open pollinated plants showed a higher germination rate than those isolated from insect visitors.

The oil content of crops in open field plot, caged with honeybees and caged without insects had 41.52, 41.49 and 38.98%, respectively. However the mode of pollination had no significant effect on the oil content of *G.abyssinica* seeds (Table 4). It was also in agreement with the finding of Dhurve (2008), who reported that mode of pollination had no significant effect on the oil content of *G.abyssinicas* seed. The oil content of the plant was in line with the finding of Naraja (2009), who reported with a range of 35-40%.

Table 4: Germination rate and oil content of *G.abyssinica* seeds

Treatment	Germination rate (%)	Oil content (%)
Open pollinated	79.0[a]	41.52
Caged with honeybees	86.2[a]	41.49
Caged without Insects	60.5[c]	38.98
LSD	13.86	2.617
P value	0.010	0.089

Column means with different superscript letters are significantly different (P<0.05)

Conclusion and Recommendation

The study revealed that honeybees and other insect pollinators had a significant effect on seed yield of *G.abyssinica*. The highest seed yield/ha was obtained from crops caged with honeybees (13.3 quintal), whereas crops excluded from insects had the lowest yield (9.6 quintal).The mode of pollination had also a significant effect on producing viable seed of *G.abyssinica*. The highest germination rate (86.2%) was found in plants caged with honeybees, while the lowest germination rate (60.5%) was found in plants excluded from insects. However, the mode of pollination had not effect on the oil content of *G.abyssinica* seeds. Therefore, it is recommended to keep sufficient number of honeybee colonies in the vicinity of *G.abyssinica* fields during its flowering period to increase the pollination efficiency and thereby enhance seed productivity.

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Environmental Conservation and Income Creation as Adaptation to Climatic Change: the Case of Landless Cattle Owners in Tigray, Ethiopia

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Abstract

A rapidly growing number of landless people coupled with the increasing threats posed due to the adverse effects of climate change have pressurized the Tigray region to rethink about long-term solutions. Distribution of communal mountainous hillside areas to the landless people was regarded as a pathway to address such a problem. This study was profoundly based on distributed hillside areas to identify whether conservation and income creation activities done by the landless cattle owners contributed to address the negative effects of climate change in the Tigray region of northern Ethiopia. Based on the potentiality of the areas in which enormous landless cattle owners were found, the study was conducted in two selected districts namely; Hintalo-Wejerat and Ofla. Out of the total 1006 landless cattle owners, 251 them were randomly selected for interview (226 males and 25 females). Data were gathered using semi-structured questionnaires including ideas from group discussants and key informants. The study revealed that repeated droughts caused by climate change left the landless cattle owners with crop failure due to lack of rain; followed by herd decimation because of lack of animal feed. Majority of them sensitized the effects of climate change in terms of rainfall variability, temprature change, lack of animal fodder, untimely raining and flooding, scaricty of water, shortage of human food and drying of water sources. To respond to these effects, the landless cattle owners in the districts applied various conservation measures such as stone bund, trench, planting trees, cactus, guarding and terracing using aloe. Having implemented vaious conservation measures, the main income sources pursued by the landless cattle owners were; beekeeping, production of vegetables, timbering, sales of fuel-wood, fodder, off-farming and livestock rearing. Estimated results revealed that gender, family size, perception on benefits, involvement in social affairs, extension services provided by development agents, stone bund terracing, tree plantation, location of the study area and guarding were the major determinant factors that affect the landless cattle owners to involve in various income sources simultanously.

Key words: *adaptation, climate change, conservation, cattle owner, hillsides, landless*

Introduction

The intertwined dependence among climatic change adaptation, environmental conservation and rural income creation has become one of the prevailing concerns of the developing world. In dealing with potential adaptive measures to respond to climatic change, environmental rehabilitation with the aim of creating sustainable rural incomes is a prior choice as long as the icome sources for the rural poor are harmless to the environment (Habibah, 2010; FAO, 2012). In the case of Ethiopia, environmental rehabilitation has long become a priority concern because about 85% of its population is predominantly relying on rural-based natural resources which are entirely liable to overexploitation. This is also compounded by severe land degradation due to poor environmental management and traditional farming systems (Yesuf et al. 2008; Badege, 2009). Consequently, the country's smallholder farming is mainly exposed to extended droughts and annual rainfall fluctuations; and its agricultural system is at its low technological capacity to respond to the adverse effects of climate changes (Barber et al., 2003). This has further put the country's agricultural productivity under the threat of climate change; where its annual yield from both livestock keeping and cropping has become unable to support the rural income and food security (Hurni et al., 2005; Carolyn and Asenso, 2011).

Similar situation has been noiced in the northern Ethiopia where the effect of climate change worsens the vulnerability of landless cattle owners to the loss of their assets which eventually led them into chronic poverty and entire loses of livelihood bases. On the one hand, the landless cattle owners suffer to fulfil the subsistence need for their faimily members by searching possible income sources, and on the other side, they need to face the existing harsh environment in search of fodder for their animals. In the face of such events, the landless cattle owners have been affected by double challenges while confronting subsequent droughts and rainfall fluctuations that come about due to the effects of climate change. Like that of the country, many people in the Tigray region do not possess land grants and landlessness in the area has become the main causes of environmental damages that ultimately triggers the negative effects of climate change. Such effects are manifested in terms of failure of cultivated crops and decimation of livestock during the worst droughts (Carolyn and Asenso, 2011), which have been further accentuated by land degradation because of dependency of many landless people on the natural environment. In the Tigray region, cultivable land has long been distributed repeatedly and has currently become very fragmented. As the result, most hillside areas, which were covered with forests during the 1970s (Berhanu et al., 2006) became devoid of vegetation.

Envisaging the continual challenges prevailing due to the negative effects of climate change and looking for long-term solutions, the Tigray Regional State regarded community-based mountainous conservation activities as one of the important measures to address the adverse effects of climate change. In the act of creating easier accesses for the involvement of the villagers on hillside conservation practices at community and individual levels, the regional government distributed bared communal hillside areas to the landless people in the thought that they could privately improve the allocated areas in due course of supplementing their incomes (Yifter et al., 2005; Carolyn and Asenso, 2011). Using the distributed hillside land grants, the landless cattle owners are the ones who have implemented various conservation practices while also maintaining their livelihoods. The intention of this study was to investigate whether hillside conservation and income creation could contribute to adapt to the negative effects of climatic change. The specific objectives of the study were therefore; 1) to identify responses of landless cattle owners to climate change and 2) to verify whether hillside conservation and income creation serve as adaptation to climatic change in the districts of *Hintalo-Wejerat* and *Ofla* in the northern Ethiopia, Tigray.

Materials and Methods

Sampling Design

This study was based on data gathered during the year 2013 from the districts of *Ofla and Hintalo-Wejerat* in the Tigray Regional State, northern Ethiopia. The district, *Ofla,* is located in the southern part of the Tigray region with an elevation ranging 1500 to 2539 meters above sea level. *Hintalo-Wejerat* is also located in the South-Eastern Zone of Tigray with its altitude ranged 1400 to 2450 meters above sea level. The study used a two stage sampling procedures for the selection of representative households. In the first stage, the study areas were stratified into two agro-ecological zones (midland and highland). The purpose of using such stratification method for the study was to increase the precision level of the needed data by eliminating the variances between the stratums. Using this method, 251 household cattle owners (25 females and 225 males) were sampled out of the total 1006 landless cattle owners. At the second stage, simple random sampling was used to select each landless cattle owner from each strata. Based on the reconissance survey, representative sample was selected by using sampling size estimator targeting on both women and men headed proportions. A total of 251 sample household heads were selected at 95% desired confidence level, and (±5%) desired confidence interval. Of these, 90% landless cattle owners were men headed and 10% were women headed.

Data Sources and Collection

The main source of the study was relied on data obtained from the survey of landless cattle owners conducted in October 2 to December 18, 2013. In this study, both primary and secondary data were gathered from the landless cattle owners, key informants and group discussants. A Semi-structured interview queationnaire was developed to collect the necessary primary data by which both quantitative and qualitative data were collected from the sampled respondents through face-to-face interview. Qualitative data were also gathered from focus group discussants, key informants and personal observations. In addition, secondary data were collected from available research reports and records of the *Tigray* Bureau of Agriculture and Rural Development and published materials.

Data analysis

Both qualitative and quantitative data analyses methods were applied. Descriptive statistics such as measures of central tendency and dispersion were employed.The strength and direction of relationships between different selected dependent and independent variables were examined using statistical tests like chi-square to look at the associations between discrete variables and the t-tests to compare the mean differences between continuous variables. In this study, Seemingly Unrelated Regression was used to verify whether the error terms of the separate equations of the various income sources (beekeeping, vegetables, timbering and fuel-wood) were correlated each other. (Kmenta, 1986). The Seemingly Unrelated Model is superior to univariate analysis because it considers the common decisions made by the landless cattle owners expressed in terms of multiple variables simultaneously (Avery, 1977). Then, a series form of the seemingly unrelated regression can be presented as:

$$\mathbf{y_1 = X_1\beta_1 + \mu_1}$$
$$\mathbf{y_2 = X_2\beta_2 + \mu_2} \quad \text{---} \ (1)$$
$$\mathbf{y_3 = X_3\beta_3 + \mu_3}$$
$$\mathbf{Y_N = X_N\beta_N + \mu_N}$$

Representing each separate equation by vector forms, the system of N number of dependent variables shown by equation (2) is:

$$\mathbf{y_i = X_i\beta_i + \mu_i} \qquad \textbf{for i = 1, 2, …, N} \quad \text{------------------------------} \ \mathbf{(2).}$$

Where $\mathbf{y_i}$ is a vector of observations on the i^{th} dependent variables; $\mathbf{X_i}$ is a matrix of observations for the explanatory variables for the ith equation; $\boldsymbol{\beta_i}$ is the vector of parameters for the ith equation; and $\boldsymbol{\mu_i}$ is the vector of disturbances for the ith equation. The outcome variables $(y_1, y_2, \mathrm{y}_3\, and\, \mathrm{y}_\mathrm{N})$are all continuous in nature just like the outcome variable for an OLS model. The key assumption we have made here is that the error terms of these four equations are correlated one another. The rationale for applying the Seemingly Unrelated Regression (SUR) is that the error terms of the four equations $(\varepsilon_1, \varepsilon_2, \varepsilon_3\ and\ \varepsilon_N)$ representing each income source may be correlated each other.

Results and Discussions

Sensitized Indicating Factors for the Effects of Climate Change

Given the importance of getting specific data on cattle owners' adaptation methods to respond to climate change, prior data were needed to unravel whether they sensitized the adverse effects of climate change and to specify the types of the effects they felt. The percentage of the sampled cattle owners that sensitized the effects is presented in Table 1. Out of the total interviewed respondents, 96% of them perceived repeated frequencies for the occurance of droughts. They sensitized that such prolonged drought occurances were their major challenges which were apparently noticed as effects of climate change. The respondents witnessed that repeated drought left them with crop failure due to lack of rain; followed by herd decimation because of lack of animal feed. For instance, 95% of the landless cattle owners confirmed that they faced crop failure twice or more times within a five years' period. In their reports, majority of them sensitized the effects of climate change in terms of rainfall variability (77%), temprature change (70%), lack of animal fodder (98%), untimely raining and flooding (94%), scaricty of water (97%), shortage of human food (86%) and drying of water sources (85%). Repondents clearly indicated that because of crop failure and loss of animal herds that caused by frequent droughts, the landless farmers fail to supplement their means of living, which further led them to poverty crisis.

Table 1: Sensitized Climate Change Effects and Percentage of Landless Cattle Owners Felt Each Effect

No.	Sensitized Climate Change Effects	Landless Cattle Owners Felt Climate Change Effects by percent (N=251)	
		Number	Percent
1	Recurrent drought	241	96
2	Rainfall variability	193	77
3	Temperature change	176	70
4	Prevalence of animal diseases	109	43
5	Untimely raining and flooding	235	94
6	Heat stress increased	177	71
7	Scarcity of water	243	97
8	Lack of human food	213	86
9	Lack of fodder	247	98
10	Crop failure	238	95
11	Recently dried rivers and other water sources	214	85

As agricultural officers and group discussants further confirmed it, the landless people became dependent on the remnant natural resource bases to win their daily bread, which in turn escalated land degradation and the negative effects of climate change. About 94% of the respondents realized land damage caused by untimely raining and flooding that was one of the reasons for the manifestations of the ill effects of climate change. Nearly 97% of the landless cattle owners felt the effects of climate change in terms of water scarcity. They indicated that during the times of water shortage owing to climatic effects, many livestock owners altogether obliged to use the same water sources (rivers, ponds, wells and streams) to drink their animals. Based on the results found from the study area, cattle herds that commonly compete for similar water sources were likely to be liable to enormous diseases. This shows the need to introduce better cattle management such as zero grazing, which may address problems related to disease prevalence due to the influx of a large number of livestock used to drink the same water sources.

Socio-Economic Characteristics of the Landless Cattle Owners

Following the age category used by Jacobsen (1999), landless cattle owners whose ages between 15 and 64 years were grouped as active labour force population, whereas people whose age below 15 years and over 64 years were considered as inactive labour force group. As depicted in Table 2, the landless cattle owners were entirely in the age category between 23–36 years. The finding shows that almost all of the landless cattle oweners were found as active labour force. In terms of gender, 90% were males and the remaining 10% were females. Based on additional ideas obtained from the key informants and group discussants, female headed landless cattle owners were generally burdened with indoor family management tasks and imposed by cultural stereotypes which detered them from accessing to various income generating activities via hillside conservation to support their own livelihood. This finding is consistent with the studies made by Chala et al., (2012) and FAO (2012) in the sense that females in Ethiopia have cultural hindrances that obstructed their involvement in various developmental activities outside their home. It was further found that women were engaged in family management of daily house tasks such as cooking, washing and taking care of their children. In most cases, the men acted as the head of the household; in making money and satisfying the family demand.

The study results indicated that 31% of the landless cattle owners were not able to read and write, 42% could write and read, 25% reached primary level and about 1% went to secondary. Landless cattle owners with higher level of educational level sensitized the adverse of effects of climatic change. More educated landless cattle owners were found to possibly aware of the effects of climate change and the importance of mountain conservation to respond to the negative effects. The landless cattle owners rented-in land on average of about 0.27 hectare from other farmers who entitled land certificate. With respect to the experiences of the landless cattle owners on environmental rehabilitation and supplementing their income sources out of it, the mean years of experience they engaged in different income generating acivities was about 6. The major inome sources annualy obtained by the landless cattle owners were from timbering, fuel-wood (mainly of charcoal and fire-wood), livestock, honey, vegetable types, fruits and others as shown in Table 2.

Table 2: Socio-economic Characteristics of the Landless People

Socio-economic Characteristics of Landless Cattle Owners (N=251)	Mean	Minimum	Maximum
Age in years	28	23	36
Experience in years	6	1	12
Size of Cattle Holding (cows and oxen)	2.6	1	7
Land size in hectare (shared in)	0.27	0.11	1.25
Family size	3	1	6
Income from timbering	518	0	904
Income from fuel-wood	489	0	1190
Income from livestock	676	0	1300
Income from fruits	372	0	3500
Income from honey	1859	0	5270
Income from vegetables	1297	0	5825
Income from others (from off-farm and non-farm)	3672	1200	7960

Adaptation Measures Pursed by the Landless Cattle Owners to Respond to Climate Change

Table 3 depicts the summary of various adaptation measures performed by the landless cattle owners all over the study areas. About 69% of the respondents didn't adopt selected cattle varieties because of lack of information, limited access to provide collaterals to lending banks and credit institutes. The landless cattle owners further indicated that they found difficult to afford the existing price of selected varieties of cows particularly of the *Bagait* breeds (local selected cow breeds) being introduced to farmers of the entire region of Tigray. Although the respodents reported that they were concious to improve their income sources based on modern methods, only 31% of them practiced selected cattle varieties.

According to the landless cattle owners, diversified livestock and crop production were taken as their major adaptation methods to climate change although only 30% of them practiced *zero-grazing* (cut and carry system to feed animals). The landless cattle owners that pursuing zero-grazing asserted that they had improved cattle management because zero-grazing avoids contacts among livestock herds which enabled them to protect disease prevalence. In addition, feeding cattle using zero-grazing saved much walking hours for sreaching animal feed and shelter. Due to adoption of zero-grazing, they became easily accessible to cattle medication centers and other veterinary services for effective livestock disease control. Hence, zero grazing was regarded as a means to mange cattle herds in a specific area provided that food and shelter are supplied sufficiently. The respondents were asked whether they simultaneously produced cattle fodder using hillide areas along with the zero-grazing approach. Only 26% of the landless cattle owners attempted to produce animal feed in the land plots they got through renting and in the hillside areas they got through granting. This entails the need to educate further in bringing the behavioural changes of the landless people to shift their animal feeding practices, particularly towards local-based affordable practices such as land saving, time and finance savings through *zero-grazing*.

As the areas were subject to drought and food insufficiency, even before climate change issues became evident, serious concerns had been heightened regarding the use of irrigation, which has the greatest chance to enhace productivity in cattle and land. As the result, the majority of the landless cattle owners (89%) participted in various irrigation schemes to use water resource to the land they shared-in through different irrigation channels so that they could grow crops and obtain piles of straw and hay to feed their cattle. In recognition of searching for additional income sources beyond relying on products of livestock and crops, most of the landless cattle owners (83%) revealed that they supplemented their income through other generating opportunities such as shop, poultry, daily-labour wage and fattening. The remaining income sources reported by the landless cattle owners were; from production of vegetables (23%), beekeeping (27%), fruits (9%) and timber (10%). Along with these, the key informants and group discussants stipulated that hillside grants given to the landless cattle owners aimed to enable them supplement their incomes.

Table 3: Various Adaptation Methods Done by the Landless Cattle Owners

Adaptation Measures (N=251)		Frequency	Adaptation Measures Done by the Landless Cattle Owners in Percent
Use of selected livestock varieties	Yes	78	31
	No	173	69
Mixed crop and livestock	Yes	159	63
	No	92	37
Zero-grazing	Yes	75	30
	No	176	70
Diversified Livestock	Yes	224	89
	No	27	11
Off-farm activities	Yes	209	83
	No	42	17
Honey production	Yes	67	27
	No	184	73
Forage Production	Yes	64	26
	No	187	74
Use of irrigation	Yes	192	76
	No	59	24
Vegetable production	Yes	23	9
	No	228	91
Replace fuel-wood by renewable alternatives	Yes	56	22
	No	195	78
Credit service	Yes	176	70
	No	75	30

Major Factors that encourage Cattle Owners to diversify Income Sources

Table 4 demonstrates the regression outputs of seemingly Unrelated Regression Model to distinctively identify the major factors that induce the landless cattle owners to involve in various income sources. The Breusch-Pagan test of independence for the presence of simultaneous correlations between the paired separate equations of each dependent variable was statistically significant at 1% probability level (Prob > chi2 = 0.0000), indicating the presence of correlations between the error terms of each paired dependent variable. There four dependent income variables represented by the separate equations were the specific items obtained from honey, vegetables, timbering and fuel-wood (fire-wood and charcoal) each measured in Ethiopian Birr. Conducting regression estimations for each dependent variable on each respective explanatory variable, Stone/Soil bund is positively and significantly related to the income levels obtained from beekeeping, vegetables, timbering and sales of fuel-wood. A previous study on farmers' involvement on conservation activities to boost their income in the Tigray regional State also found that farm households that actively participated in conservation were more likely to reap agricultural yields than those did not (Carolyn and Asenso, 2011).

Table 4: Determinants of the Income Levels of the Landless Cattle Owners Using Seemingly Unrelated Regression (SUR)

Variables	Income from Honey		Income from Vegetables		Income from Timbering		Income from Fuel-Wood	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Age	1.53892	0.565	10.7013	0.231	0.1626872	0.965	-1.410901	0.602
Male	451.9325	0.657	-2.291286	0.770	-168.069	0.122	-111.3531	**0.0000*****
Conflict	11.39416	0.952	-25.13975	0.841	1.321187	0.217	-13.55066	0.371
Tree plantation	1.208379	**0.005*****	4.686952	**0.085***	0.6247605	0.463	0.0135392	0.981
Stone/Soil bund	5.170893	**0.029****	4.023367	**0.0000*****	2.005753	**0.0000*****	0.543965	**0.007*****
Perception on land degradation	584.6866	0.239	80.37358	0.958	0.21002	0.411	0.76210	0.101
High-land	298.6551	0.189	-93.70262	0.272	1.562011	**0.004*****	8.22092	**0.036****
Family Size	-93.09943	0.289	2.23174	**0.045****	-13.24413	0.173	5.00281	**0.021****
Trench	-30.47937	0.416	0.6071936	0.962	-12.69505	0.172		
Guarding	-412.5676	**0.044****	-122.7165	0.111	0.62032	**0.001*****		
Illiterate	-251.6143	0.316	93.45509	0.270	2.48305	0.841		
Primary	1280.67	0.289	-201.9921	0.636	16.36208	0.901		
Secondary	929.1628	0.443	-162.3863	0.704	19.63374	0.882		
Tertiary	898.5381	0.459	-23.57265	0.956	30.76669	0.16		
Development	-1004.064	0.232	0.1035513	0.224	-8.044933	0.771		
Association leader	-604.1491	0.512	-3.02381	0.901	61.92793	0.212		
Social affairs	-1886.95	**0.046****	0.217121	**0.000*****	61.75722	0.248		
village justice	-891.8337	0.286	2.521320	0.326	26.30706	0.924		
Marketing	95.7389	0.892	0.704012	0.318				
Amount of Credit	-203.4103	0.534	19.64619	0.135				
Distance to Market	2.651528	0.464	104.3301	0.765				
Cattle size	-77.43488	0.352	14.2462	0.652				
Land-size (share in)	-105.022	0.244	-142.1858	0.624				
Perceived Benefit	48.1776	**0.030****						
Extension Service	12.20848	**0.015****						

Breusch-Pagan test of independence: Chi2(6) = 365.468, Pr = 0.0000

Significance level: ***=1%, **=5% and *=10% respectively

While the participation of the landless cattle owners in tree plantation was evaluated in terms of the number of survived trees achieved at the end of the year. Estimating the variable ***Tree plantation***, it was found that tree plantation done by the landless cattle owners had positively and significantly related to the amount of income earnings obtained from beekeeping. Evidences from honey producers in the district of *Atsbi-wemberta* also suggest that the more the farm households engaged in conservation measures, the higher yield they reaped (Chala al., 2012). In agreement to this, the involvement of the landless cattle owners in planting nectar bearing flowering trees around the bee yards were found to be compatible to the beekeeping production which in turn improved their income levels from sales of honey. As shown in Table 5, tree plantation was however; significantly and negatively correlated to the level of income from vegetables. Along with this, the landless cattle owners that obtained repeated extension services from development agents is found to be statistically and positively significant at 1% probability level in affecting the income level from honey. This might be because of the involvement of the landless cattle owners largely in beekeeping farming is integrated with extension services and conservation practices at private and communal levels which may help them aware about environmental rehabilitation practices.

In Table 4, the outputs obtained from Seemingly Unrelated Regression (SUR) model indicate the participation of the landless cattle owners on private hillside conservation practices significantly and positively related to the income levels gained from beekeeping, vegetables, timbering and fuel-wood. Considering whether the perception of the landless cattle owners on the benefits of such income sources represented by the variable, (*Perceived* Benefit), for which other factors being constant, the perception of the landless cattle owners on the benefits they obtained was positively and significantly related to the income level obtained from honey at 5% probability level. Comparing the landless cattle owners pursuing on beekeeping, the ones they perceived it as their permanent strategy to improve their income obtained Birr 48 more than those considering it as a supplementary benefit to fill their short-run income shortages. Besides, the involvement of the landless cattle owners on various social committees (Social affairs) within their respective communities is positively and significantly associated with the income level they earned from beekeeping at 5% probability level. The landless cattle owners having high social interactions via their participation on various village committees either as leader or members have better access to be aware of pursuing environment friendly income generating strategies such as beekeeping, irrigation schemes for growing vegetables and fruits, timbering and fodder productions. These could eventually instigate them to put their maximum efforts to implement various hillside conservation practices by which they can adapt the adverse effects of climate change.

The provision of continual extension services (Extension Service) by the development agents at village level was found an important catalytic pathway in improving the income levels of the landless cattle owners from beekeeping farming. Thus, creating access to the landless cattle owners to get adequate extension services and strengthening village-based social net-works for achieving sustainable income sources using apiary farming are the plausible potentials that can easily be affordable by the landless cattle owners to significantly adapt to the negative effects of climate change at village levels. Taking Male as a dummy variable for gender, it was negatively and significantly related to the income levels that reaped from sales of fuel-wood (fire-wood and charcoal). Holding other variables constant, male-headed landless cattle owners earned less income from sales of fuel-wood by about Birr 111as compared to their female counterparts.

This can be due to the fact that female headed landless cattle owners mainly confined at housework duties to look after their children by fetching fire-wood and charcoal from nearby forests (Chala, 2011). This is an indication that the landless cattle owners are still dependent on the available remnant natural forests to supplement their income which further escalates vegetation damages and the adverse effects of climate change.

Looking at the effect of location, the dummy variable High-land was found to have positive and significant effect on the income sources from both timbering and sales of fuel-wood at 1% and 5% significance level respectively. As shown in Table 5, the income sources extracted from timbering and fuel-wood are larger in the highland villages. The key informant discussants composed from local leaders, experienced landless cattle owners, animal experts and forest officials had confirmed that the hillside areas in the highland district were generally regarded as denuded areas and have scarce vegetation. Compared with the lowland hillside counterparts, the highland areas are known for their remnant stands of small forests often located on church yards and hilltop ridges. Since such steep areas are severely denuded and exposed to land degradation, there is low harvest of crop and livestock products in the highland district. The key informants and group discussants further narrated that the overuse of resources in the highland led to scarcity of fodder, fuel-wood and log-wood for house construction and energy cosumption. The current hillside areas in the highland have become severely destroyed. Apart from the challenges caused by continuous droughts and land degradation, scarcity of animal feed, loss of soil fertility at the foot of hillside areas (plain farm plots) and the drying up of streams have enabled the the villagers to sensitize the adverse effects of climate change in real terms. In response to these, the landless cattle owners along with the entire village members have started protecting the hillside areas fearing that even a single tree for shading would become unavailable in the future due to the negative effects of climate change. Overall, the landless cattle owners in the highland areas recognized the changing pattern of rain fall and occurrences of droughts due to climate change.

Conclusions

The study revealed that landless cattle owners did not adopt selected cattle because of lack of information, limited access to collaterals to lending institutes and the unaffordabilty of the price of local selected cattle breeds. About 30% of the landless cattle owners practiced diversified livestock and crop production to adapt to climate change. Zero-grazing was regarded as a means to manage cattle herds; by which the landless cattle owners enabled to protect disease prevalence since it avoids contact among livestock herds, reduces walking hours for sreaching animal feed and shelter, created easy access to cattle medication centers and other veterinary services for effective livestock disease control. Using the Seemingly Unrelated Regression model, it was found that conservation methods such as stone bund, soil bund, tree plantation, trenching and guarding were the major variables positively and significantly related to the income sources obtained from beekeeping, vegetables, timbering and fuel-wood. Therefore, the participation of the landless cattle owners in the hillside conservation were the most important responding approaches to respond to the negative effects of climate change. Enabling the landless cattle owners to rehabilitate the denuded hillsides by strengthening their income sources through beekeeping, production of fruits, producing vegetables, commercial trees, fodder and off-farming activities were found the prominent interventions that can be made through allocation of hillside areas to the landless cattle owners. In effecting these, the landless cattle owners have to be technically supported by agricultural experts on how to integrate livestock rearing, cropping and other off-fam opportunities.

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Impact of Farming System Shift and Land Fragmentation on Livestock Production with Special Emphasis on Fogera Cattle: The Case of Fogera District

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Abstract

Changes in farming system and land fragmentation are prominent challenges of Fogera District over the last years due to expansion of cultivated land largely at the expense of grazing lands. This review was meant to clearly show the impact of farming system shift and land fragmentation on livestock production on the case of Fogera District. Secondary data was collected from Fogera district Office of Agriculture and various documents were reviewed. The desktop analysis of facts and figures of the past and current situation of Fogera district showed that Fogera district used to have sufficient grazing wet lands as primary sources of dry season feed for livestock in the district and from the neighboring district which now shifted to crop residues including millet and rice straws. The production system in the early days was dominantly livestock which changed to rice dominant crop livestock production system largely at the expense of grazing land. In Fogera district, cultivated land increased by 26% at a rate of 27% during the year 1972-2005. Similarly, average land holding per household has decreased from 1.6 ha to 0.4 ha in over the past 30 years. Since early 1970s, the introduction of extensive rice production in the flooded plain is remarkably increasing to about 6000 hectares which covers about 67% of the area of cropping. This driving force is putting pressure on grazing lands. In the mean time, grazing lands slightly declined from 21% to 12.6% at a rate of -0.3% as a result of the increasing population pressure which turned grazing lands to cultivated lands. This situation forced transformation of transhumant way of cattle management to sedentary farming and in turn a decline in the Fogera cattle population and genetic merit. From 1982-2004, Fogera cattle population has declined from 800,000 to 15,000 due to farming system shift and land fragmentation. Besides, the genetic potential of the breed has declined which was manifested by a decline in lactation milk yield per cow of Fogera cattle from 1500 liters to less than 500 liters due to genetic dilution from highland zebus because of transhumance to other areas during intense inundation of the plain and preference to rear a small breed, highland zebu. In connection with this, in the last 6 years (since 2007), the probability of extinction of Fogera breed has increased from 0.43 to 0.67. In a nut shell, from this review it was clearly elucidated that livestock production is highly constrained by the shift in farming system and land fragmentation which necessitates a strategy to conserve, preserve, improve and promote the economic and genetic importance of Fogera cattle breed.

Key words: Farming, Fogera, fragmentation, land, livestock, system

Introduction

The expansion of cultivated land largely at the expense of grazing land is a big challenge in Fogera district over the last 30 years due to expansion of cultivated land largely at the expense of grazing lands. The most daunting drivers of change are population pressure; agricultural interventions land tenure policies (ibid). In this regard, livestock production is vulnerable to this paradigm shift in Fogera district. Fogera cattle breed known for its remarkable genetic qualities, high milk yield per cow, good body conformation and growth rate, good draught power and sound adaptability to waterlogged Fogera plain compared to other indigenous cattle resources of the country is declining in terms of population size and genetic potential. For instance, the population size of Fogera cattle has on the average been declining at an alarming rate of 35,700 per year, as can be calculated from the studies by Alberro and Haile-Mariam (1982) and Gebeyehu *et al.* (2004). Considering the recent population estimate of 15,000, Fogera breed may be considered *Insecure* according to a basic terms of reference proposed by Bodo (1989) which include six categories (*normal, vulnerable, insecure, endangered, critical and extinct*). Furthermore, the current situation of Fogera cattle (rate of population decline, change in production system and environment, farmers attitudes and absence of strategy for its conservation) indicates the high risks that could lead to its extinction as a breed. Therefore, this review is meant to show impact of farming system shift and land fragmentation on livestock production and to pinpoint and recommend existing farming system based alternative strategies for enhanced livestock production on the case of Fogera District.

Materials and Methods

Description of the Study Area

Fogera district is Located 625 km from Addis Ababa and 55 km NE from Bahir Dar (Figure1). The altitude of the district ranges from 1800 to 2500 m.a.s.l. The total human population of the *woreda* is 233,529, of which 206,717 is rural population. The major farming system is mixed (crop-livestock) farming with major engagement of 92% of the people. Rice, maize, sorghum and Teff are the dominant crops in the area. The temperature ranges 10 ^{O}C-27 ^{O}C with an average Rain fall of 1284 mm. The dominant soil type by its color is black followed by red, brown, and grey at 65%, 12%, 20%, and 3%, respectively.

Material and Methods

Secondary and primary data sources were used to synthesis this information. Secondary data was collected from office of agriculture of Fogera district and Amhara Design Works enterprise. Besides, focused group discussion, individual interviews were and transect walk was done to depict the real situation of the area. Various socio-economic and GIS based survey results were also reviewed basically to analyze the trend of paradigm shift within the last 30 years.

Results and Discussions

Farming System Shift and Land Fragmentation

Various studies evidenced that there is a paradigm shift in farming system over the last 30 years in Fogera District. Fogera district used to have vast productive grazing land that would usually be flooded by overflows from Lake Tana during the rainy season (Abebe *et al.*, 2012). The flooding which covers the whole Fogera plain during the rainy season had inhibited crop cultivation before the introduction of rice production to the plain (Gebey, *et al.*, 2012). The wetland was thus a primary source of dry season feed for livestock in the *woreda*, as well as from neighboring *districts*. But currently the vast productive grazing land does no longer exist as the area is used for rice production*. According to* Biru (2007) from *1982* to 2003, the cropland expanded from 53% to 61%, while grazing lands decreased from 21.2 to 12.6 % in Wej-Awuramba transect. This phenomenon was also evidenced by Arial satellite images highlighted in yellow taken during the years (Figure 2). Similar study in Kuhar Michael study indicated that 18% of communal grazing land was converted to cultivated land during the last 30 years (Hussien, 2007). The average land-holding in fogera district per rural person were 0.5 hectare in the 1960 and 0.21 hectare in 1999. Hussien (2007) in Kuhar Michael, kebele belonged to Fogera district also, showed that cultivated land per household has decreased from 1.2ha to 1 ha over the last 30 years. According to Biru (2007), average land holding sizes also decreased from 1.2 to 0.4 from 1957 to 2001 in Woji-Awramba transect (Biru, 2012). The aforementioned drivers of changes have triggered an increase in demand for feed and energy biomass requirements around Lake Tana Basin (Table1).

Table 1: Dynamics of causes for farming system shift and land fragmentation in Lake Tana Basin

Parameters	Value			Change (%)
	1960s	1980s	2000s	
Population density/km2	42	125	199	181.7
Land holding per capita(ha)	1.15	0.53	0.34	-0.81
Crop land per capita(ha)	0.67	0.13	0.1	-0.57
Feed biomass requirement (Tons/year)	$1.6x10^6$	-	$3.5x10^6$	118.75
Biomass energy requirement (Tons/year	684212	-	$3x10^6$	338.46

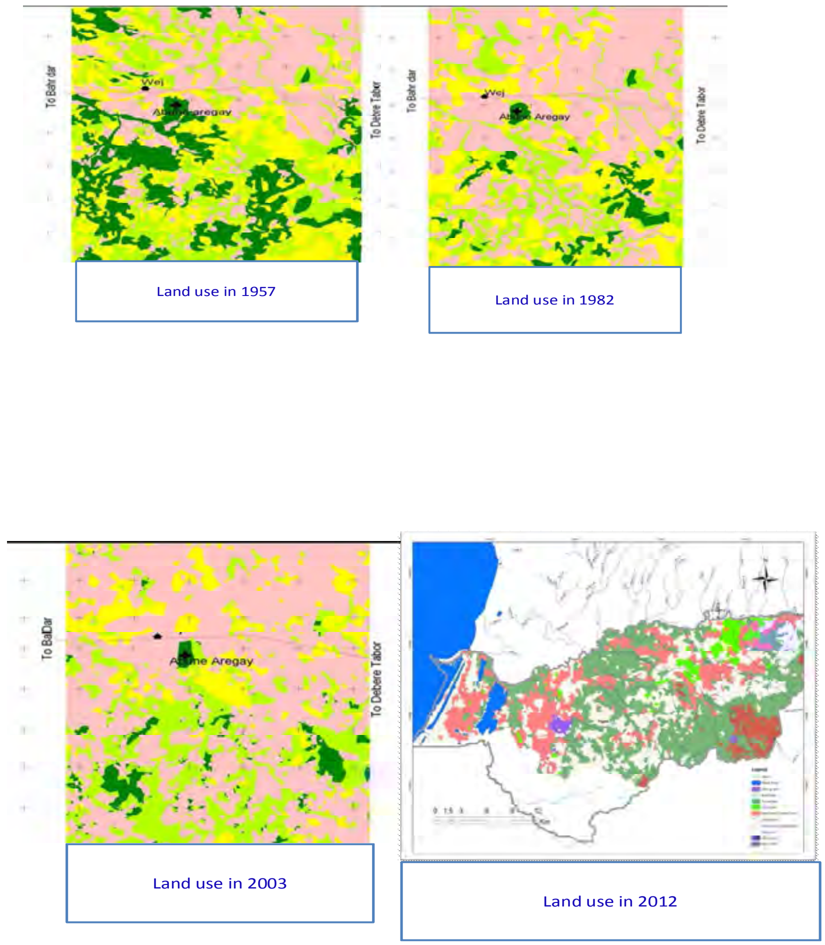

Figure 1: Change in land use pattern of Fogera district since 1957

Effect of Farming System Shift on Grazing Lands and Feed Resource Base

Communal grazing used to be the major source of animal feed in Fogera district 30 years ago. However, later during the Derg era, part of the communal grazing lands was distributed for cultivation which resulted in shrinkage of grazing lands.Fore instance, during the last 20 years, Shesher Wetland shrank from 1,557 hectares to 136 hectares and Welela Wet land shrank from 298 hectares to 159 hectares (Abebe *et al.*, 2012). A study undertaken in Kuhar Michael showed a net decrease of grazing lands at a rate of -0.3% per year due to conversion into cultivated lands for the last 30 years (Husien, 2009). Pressure on grazing land is increasing due to greater population density resulted in severe degradation of grazing lands, the disappearance of palatable forage species and emergence of unpalatable noxious weeds like *Hygrophilla auriculata (Gebey, et al., 2012).* Moreover, the introduction of rice in late 1990s has triggered the drastic shift of land use at the expense of shrinkage of grazing, shrub and swampy lands. These days, rice is the dominant crop which covers 67% of cropping area replacing grazing lands. Crop residues like rice, teff and maize straw which would have been used for other purposes are currently being used as major sources of animal feed. Due to high energy demand crop residues which could have been used for livestock feed and animal manure which could contribute to fertilize grazing lands are being used now for fuel. This situation resulted in sever overgrazing of the available limited grazing land and in turn increased risk of livestock disease transfer. The practice, of fallowing has also been declined. Contrary to the decreasing trend of livestock holding and grazing lands per household, the density of livestock per unit area of land is 2.7 TLU/ha which is much higher than the recommended TLU/ ha, 1.5, for a well established grazing land (Biru, 2012).

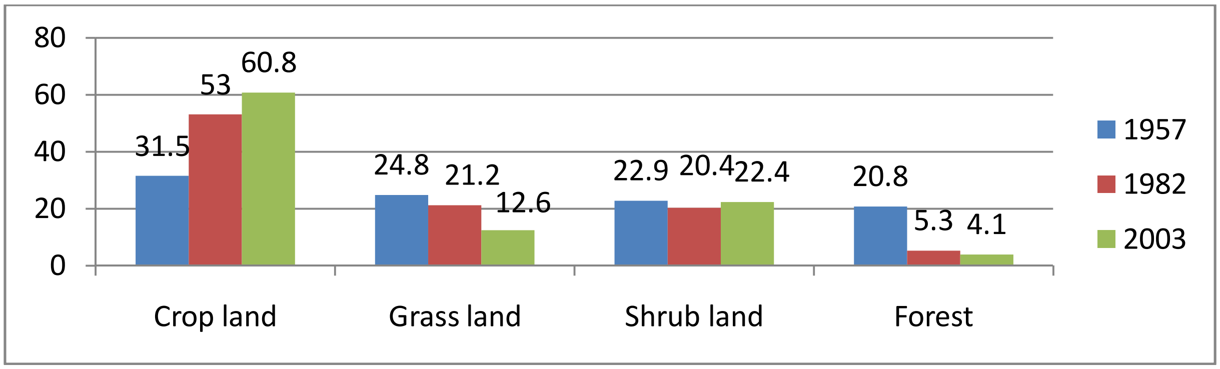

Figure 2: Land use/cover changes of Wej Awramba (Biru, 2007)

Figure 3: Teff and maize cropping on reclaimed land (left); Remnants of grazing lands in Wagetera Kebele (right)

Change in Population Dynamics of Livestock Production

The overall paradigm farming system shift and land fragmentation situation forced transformation of transhumant way of cattle management to sedentary farming and in turn a decline in an important cattle breed (Fogera) population and genetic merit. The district office of Agriculture also confirmed a decreasing trend of cattle population from 1996 to 1999, specifically Fogera cattle. In contrast since 2001, there was an increasing in cattle population which might be attributed the ownership of small highland zebu cattle breeds. Despite a constant ownership of goat population, sheep population ownership is showing a steady increment which might have been due to the preference/attitude of farmers towards rearing of small ruminants to adapt to the existing chronic feed resource base shortage. Farmers also confirmed that there is an increasing trend of sheep rearing.

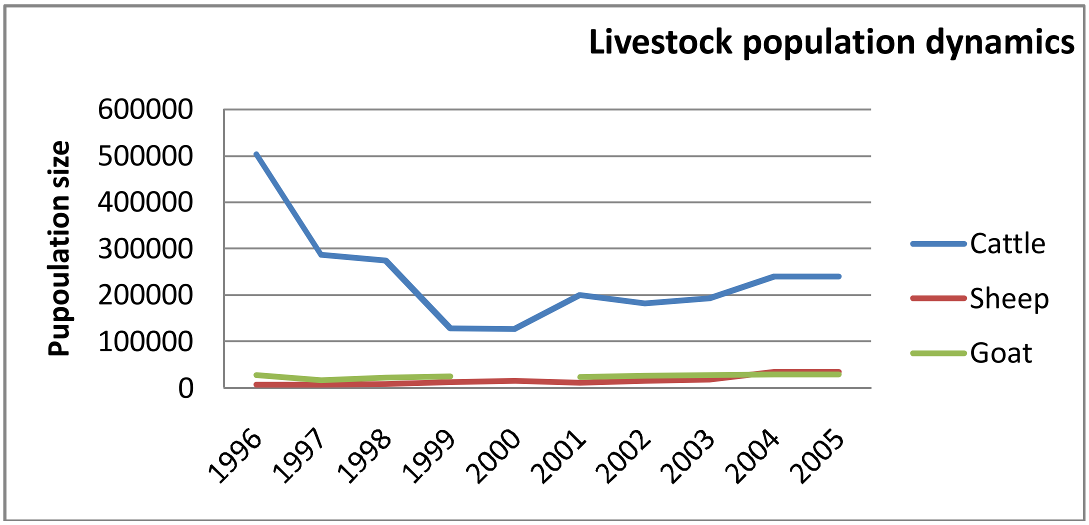

Figure 4: Impacts on Dynamics of Livestock Population (DoOA, 2012)

Characteristics of Fogera cattle

Fogera cattle are the renowned milk breed naturaly residing around the belts of Lake Tana. It is large framed and with high milk yield, relatively tolerant to parasite and disease heat stress, high fattening potential, high traction power, relatively with higher feed requirement. Fogera cattle population decreased by 27% between 1981 and 1999 respectively (Zerabaruk *et al.,* 2007). From 1982-2004 Fogera cattle population has declined from 800,000 (Alberro and Haile-Mariam, 1982) to 15,000(Gebeyehu *et al*., 2004). Besides, due to farming system and land fragmentation the probability of extinction of Fogera breed has increased from 0.43 to 0.70 and currently can be regarded as endangered breed. Currently, Fogera district office of agriculture reported that the population of Fogera cattle is 2385. Lactation milk yield per cow of Fogera cattle has also declined from 1500 liters to less than 500 liters due to genetic dilution. Personal communication and group discussion indicated a decline in the interest/attitude towards rearing of Fogera cattle breed.

Conclusion and Recommendations

Livestock production is highly constrained by the shift in farming system and land fragmentation which necessitates a strategy to conserve, preserve, improve and promote the economic and genetic importance of Fogera cattle breed. Intensification of livestock husbandry practices deserves due attention to cope with the change in the farming system and land fragmentation so as to optimize production and productivity from the indigenous Fogera cattle.

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Estimation of Live Body Weight from Linear Body Measurements of North Westerns Highland Goat

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Abstract

The study was conducted in Semen Achefer, Mecha, Gonji kulela, and Bahirdar Zuria districts of west Gojjam, Amhara National Regional State to develop regression models for prediction of body weight from other linear body measurements. Data on body weight (BW) and other linear body measurements (Body Length (BL), Wither Height (WH), Chest Girth (CH), Pelvic Width (PW) and Ear Length (EL)) were taken from 700 goats. Simple and multiple linear regression models were developed using Statistical Package for Social Sciences (SPSS version 12.0). For the multiple linear regressions, step-wise regression procedures were used. Predicting models were developed for both sex groups. Positive and significant (P<0.05) correlations were observed between body weight and linear body measurements in both sex groups. In general, much of the variation in weight was explained when many traits were included in the model. However, for ease of use and to avoid complexity at field condition, it is possible to use Chest girth alone as a predicting tool. Among the four linear body measurements, Chest girth had the highest correlation coefficient (0.71 to 0.98%) with body weight and the first variable to explain more variation than other variables in both sex groups which is followed by body length, height at wither and pelvic width. Thus chest girth could be used for the prediction of body weight. As a method to estimate weight using linear body measurements, it is possible to use these linear body measurements for selection in an effort to improve body weight of North western highland goat.

Key words: *North western highland goat, body weight, linear body measurements, regression model*

Introduction

Goat is a multi functional animal and plays a significant role in the economy and nutrition of smallholder farmers (Carl Jansen, 1996). Knowing the body weight of the animal (goat) is important for a number of reasons, related to breeding (selection), feeding and health care. Additionally, in countries where sale price is based on weight, live weight has a direct relation to the profitability of the enterprise. Increase meat yield from the animal (goat) also require genetic improvement of its live weight. However, this fundamental knowledge is often unavailable under village condition, due to lack of weighing scales. Hence, farmers have to rely on questionable estimates of the body weight of their goats, leading to inaccuracies in decision-making and husbandry. Such difficulties can be overcome by developing a simple, yet reasonably accurate method to predict the body weight. For instance, a prediction equation can be established, based on a linear body measurement (Mayaka, 1995). According to these authors, body weight of West African Dwarf (WAD) goats has been satisfactorily predicted by using linear body measurements particularly heart girth as the only regress or. Earlier reports also indicated that selection based upon the body measurements should improve the meat production (Hassan, A. & Ciroma, A., 2007). Thus, the present study was carried out to investigate the relationship between the linear body measurements and the body weight of the animal and to develop prediction equation to estimate body weight of the animal from linear body measurements under village condition.

Materials and Methods

Description of the study area

The study was carried out in Semen Achefer, Mecha, Gonji kulela, and Bahirdar Zuria districts, West Gojjam Administrative Zone of Amhara National Regional State. The study areas fall within longitude of 15º 16'N and latitude of 37º 29'E with altitude ranging from 700 to 2635 meter above sea level (m.a.s.l). The temperature in the area can be as high as 35 ºC and can also reach lowest value of 10 ºC (WOARD, 2001). The predominant farming system is mixed crop-livestock production.

Data collection and management

Data on Weight and other linear body measurements were collected from 700 goats, with different sex groups. Weight measurement, the live weight of an animal, was taken using the Salter scale (100 kg capacity with 500 gram precision) and the prepared format. Linear body measurements (heart girth, wither height, body length, pelvic width and ear length) were taken using flexible metal tape (4 meter length) to the nearest 0.5 cm after restraining and holding the animals in an unforced position. The reference points taken were: heart girth - the circumference of the chest posterior to the forelegs at right angles to the body axis; wither height - the highest point measured as the vertical distance from the top of the shoulder to the ground (bottom of forelegs); body length - horizontal length from the point of shoulder to the pin bone; pelvic width - horizontal distance between the extreme lateral points of the hook bone (*tuber coxae*) of the pelvis; and ear length - length of the external ear from its root to the tip (Workneh Ayalew and J. Rowlands, 2004). Finally, the data collected from each site were checked for any mistake and entered into the computer for further analysis.

Statistical Analyses

Statistical analyses were carried out using Statistical Package System Software version 12.0 (SPSS 2003) General Linear Model (GLM) and linear regression procedures. Sex was considered as fixed effect. Live weight was regressed on other body measurements for sex groups.

In the multiple regression equation, prediction equations were developed using a stepwise elimination procedure.

The following models were used for data analysis.

Yij = + Si +eij (GLM) Model 1

W = a + bG (Simple linear) Model 2

W = a + b1G1 + b2G2 +.... + bnGn (Multiple linear) Model 3

Where Yij = the observation on body weight and other linear body measurements; W = the observation on live weight of the animal; = Overall mean; Si = Fixed effect of sex (i = Female, Male); a = Intercept; b= Regression coefficient of weight on body measurements; G = Body measurements; n = nth number of body measurement; eij = effect of random error

Result and Discussions

Body Weight and Linear Body Measurements

The mean body weight and linear body measurements of NWHG are presented in Table 1. The overall mean body weight, wither height, body length, chest girth, pelvic width and ear length obtained in the present study was 32.7±0.15 kg, 70.6±0.17 cm, 48.2±0.17 cm, 78.5±0.22 cm, 14.4±0.07 and 15.1±0.03 cm, respectively. There was significant difference ($p<0.05$) in body measurements (except ear length) between sex groups. Males were superior over females in all the measurements except ear length where they were similar ($P>0.05$). The average body weights, body length, height at wither, and chest girth obtained in this study was concurrent with the previous findings reported by Nigatu Alemayehu (1994) for Central highland female goats. The average ear length was higher than the reports of Nigatu Alemayehu, (1994) for goat types of north-western Ethiopia which ranges from 12.01±0.05 to 14.4±0.07 cm.

Table 1. least square means (LSM) ± standard errors (SE) of body weight and linear body measurements of NWH goat as affected by sex

Variable	Body weight Kg		Body length cm		Wither height cm		Chest girth cm		Pelvic width cm		Ear length cm	
	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	700	32.7±0.15	710	48.2±0.17	715	70.6±0.17	715	78.5±0.22	720	14.4±0.07	710	15.1±0.03
Sex	*		*		*		*		*		NS	
Male	130	40.6±0.29[a]	130	55.3±0.31[a]	132	71.8±0.29[a]	135	81.9±0.41[a]	128	15.4±0.15[a]	122	15.5±0.05[a]
Female	570	28.1±0.14[b]	580	44.1±0.16[b]	583	69.9±0.14[b]	580	76.4±0.21[b]	592	13.9±0.07[b]	588	14.9±0.02[a]

N= Number of observations; [a,b,c] Means in a column with different subscripts are significantly different; *Significant at 0.05; NS = Not-significant (p>0.05); LSM=least square means ; SE=Standard error

Correlation between Weight and Linear Body Measurements

The Pearson's correlation of linear body measurements with weight and with each other is presented in Table 2. There were significant and positive relationships between body weight and other linear body measurements and with each other irrespective of sex, except ear length to which there was inconsistent relationships. Chest girth had the highest correlation coefficient (r=0.84-0.87; p<0.05) with body weight in both sex groups which is followed by body length and wither height. Ear length has almost no correlation with body weight (inconsistent relationship). With regard to sex, males had better correlation coefficient. The highest coefficient was found with chest girth (87% for males and 84% for females) followed by body length (83%) for males and wither height (71%) for females. The high and significant correlation coefficients between body weight and linear body measurements for the two sex groups suggest that either of these variables or their combination could provide a good estimate for predicting live weight of NWHG.

Table 2. Correlation coefficients between body weight and linear body measurements of NWH goat by sex groups

Parameter	Measurements	BL	CG	WH	PW	EL
Overall	BW	0.79*	0.87*	0.78*	0.69*	0.07*
	BL		0.66*	0.75*	0.61*	0.11*
	CG			0.73*	0.67*	0.08*
	WH				0.62*	0.10*
	PW					0.09*
Sex						
Female	BW	0.77*	0.84*	0.71*	0.68*	0.12*
	BL		0.64*	0.72*	0.61*	0.15*
	CG			0.70*	0.64*	0.16*
	WH				0.61*	0.16*
	PW					0.13*
Male	BW	0.83*	0.87*	0.86*	0.71*	0.02^{NS}
	BL		0.67*	0.79*	0.62*	0.08^{NS}
	CG			0.78*	0.70*	0.01^{NS}
	WH				0.62*	0.04^{NS}
	PW					0.02^{NS}

**P<0.05; NS Not significant*

The obtained positive and significant (p< 0.05) correlations between body weight and linear body measurements in both sex groups, were in agreement with Nigatu Alemayehu (1994) for different goat types of Ethiopia.

Prediction of Weight Using Body Measurements

Regression models developed are presented in Table 3. Different regression models were developed for different sex groups.The regression equations developed had different coefficient of determination. With regard to sex, the coefficients of determination of prediction equations were almost similar ranged from 75.5-82.8 for female goat and 76.6-89.1 for male goat. Chest girth was the first variables to explain more variation followed by body length in both male and female goat. Chest girth was the first variable to explain most of the variation in weight. Hence, this regression equation alone may be used to predict the body weight of NWHG at different sex groups.

In general, much of the variation in weight was explained when many traits were included in the model.

Table 3. Linear and Multiple linear regression equations for predicting body weight from linear body measurements for sex group

Sex	Model	A	b1	b2	b3	b4	R^2	Std error
Male	a + b1 CG	-39.41	0.681				0.766	0.8897
	a + b1 CG + b2HW	-50.003	0..445	0.525			0.875	0.8306
	a + b1 CG + b2HW +b3PW	-50.793	0.355	0.381	-0.081		0.891	0.8099
Female	a + b1 CG	-24.81	0.684				0.755	2.2130
	a + b1 CG + b2HW	-74.634	0.516	0.416			0.810	2.2058
	a+ b1 CG + b2HW +b3BL	-67.082	0.468	0.381	0.187		0.814	2.1481
	a + b1 CG + b2HW +b3BL+ b4PW	-66.949	0.442	0..331	0.210	-0.108	0.828	2.1213

CG = Chest girth; BL = Body length; PW = Pelvis width; WH = Wither height. BW (Body Weight) = the dependent variable a= the intercept b1, b2, b3 and b4 = the regression coefficients R^2=Coefficient of determination STD error = standard error

Conclusion

Body weight and other linear body measurements were significantly and positively correlated with weight and each other. From the result, it can be concluded that using linear body measurements can be a simple and reliable method for estimating body weight for NWHG.
The higher association of body weight with heart girth, in general, over other linear measurements indicates use of this measurement alone or in combination with others can estimate weight with better accuracy and relative ease. As a method to estimate weight using linear body measurements, it is possible to use these linear body measurements for selection in an effort to improve body weight of NWHG.

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Characterization of Husbandry Practices of North Western Highland Goat in West Gojjam Zone of Amhara Region, Ethiopia

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Abstract

On-farm characterization of the husbandry practices of North Western Highland Goat in West Gojjam zone, Amhara National Regional State, was conducted by implementing single visit questionnaire. Study areas and sites were selected purposively. Data analysis was done separately for different data types using different procedures of statistical package for social science. The purpose of keeping goat in the area was to generate income, for meat, skin, manure and as means of saving, in a decreasing order of importance. The mean goat flock size per household was 9.61±4.53. There was relatively high proportion of adult goats (38.5%) than young goats (23.4%). Similarly, there was also relatively high proportion of females (54.4%) than males (38.9%). Disease, theft and predator were the most important goat production constraints reported. Appearance/conformation, colour, fast growth and pedigree were the criteria's for selecting breeding male where as kidding interval, twining ability, mothering ability and pedigree were for selecting breeding female goats. The average market ages of male and female goats were 9.69 ± 2.01 and 11.31 ± 1.91 months, respectively. Age at puberty of the buck and the doe were 11.2 ± 2.05 and 8.1 ± 1.75 months, respectively. Age at first kidding, kidding interval, and lifetime productivity of the ewe were 13.1 ± 2.40 months, 8.01 ± 1.13 months, and 11.2 ± 2.52 kids, respectively. It was concluded that the goat husbandry practices of the area is characterized by no or few inputs and imposed by different production constraints.

Key words: Characterization, Husbandry practices, North Western Highland Goat, West Gojjam

Introduction

Goats form an important component of the livestock system in all agro-climatic zones of Ethiopia (Alemayehu Reda, 2003) and they have a variety of functions for the smallholder farmers (Carl Jansen, 2006). Although goats' contribution to the economic well being of the small holder farmers is significant, these animals have never been a subject of much attention for research and development. Despite the large size of the country goat population and their high apparent potential, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This situation is generally attributed to different factors such as poor plane of nutrition, lack of appropriate health services, lack of appropriate breed and breeding strategies (Alemayehu Reda, 2003). Therefore, to improve the productivity there is a need to improve the production environment of the animal. This task involves characterizing the existing production system to provide managerial, nutritional and health interventions (Kiwuwa, G. H., 2007). But, work on characterization of the husbandry practices of the goat types in the area is scanty. Thus, this study was aimed at characterization of husbandry practices of North Western Highland goat in West Gojjam zone, in their respective environments.

Materials and Methods

Study areas

The study was conducted in four (Semen Achefer, Mecha, Gonji kulela, and Bahirdar Zuria) districts of West Gojjam Administrative Zone, Amhara National Regional State. According to the respective Woreda Office of Agriculture and Rural Development (WOARD, 2011) of the four districts, the four districts situated within longitude of 15º 16'N and latitude of 37º 29'E with altitude ranging from 700 to 2635 meter above sea level (m.a.s.l). The temperature in the areas is as high as 35 ºC and as low as 10 ºC (WOARD, 2011). The study area has uni-modal rainfall pattern and the rainy season extends from end of May to the end of September. The predominant farming system is mixed crop-livestock production.

Data collection and management

Rapid field survey was conducted before the main survey. Four representative districts mentioned above and three peasant associations from each selected districts (Semen Achefer: Sankira, Kunzilla, & Denbola; Mecha: Andinet, Goragot, & Bachimma; Gonji kulela:Woyzazirt, Zegansa & Wolekea and from Bahirdar Zuria: Zemochinazelanbet, Majdebrenigist & Achader) were selected purposively. Data on traditional goat production system in the study area was generated by implementing a single-visit-questionnaire and using secondary data sources. The questionnaire was administered to the selected 120 household heads. Information which covered all aspects of production at all levels of livestock holdings was collected. Finally, the data collected from each site was checked for any mistake, coded and entered into the computer for further analysis.

Data analysis

Data analysis was done separately for different data types using the different procedures of Statistical Package for Social Sciences, version 16 (SPSS).

Results and Discussion

Farming activities

All of the interviewed farmers keeping goat indicated that they practice both crop and livestock production. The average land holding size is 1.5 ha (1-2.5 ha) per household which is lower than the average land holding size of the region (1.7 ha) but coincides with the national average land holding (1.0-1.5ha). Ranking of major farming activities for their contribution to food and income of the family were done. In the area crop received a higher ranking with index of 0.51, followed by goat and cattle with index of 0.28 and 0.12, respectively for family food. Whereas for income generation goat contributed more than any other farming activities with a total index of 0.61 followed by cattle with index of 0.25. The contribution of crop for the family income was small (index = 0.08). The contribution of goat for the family income obtained in this study was much higher than other report on goat in mixed farming areas where goat provide 40 percent of farmers cash income and used for purchasing of agricultural inputs , household goods, and service

(Greeyles and Anderson, 2005). The relatively higher contribution of goat in the area to food and income of the family indicated that the area is in favour of goat than other livestock species and crop production.

Purpose of goat rearing in the study areas
The main purposes of goat rearing as given by the respondents were presented in table 1.

Table 1. Ranking of purpose of goat rearing in the study area

Objectives	1	2	3	Index	Rank
Sale of live goat *(to generate income)*	30	15	10	0.45	1
Household consumption *(meat)*	18	12	5	0.29	2
For skin	6	4	2	0.10	3
For dung or source of fertilizer *(manure)*	5	4	3	0.09	4
Means of saving	5	3	2	0.08	5

Flock size, species composition and ownership pattern

Goats were the predominant species in the area (48.2 %) followed by cattle (24.6%). Horses and Mules were rare. The dominancy of goat in the study area might be associated to the suitability of the area for goat production and also because of the fact that stone aggregated and vegetation covered areas could not support crop production as well as maintain larger animals like cattle. Additionally, subsistence farmers prefer small ruminant animals as the risk of large animal dying and leaving family without anything is too dangerous (Carl Jansen, 2006). The mean flock size obtained in this study (9.61 ± 4.53) was higher than average holding of goats 6 for Keffa goat types but lower than the average holding of 20 for Abergelle goat types (Nigatu Alemayehu, 1994). It agrees with the average holding of goats 7.65-9.6 for central high land goat types (Tesfaye *et al,* 2007). The variation could be due to the difference in production system in the areas.

Family ownership pattern (94.2%) is the ownership pattern practiced than individual ownership pattern (5.8%). The result obtained for ownership pattern is concurrent with the reports of (Wilson, R.T., 2006) for tropical Africa goat breeds.

Flock structure

The flock structure of the surveyed flock is presented in table 2. There is relatively high proportion of female goats than male goats. This might be because of marketing of the young male goats at early age or keeping of more female goats for breeding/ kid production Where as the relatively more adult goats than the young one could be due to sale of fast growing young animals before breeding age, the adult mortality and/or culling rate is low and/or pre-weaning mortality is high or the kidding percentage is low (Zelalem and Fletcher, 1998).

Table 2. Age and sex composition of the surveyed flock

PPI	Age group (Month)	Goat classes and number of goats				Flock %
		Male	Female	Castrate	Total	
0	< 13	154	144	5	303	38.35
1	14-17	45	44	15	104	13.14
2	18-23	32	32	15	79	10
3	24-36	44	58	11	113	14.30
*4	> 41	33	152	6	191	24.18
Total		256	5001	33	790	
% of the flock		32.41	63.39	4.20		

** including broken mouthed and Gummy*

Housing

In the study area, the majority of the respondents (70%) housed their goats under some kind of shed while the rest of the respondents (30%) used open kraals. Almost all farmers (94.2%) practice group housing than individual housing (5.8%). Farmers in the study area housed their goats to give safety (Index value= 0.38), to protect unfavourable climatic conditions (Index value = 0.29), to give more attention on the breeding and management practices (Index value = 0.20) and the remaining of the respondents for collection of manure. The reasons for housing (housing types and systems) of goats obtained are concurrent with the reports of (Hailu *et al*, 2006) for Ethiopian goat types/breeds.

Herding (Tending)

Goats were herded mostly mixed with other livestock species mainly with sheep and cattle (50%). Children were the major labour force (60%) involved in goat herding. On the other hand, about 20% of the respondents did not practice herding. The main reason of not herding was noticed to be labour demand for other activities and labour is relatively expensive in the study area. Relatively high proportion of the respondents herded their goats alone (30%). This is because to avoid the spread of diseases from one species to the other and to avoid abortion by kicking by large animals.

Feed sources and feeding management

Natural vegetation/ browse trees and shrubs (Index value = 0.51) are the major source of feed available for goats as well as for cattle followed by Communal grazing land (Index value= 0.24). The majority of the respondents (80%) do not supplement their goats. Thinning of sorghum and maize, Sesbania hay, concentrates, non-conventional feed (*Atela*) are other reported feed sources in the study area. Feed shortage is not a major production constraint by the majority of the respondents (90%). However, in many other places, feed shortage is reported as the major constraint of goat production (Workneh Ayalew, 1992; Tesfaye *et al*, 2007). Provision of salt (mineral supplementation) was a recognised practice particularly during the rainy season. This is because farmers in the area believed that supplementation of salt during wet season initiate the appetite of the animals so as to efficiently utilize the available feed.

Diseases and disease control

Farmers mentioned that Anthrax (Index value = 0.35), external parasites (Index value = 0.27), lung worm (Index value = 0.20), pastuerolosis (Index value = 0.17), and internal parasites (Index value = 0.09), in that order, as the common health problems of goat at different seasons of the year. According to the respondents (90%), vaccination was provided only when there was a disease outbrakes.

Kid rearing and weaning

The newly born kids and their mothers were kept in the house only for one day after kidding and the newly born kids are kept separately in the house for about one to two months age, until the kid grow horn. Special care for newly born kid was less frequently reported.
Kid which will become orphan or their dam not produce enough milk were allowed to suckle another doe (grafting/fostering of orphan kids). All farmers practice natural weaning. The average weaning age was 3-4 months for male and 4-4.5 months for female kids.

Selection criteria for breeding buck and doe

The majority of the respondents (90%) practice selection of both male and female goats. Appearance/conformation (Index value =0.59), Colour (Index value= 0.30), Fast growth (Index value = 0.05) and Pedigree (Index value = 0.05) were the selection criteria for selection of breeding buck. Whereas Kidding interval (Index value=0.40), Twinning (Index value = 0.30), Mothering ability (index value= 0.28) and pedigree (Index value=0.02) were for selecting breeding does.

Mating

Mating occurs at random. The average age at first mating for female was 8.1± 3.23 months where as for male was 11.2 ± 2.23 months. The average service life of a buck was 3.63 ± 0.96 years and it is in contrast with Workneh Ayalew (1992) for Southern Ethiopia goats (six years). Farmers prevent unwanted mating by castration or by culling of the unwanted male animal (more common) and by culling of the unwanted female animal (less common). A few farmers (30%) recognized a peak mating season (March to end of May) when there is better feed availability and quality at time of kidding.

Culling

All of the respondents practice culling of both male and female goats. Poor body conformation, bad behaviour, and unwanted coat colour type were the major criteria for culling of the male goat whereas poor reproducing/low conception rate, long kidding interval and low mothering ability were for female goats. The reported average culling ages of both male and female goats were 3.5 and 7.5 years, respectively. The result obtained was in agreement with the reports of Tesfaye *et al*, (2007) for Central Highland goats, the average culling ages for both male and female was 3.5 and 7.5 years, respectively.

Castration

The majority of the respondents (80%) practice castration. Castration was primarily a means of getting higher sale prices at a later date; secondly a means of not getting progeny from undesirable bucks and others to minimize the buck odour. The age of castration largely influenced by the number of does , the presence of replacement bucks, the buck characteristics, the competency of the buck itself and the cash need of the flock owner and it varied from the appearance of the first pair of permanent incisors to the appearance of the four pairs. 96.7 % of the goat owners use traditional castration method even though very few respondents (3.3%) take their animal to the nearest agricultural office for castration.

Buck ownership pattern, Source and Purpose of keeping

Out of all goat owners, 55.8 % had no breeding buck where as 44.2 % had breeding buck. About 48.2% of the respondents use buck born in their own flock as source of breeding buck.It was followed by 36.8% of the respondents use buck of neighbouring farmers and/or purchased from the market and the remaining of the respondents (15%) use flock/herd mating. Major reasons for keeping buck were for breeding and fattening (Index value = 0.67) followed by for breeding only (Index = 0.25) and then for breeding, fattening and socio-cultural reasons (Index value = 0.05).

Products and products use

Goat meat, skin and manure are useful products of goat in all study areas. Goat meat is consumed in all the study areas even though very few farmers did not consume goat meat due to some cultural taboos. In all the study areas farmers do not milk goats. Goat skin is an important source of cash for the flock owner. About 60% of the respondents sell to buy various household goods, farm inputs etc. Manure is the major by-product of goat which is used as fertilizer for cereals.

Socio-cultural, Perception of farmers and Marketing aspects

No community was found not to keep goats due to cultural taboos. The interviewed farmers tried to mention the merits and demerits of goat production. About 75% of the respondents mentioned its broad feeding habit, its suitability to generate quick cash and its prolificacy & rapid reproductive cycle as the three most appreciated features of goat. 25 % of the respondents also appreciated its adaptability to harsh environment, drought and diseases tolerance. Almost all of the respondents mentioned it requires close supervision, bad behaviour, its manure odour; it's prone to predator & theft, and the buck odour as demerits of goat production. Farmers sell their goats particularly during holidays, festivals, during wet and dry seasons. The sale price of the goat was found to be high during Easter, Christmas, and the Ethiopian New Year and low during the wet season. Generally, all the interviewed farmers believed that goat rearing was second to grain production as food and first as income source for the family. This finding agrees with the earlier reports on goat production in mixed farming areas where they provide 40% of farmers' cash income (Greeyles and Anderson, 2005). The average marketing age of 9.69± 2.01 and 11.31±1.91 months were reported for male and female goats, respectively.

Table 3. Ranking of the reported reasons for sale of goats in the study area

Reasons	1	2	3	Index	Rank
Input purchase (fertilizer, seed…)	24	15	9	0.40	1
Grain purchase	18	10	8	0.29	2
Financial obligations	8	5	1	0.13	3
School expense	6	3	3	0.10	4
Labour share	5	3	2	0.08	5

Constraints to goat production

Farmers tried to list the different limiting factors of goat production. Disease (Index value = 0.34), predators and theft (Index value = 0.27), labour scarcity (0.18), water problem (Index vale=0.12) and feed shortage (index value= 0.08) were the reported goat production constraints. About 8.3% of the respondents also mentioned lack of improved genotype/buck as their goat production constraints. In general, all above mentioned or reported production constraints were also reported as the major goat production problems for smallholder goat producers (Workneh Ayalew, 1992).

Reproductive performance of goat types in the study area

The average age at first service/puberty of the female was 8.1±1.75 month where as that of male was 11.2±2.05 months. The result obtained is higher than the value reported for tropical female and male goat (4.5 months) (Payne, W.J.A. and Wilson, R.T, 2006). The average age at first kidding was 13.1± 2.40 months and it is much shorter compared to reports of (Payne, W.J.A. and Wilson, R.T., 2006) for most of traditionally managed African goat does (12 to 18 months) and Wilson, R.T., (2006) for tropical goat breeds (12 to 24 months). The average kidding interval was 8.01±1.13 months. The value obtained is shorter than the value ranged from 11.67-11.87 months for East Africa goats and their crosses with Boer and Kamarori Tanzania, 11.67 months for Boer goats in Botswana (Payne, W.J.A., and Wilson, R.T., 2006), and close to the values reported in tropics which is 8.17 months (Wilson, R.T., 2006). But it is almost similar with the reports of Tesfay *et al*, (2007) for goat types in kewet woreda (North Shewa) which is 7.87 months. The average reproductive life span of doe was 8.92 ± 1.14 years and it is in agreement with the reports of Workneh Ayalew (1992) for Southern-Ethiopia goat types in that about 50% of the respondents estimated the life span of a doe to be between 8 and 10 years. The estimated average litter size (LS) obtained is 1.1 and it is higher than the reports of Nigatu Alemayehu (1994) with average LS of Long-eared Somali goats to be 1.04 but lower than average LS of goats in Sidama (1.3). The result obtained fall within the range value given (1.08 to 1.75) for tropical goats by the same author.

Conclusion and Recommendations

The overall management conditions reflected that the goat husbandry practices of the area is characterized by no or few inputs for the overall management conditions and imposed by different production constraints. Based on the objectives and selection criteria reported, improving the productive (meat production) and reproductive performance of the animal is the production objective of the farmers in the area. The breeding practice is uncontrolled. The area is in favour of goat than other livestock species and crop production. Therefore, the following points were suggested: More emphasis needs to be placed on the improvement of the production environment of the animals which in turn affects the productive and reproductive performance of the animal; On-farm monitoring of growth and reproductive performance of the goat types in the study area is suggested; maintaining controlled breeding practices should be considered.

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Determinats of of Dairy Farmers Cooperatives Performances: the case of North Shewa zone of Amhara Region, Ethiopia

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Abstract

Dairy marketing cooperative are considered as the best alternative to initiate and to strengthen progressively and creating an avenue for marketing the surplus of milk available in the village with the member dairy farmers. However, many rural dairy farmers in Basona werana and Angolelana tera districts of North Shewa zone of Amhara region are not members of dairy marketing cooperatives to sell their surplus milk through the cooperative marketing channel. This study explored the determinants of dairy farmers' decision on dairy cooperatives. Purposive sampling was employed to select the districts and the kebele at the study area while Systematic Random Sampling technique was used to draw 120 sample respondents by using Probability Proportional to Size technique. Household survey method, key informant interview and focus group discussion were the tools used to collect the data in order to address the objectives of this study. Both descriptive statistics and logistic regression (Binary logit) were employed to analyze the data. The econometric model result depicted that, the probability of dairy farmers' membership decision to join the dairy marketing cooperative was positively affected by education level, active family members, access for information, access for financial credit, extension contacts, and average daily milk production; while an increase in age of a household head and distance of the household's residence from the milk collection centers were negatively related with the probability of farmers' membership decision to join the dairy marketing cooperative. Setting up milk collection centers closer to the dairy farmers' residence, building their technical and literacy capacity, creating room for them to access the financial credit, offering uninterrupted and continuous extension services should be the major intervention areas.

***Key words**:- Dairy farmers, Dairy marketing cooperatives, Membership decision*

Introduction

In Ethiopia, there are different types of Cooperatives engaged in different activities primarily aiming at solving the socio economic problems of their members. Among these the agricultural cooperatives are the most successful type of cooperatives in addressing the socio economic interests of their members and fighting against poverty. In Ethiopia about 900,000 people in the agriculture sector are estimated to generate part of their income through their cooperatives (Tesfaye, 2007). Dairy marketing cooperatives are one type of agricultural cooperatives in which milk producer farmers come together to sell their products where there is market and access services which is not easily accessible individually. The Ethiopian Growth and Transformation Plan (GTP) also highly supports the idea and gave a due emphasis as cooperatives have a tremendous potential for development and minimizing such acute demand supply variation if they are well managed and economically become strong. The promotion of marketing cooperatives, as a means of linking smallholders to markets, is a key pillar of Ethiopia's rural development strategy (FDRE, 2010). Cooperatives can be expected to help the smallholders to increase market access and so help them to increase their wealth. As part of the rural development process in Ethiopia dairy marketing cooperatives are emerging in most potential parts of the country following the existence of conducive environment for cooperatives as of 1991. The highland districts of North Shewa zone of Amhara regional state particularly, Basona werana, Angolelana tera, Siya debirna wayu, and Debrebirhan town, are considered as potential areas of Milk production. The main localities with significant dairy production include North Gonder, East and west Gojam, South wollo and North Shewa (Aklilu, 2004). Dairy marketing cooperatives are the newly emerging marketing outlet for Ethiopian smallholder milk producers, but the opportunity is not yet accessed to the required extent. Remoteness of farmers and existence of intermediaries between producers and final consumer, demand fluctuations due to religious factor and seasonal pattern of feed availability and milk production is reason for falling down of milk price especially in town such as Bahir Dar and Debrebirhan (Aklilu, 2004). Sparsely populated rural areas and high transport costs are physical barriers to access markets; lack of negotiating skill; lack of collective organization & lack of market information are other impediments to market access. Financial problem for dairy farmers, cooperatives, and milk traders is a challenge that limits them from investing on dairy business. ATA *et al* (2012) in the agricultural cooperative development strategy 2012-2016 stated that financial problem is one of the bottlenecks for agricultural cooperative. Households (HH) who are not members of a dairy cooperative have less access to a market; information that the cooperative offers; and services such as veterinary support, artificial insemination, financial and materials credit, and the occasional feed supplies. Much of the milk produced remain at home for local processing and sold for informal traders frequently, though the finding of Addisu *et al*. (2011) showed that dairy cooperatives were dominant milk buyers from producers at all milk marketing quality level. Besides, the amount of milk supposed to be collected and supplied to market does not properly reach the consumers. Most rural milk producer farmers are found suffering from informal market system and lacking to link themselves to the formal and legal marketing institutions. The general objective of the study is to identify the influential factors, which affect dairy farmers' membership decision on dairy marketing cooperative, and assessing their constraints & opportunities, and perception of dairy farmers on performance of cooperatives and their management body in the selected milk producing areas.

Methodology

Sampling method

There are five potential districts where milk is highly produced in North Shewa zone of Amhara regional state. Among these, only two districts namely Basona Weran and Angolelana Tera were selected because of the availability of dairy marketing cooperatives in these districts. Similarly, a total of four (4) kebeles from the two districts with dairy marketing cooperatives were subjected to be selected by a simple random sampling technique. A simplified formula provided by Yamane (Yamane, 1967 cited in: Yilma Muluken, 2005) were employed to determine the required sample size at 95% confidence level, degree of variability=0.5 and level of precision= 9% (0.09).

$$n = \frac{N}{1+N(e)^2};$$

Where n is the sample size, N is the population size (total household heads size which is equal to 1177), and e is the level of precision. Therefore, $n = \frac{1177}{1+1177(0.09)^2} = 111.7$

However, 120 respondents were determined as a sample size for the study to increase precision. Following this, lists of the farmers were prepared from fresh document obtained from Agricultural development office of the two districts, and kebele administrative offices namely: Cheki, Chefannen, Angolela, and Kormargefiya. Then, by using Probability Proportional to Size (PPS) technique, a representative sample size from each kebele was determined. Finally, using a simple random sampling technique individual sample HH was drawn from each kebele that accounts a total of 120 respondents from four kebeles of the two districts.

Table 1. Distribution of the sampled HH heads by kebeles

PA	Total HH heads	Total dairy farmers		Sample taken	
		N	% out of total HH	N	% out of total dairy farmers
Cheki	743	253	34.05	26	10.28
Chefannen	852	308	36.15	31	10.06
Angolela	912	334	36.62	34	10.18
Kormargefiya	821	282	34.35	29	10.28
Total	3328	1177	35.37	120	10.2

Source: Wereda agricultural dev't office and kebele administrative offices, 2013

Methods of data collection

The study used both primary and secondary data sources to gather both qualitative and quantitative data for achieving the stipulated objectives. The study used structured interview schedule to collect information from respondents and a questionnaire to collect data from a total of 30 officials and employees of agricultural bureau, cooperative promotion bureau, administration offices, and NGO. In addition, Focus Group Discussion (FGD) was conducted with 30-40 key informants selected among dairy farmers for getting in-depth information about issues in respect to dairy production and marketing system.

Method of Data analysis

Narration, interpretation, and conceptual generalization were employed to analyze data having qualitative nature; whereas, for quantitative data which is used to assess farmers' perception towards dairy marketing cooperative performance and related issues; descriptive statistical tools like percentage, mean values, and standard deviation were employed. Inferential statistics such as t-test and chi-square tests were used to test the significance of continuous and dummy variables, respectively. An econometric binary logit model that best fits the analysis was used. It is more advantageous than the others in the analysis of dichotomous outcome variable in that it is extremely flexible and easily used model from mathematical point of view and results in a meaningful interpretation (Hosmer and Lemeshew, 1989).

Result and Discussion

Rural households are characterized by demographic, socio-economic, and institutional characteristics, which directly or indirectly influence the day-to-day decision and choices. In this regard, the decision of dairy farmers towards cooperative membership in the study area is influenced by the aforementioned characteristics. Hence, examining the demographic, socioeconomic and institutional characteristics of the sample dairy farmers is of paramount importance. To these effect variables having significant effect on farmers' decision are presented as follows.

Socio-economic and institutional characteristics of sampled household

Institutions are the rule of the game for development endeavor. In rural area, one can find a number of locally available rural institutions with varying objectives and degree of comprehensiveness. They play an important role in the day-to-day activities of the rural community. Among these cooperative societies, credit institutions, and extension institutions play a leading role in the development arena of the study community. The following discussion shall examine institutional factors like frequency of extension contacts, access for financial credit, access for information from different sources, participation in different local association and administration, and membership to other cooperatives are considered to enhance or discourage a dairy farmers' decision towards cooperative membership.

Extension contacts: Survey result indicates that 60.8% of sampled dairy farmers have not extension contacts with development agents and experts concerning cooperative promotion in reference to the year 2012 while 39.2% do have a contact at least once a month. The chi-square analysis shows that there is a statistical significant difference (χ^2 =50.385, p < 1%) which implies extension service affects dairy farmers' membership decision on cooperative membership. Farmers who had participated in the Focus Group Discussion said that the state of extension contact with cooperative extension agent has an influence on farmers' membership decision, because farmers' awareness increases as there is uninterrupted extension contact with extension agents. Tesfaye (2003), Yitayal (2004), and Woldegebrael (2010) showed that farmers' decision is dependent on their extension contact with development agents and respective experts.

Table 2: Households distribution by the extension contact (N=120)

Extension contact	Decision				χ^2	Total	
	Not to join		To join				
	N	%	N	%		N	%
No contact at all	64	87.7	9	12.3	50.385***	73 (60.8%)	100
Contact at least once a month	11	23.4	36	76.6		47 (39.2%)	100
Total	75	62.5	45	37.5		120 (100%)	100

Source: Survey result, 2013

χ^2= Chi-square, (xx%)= Percent out of the total sampled HH, *** Significant at <1% sig. level.

Access for financial credit: The analysis showed that there is a statistical significant difference (χ^2 = 24.451, p<1%) between the household respondents who have access for credit and have no access for credit in relation with their membership decision. The implication is that farmers' membership decision is dependent on access for financial credit. During the focus group discussion, individuals have raised the importance of credit to fulfill different inputs required for increasing milk production and productivity. However, because of high interest rates (only for ACSI), collateral problem, and cumbersome loan procedure the difficulty of accessing credit from commercial banks and ACSI is raised as problem by farmers. Besides, they rose as it affects dairy farmers' membership decision. The finding of and Tesfaye (2003), Pender *et al.,* (2004) depicted that farmers decision is dependent on credit access.

Table 3: Sampled households'' access to the financial credit (N = 120)

Access for credit	Decision				χ^2	Total	
	Not to join		to join				
	N	%	N	%		N	%
Have no access	59	79.7	15	20.3		74(61.7%)	100
Have access	16	34.8	30	65.2	24.451***	46(38.3%)	100
Total	75	62.5	45	37.5		120(100%)	100

Source: Survey result, 2013
χ^2= Chi-square, (xx%) = percent out of the total HH, *** significant at <1% level of significance.

Participation in local association and administrative structure: According to the survey result showed 48.3% of the total household heads participate at village /*tabiya*/ and kebele level in different social and administrative structure, while the remaining 51.7% did not. Out of those who participate, 55.2% and 44.8% showed their positive and negative decision on cooperative membership respectively. Similarly, 21% and 79% of households who do not have any participation have positive and negative decision respectively.

The Pearson chi-square analysis shows that there is a statistical significant difference (χ^2=13.634, p<1%) between those who participate and not participate in administration structure with respect to their membership decision. The implication is dairy farmers cooperative membership decision has a relationship with participation in local association and administration structure. Such participation in local administration structure enables farmers to analyze situations critically and decide to join the dairy cooperative as compared to those who do not participate because they have a diversified interaction. This result is similar with the findings of Woldegebrael (2010) in Tigray region. This is also confirmed by participants of focus group discussion in that individuals who an engagement in any administrative structure have an exposure to meet and communicate with others which results an increase in awareness and acquirement of information.

Table 4: The sampled household participation in administrative structure (N=120)

Participation in admin. Structure	Decision				χ^2	Total	
	Not to join		To join				
	N	%	N	%		N	%
Not participate	49	79	13	21	13.634***	62(51.7%)	100
Participate	26	44.8	32	55.2		58(48.3%)	100
Total	75	62.5	45	37.5		120(100%)	100

Source: Survey result, 2013
χ^2= Chi-square, (xx%) = percent out of the total sampled HH, *** significant at <1% level of Significance.

Access for information: From the survey 71.4% of households who have information access from different sources showed positive membership decision while 85.9% of the household who do not have adequate information access responded negatively in their decision. The Pearson chi-square analysis showed that there is a statistical significance difference (χ^2= 40.676, p<1%) between the two groups of respondents in reference to their membership decision. Hence, access for information as a variable affects dairy farmers' membership decision. The reason could be that there is an exchanging of information with friends and neighbors at any occasion formally or informally; they access from radio, and from the meeting and workshop they participate by which they acquire knowledge and better understanding. Then, they decide to join a cooperative. According to Woldegebrael (2010) farmers have become member based on their interest because they have developed positive attitude on cooperative from different Medias and public meetings.

Table 5: Distribution of the sampled households by accessing information (N=120)

Accessing information from different sources	Decision				χ^2	Total	
	Not to join		To join				
	N	%	N	%		N	%
Do not access	61	85.9	10	14.1	40.676***	71(59.2%)	100
Access	14	28.6	35	71.4		49(40.8%)	100
Total	75	62.5	45	37.5		120(100%)	100

Source: Survey result, 2013
χ^2 = Chi-square, (xx %) = percent out of the total sampled HH, *** significant at <1% sig. level.

Distance of house hold residence from the milk collection center: Dairy farmers who travel less than one hour were taken as one group (nearby distance), and those who travel more than one hour were considered as other group (far off distance). Focus group discussion participants confirmed that traveling by carrying fresh milk more than an hour is difficult to reach the collection center by keeping its quality and freshness. According to the survey result, out of the total respondents 70% of them travel more than one hour to reach at the milk collection center. The remaining 30.0% of the household respondents travel less than 1 hour. Among those who travel more than one hour, 78.6% of them responded that decision to join dairy cooperative is affected if the distance they travel to milk collection center takes more than an hour. The Pearson chi-square analysis shows there is a statistical significant difference (χ^2= 30.857, p<1%) between households with respect to their decision implying that distance of dairy farmers' residence to the milk collection center affects their membership decision. The finding of Holloway, et al (2000), Wolday (1994), Gizachew (2005) depicted that farmers' decision in participating market outlet is dependent on the distance of household residence.

Table 6: Distance of sampled households' residence from the milk collection center (N = 120)

Distance of HH residence from collection center	Decision				χ^2	Total	
	Not to join		To join				
	N	%	N	%		N	%
Less than 1 hour (Nearby)	9	25	27	75		36(30%)	100
More than 1 hour (Far off)	66	78.6	18	21.4	30.857***	84(70.0)	100
Total	75	62.5	45	37.5		120(100)	100

Source: Survey result, 2013

χ^2 = Chi-square, (xx %) = percent out of the total sampled HH, *** significant at <1% sig. level

Average daily milk production: From the survey 3 liters and 12 liters is the minimum and maximum average daily milk production respectively registered in the area. The average daily milk production for the respondents in the study area is 6.44 liters with a standard deviation of 3.209. In the same talk 8.51 liters and 5.2 liter is the average daily milk production of the households whose membership decision is joining and not joining dairy cooperative respectively. The inferential statistics (independent t-test) shows that there is a statistical significant difference (t = 6.298, p<1%) implying that farmer's membership decision is dependent on his/her average daily milk production. Participants of FGD told that joining dairy marketing cooperatives with no having required quantity of milk may not be practical or economical; because as a member he/she must to supply a certain quantity of milk for a certain number of days in a year and shall continue to be a member only if he /she keep up this commitment.

Table 7: Average daily milk production of the sampled HHs (N=120).

Average daily milk production	Decision		t-value	Total
	Not to join	To join		
N	75	45		120
Min	3	3		3
Max	12	12	6.298***	12
Mean	5.2	8.51		6.44
SD	2.547	3.152		3.209

SD=Standard Deviation, t-v= t-test value, *** significant at less than 1% level of significance.

Performance of milk-marketing cooperative

Business transaction of dairy cooperatives: Out of the total sampled household heads 55.83% and 23.3% showed positive and negative response on their membership decision respectively while the remaining 20.83% are neither positive nor negative. According to the idea of participants of the focus group discussion, those who agreed with the cooperatives in doing of business transaction with non-members, are in need of selling their milk through cooperative without being a member while those who disagreed are in need of selling their milk through cooperative by being a member. Hence, as the cooperative increases its business transaction with non-members farmers are not in need of joining the cooperative because of their fear for the obligatory conditions imposed before and after joining.

Training and education: Out of the sampled dairy farmers, 21.7%, 19.2%, 18.3%, and 40.8% strongly disagreed, disagreed, neutral, and agreed respectively with respect to their perception on delivery of training and education of milk-marketing cooperative. This may be due to the way farmers perceive it, or due to the effort made by the dairy marketing cooperatives is weak. Farmers participated in the FGD said that the type and extent of training and educational activities offered by the cooperatives in the study area is weak. Most of the cooperatives give a sort of training to the farmers (mostly for members only) once in a year while conducting the general assembly meeting. Continuous education and training help farmers to be equipped with the skill, knowledge and confidence that enable them to join, participate in, and control the cooperative more effectively and to be more cooperators.

Milk collection and processing capacity: From the total respondents 14.2%, 36.7%, 13.3%, and 35.8% strongly disagreed, disagreed, neutral, and agreed with the existing collection capacity of milk-marketing cooperative. Similarly, 15%, 41.7%, 20%, and 23% strongly disagreed, disagreed, neutral, and agreed regarding the processing capacity of dairy marketing cooperatives.
Some cooperatives collect milk from the nearby farmers and process it to butter and cheese, while some others directly sell raw milk to individual processors. In Dessie (south wollo) and Chacha (North Shewa), cooperative sell raw milk in their own shops that are located in town and sell only the excess to processors (Aklilu, 2004).

Dairy marketing cooperatives inefficiency with poor infrastructure in the study area makes the cooperatives collection coverage limited and weak. Participants of focus group discussion also raised the problem that "Because milk-marketing cooperative do not collect milk in the evening, we allow it to ferment naturally at home and process in to butter and sell to itinerant traders who round from village to village at lower price". According to the study conducted by Aklilu (2004), the small milk quantities produced, seasonal supply and poor infrastructure in many parts of the region make collection system difficult to operate and uneconomical.

Performance of management body of dairy cooperatives

Each part of the team of management body of cooperatives has its own distinctive duties and responsibilities related to the cooperative's current and future performance and position and ongoing service and benefits to members. During the survey, respondents had been asked a question how they perceive the overall performance of the management body of dairy marketing cooperatives found in their corresponding kebele. Perception of the sampled HHs on performance of management body of dairy cooperative is depicted in table 10. At the time of FGD, participants said that few members of the management committee are corrupted and run for their own business. They are found dominating employees and other members of the committee. They also told that most of the time the members of the control committee are not seen doing corruption; rather they do not follow up and do what they are supposed to do. Generally, corruption and irresponsibility were raised during FGD as a critical problem of the management committee.

Table 8: Perception of the sampled HHs on performance of management body of dairy Cooperative (N=120).

	Management committee		Control committee		Employees	
Respondents perception	N	%	N	%	N	%
Strongly disagree	30	25	20	16.7	16	13.3
Disagree	37	30.8	47	39.2	40	33.3
total	67	55.8	67	55.8	56	46.6
Neutral	28	23.3	31	25.8	32	26.7
Agree	20	16.2	22	18.3	30	25
Strongly agree	5	4.2	0	0	2	1.7
total	25	20.4	22	18.3	32	26.7

Econometric Analysis of the Determinants of Cooperative membership decision

This section reports the results of analyses of determinants of cooperative membership decision in the study area and discusses the significant explanatory variables pertaining to farmers' membership decision. Data gathered from 120 dairy farmers was subjected to logistic regression analysis. Therefore, all the demographic, socioeconomic, and institutional explanatory variables were included in the model. Before running, the model, explanatory variables were checked for multi collinearity problem by using Variance Inflation Factors (VIF) and verified their degree of association. According to Gujarati (2003), the larger the value of VIF (x_{i_i}) the more "troublesome" or collinear the variable X_i is. As a rule of thumb, if the VIF of a variable exceeds 10, there is a multi-collinearity problem. The VIF values have shown that all the explanatory variables have no serious multi-collinearity problem. According to the results, significant problems of multi collinearity and very high degree of association were not observed.

Model output

In the preceding section, variables characterizing the farm households and their decision were identified. However, in the logit model analysis, we emphasize on considering the combined effect of variables on household decision towards dairy cooperative membership in the study area. Therefore, the emphasis is on analyzing the potential variables together, not one at a time. By considering the variables simultaneously, we are able to incorporate important information about their relationship. Among those hypothesized variables, demographic, Socio economic and institutional variables (accounts 14 variables) were found to be potential in affecting smallholder dairy farmers' decision to cooperative membership. The model result supports almost all result obtained from the descriptive statistics mentioned in the previous section except rejecting only the statistical significance of one variable namely, participation in local administration structure. The discussion of the regression results are briefly presented as follows.

Table 9: Maximum likelihood estimate of binary logit model of dairy farmers' decision on dairy cooperative membership

Explanatory variable	Coef.	Std.Err.	P>|Z|	Marginal effect
Sex	1.0297	1.4667	0.483	0.01517
Age	-0.1126	0.0613	0.066*	-0.005568
Edulev	2.4798	0.7961	0.002***	0.1544138
Dist	-2.9024	1.2818	0.024**	-0.146199
Acfmem	1.3717	0.5899	0.02**	0.0664433
Acinfo	0.2074	0.5964	0.045**	0.0811321
Padmin	1.501	1.1509	0.192	0.0709788
Acfcrt	0.1342	0.5937	0.049**	0.1240832
Mshocoop	-1.8675	1.3872	0.178	-0.009606
Excont	0.5295	0.0373	0.015**	0.1831997
Avmprod	0.3737	0.2975	0.054*	0.0187238
Price	0.4155	0.419	0.189	0.0269904
Offact	-1.0728	1.1669	0.358	-0.0653271
Wlths	-1.0113	0.9724	0.298	-0.014603

Source: Survey data model output, 2013
***, ** and * represents significant at p<0.01 p<0.05 and p< 0.1 level of significance respectively.
Log likelihood = -17.638568 Prob > chi2= 0.0000 , LR chi2 (16) = 123.5, Number of obs = 120 , Pseudo R2 = 0.7778

Brief discussion on significant explanatory variables

Education level of a Household (Edulev): As hypothesized earlier, education level influences households' decision on cooperative membership positively at a probability of less than 1% (P = 0.002) significance level. Literate farmers more likely decide to join dairy cooperatives than illiterate farmers by 15.4%. The implication here is as farmers get educated the probability of their decision to join a cooperative increases than those who do not get educated. This result is in conformity with the finding of Woldegebrael (2010) in Tigray region and Kharli, B. *et al* (2007) in Turkey pertaining to agricultural cooperatives.

Distance of Household residence (Dist): Distance of household residence from milk collection center influences the farmers' decision negatively at a probability less than 5% (P = 0.024). Farmers at far off distance less likely decided to join dairy cooperative than farmers at a nearby distance by 14.6%. The possible reasons for this is that milk by its nature is perishable and difficult to transport for a long distance without preservative equipment, so the close proximity is crucial to rich the collection center timely while keeping the liquid milk fresh. The other reason being, the reduction of cost, time and labor as well. This result is similar with the study conducted by Holloway *et al* (2000) on expanding market participation among smallholder livestock producers in Ethiopia high lands revealed that the distance to milk market was negatively related to milk market participation decision of dairy households. Similarly, the study conducted by

Wolday (1994) on food grain market in Alaba Siraro and Gizachew (2005) participation on milk market indicated negative relationship between distance from household residence to the market.

Active family members (Afmem): The variable is statistically significant at less than 5% (P = 0.02) significance level. The marginal effect result revealed that an increase in active family member by one unit would increase the probability of dairy farmers' decision to join dairy cooperative by 6.6%. The positive and significant relationship indicates that as dairying is labor-intensive activity, larger family size provides higher labor to undertake dairy production and management activities easily which in turn increases daily marketable milk volume leading to increased capacity of dairy household milk market participation and decision to join dairy marketing cooperatives. This result is unlike to the result of the study done on agricultural cooperative by Woldegebrael (2010) in Tigray which had negative relationship. But, the finding of Dagnet (2002) and Tesfaye (2004) on the adoption decision of improved agricultural practices revealed that there is positive and significant relationship between explanatory and dependent variables.

Accessing information (Acinfo): The model result showed that it is statistically significant at probability of less than 5% (P = 0.045) and has a positive relation with the decision of farmers. Dairy farmers who have enough information access more likely decide to join dairy cooperative than those who have no information access by 8.1%. This implies that having information from different sources such as radio, neighbors or friends, and from meeting and workshop enables farmers to acquire knowledge and better understanding by avoiding their confusion. This result, in parallel way, is similar to Aklilu (2004) in Amhara region, in that information about market is typically relayed and transmitted across markets inexpensively by word of mouth with neighbors and itinerant traders. Woldegebrael (2010) in Tigray recorded similar finding.

Access for credit (Acfcrt): As hypothesized earlier the result of the logit model revealed that the variable influences farmers' membership decision positively; and it is found statistically significant at probability of less than 5% (P = 0.049) significance level. Dairy farmers who have an access for credit more likely decide to join dairy cooperatives than those who have no access by 12.4%. The possible explanation for this could be, due to the availability of financial credit, farmers are able to fulfill crucial inputs to raise their milk production and productivity, which results in increasing the average daily milk production and influence farmers' decision to join dairy marketing cooperatives. The finding of Pender *et al.,* (2004), and Tesfaye (2003) showed how availability of credit motivates farmers to adopt technologies i.e. it affects their decision positively.

Extension contact (Excont)): Extension contact is statistically significant at the probability of less than 5% (P = 0.015) and it is found to have positive relationship with the farmers' membership decision which is similar with the prior expectation. Dairy farmers who have an extension contact with development agents at least once a month more likely decide to join dairy cooperatives than those who have not a contact by 18.3%. This logical relation shows that, as frequent contacts of development agent increase, farmers can have knowledge and awareness in selecting the best milk-marketing outlet and about the reason of joining dairy marketing cooperatives. Then the probability of farmers' decision to join dairy marketing cooperatives becomes increases. This result is similar with Tesfaye (2003) and Yitayal (2004) on adoption decision and Woldegebrael (2010) on agricultural cooperative membership decision.

Average daily milk production (Avmprod): As hypothesized earlier, this variable has positive relationship with household's cooperative membership decision; and it is statistically significant at probability of less than 10% (0.054) significance level. An increase in a unit of average daily milk production increases the probability of farmers' decision to enter into dairy marketing cooperative by 1.8%. The positive and significant relation between this explanatory and the dependent variable indicates that as average daily milk production of a household increases, percentage share of sold volume of milk per day per household also increases. This may be because of either the number of milking cows have gone up, an increase of productivity per cow, or availability of improved /cross breeds. This in turn increases farmer's decision to join the dairy marketing cooperatives.

Conclusion

Potential explanatory variables were tested for their significances in influencing dairy farmers' decision. Based on the descriptive analysis result dairy farmers' membership decision is dependent on Age, Distance, Education, Access for information, Access for credit, Active family members, Participation in administration structure, Extension contact, and Average daily milk production. The other variables sex, membership to other cooperatives, participation in off-farm activities, and wealth status had no influence on farmers' membership decision. e binary logit model output shows that variables namely, Education, Access for information, Access for credit, Active family members, Access for information, Extension contact, and Average daily milk production had positive and significant influence on dairy farmers' decision to join dairy cooperatives while Age and Distance had negative and significant influence. The attitude of farmers on milk collection, processing, delivery of training and education, cooperative business transaction with non-members, and performance of management body of dairy cooperatives were the most important attributes. Out of the total respondents, 23.3%, 20.83%, and 55.3% of them disagreed, neutral, and agreed with the business transaction of dairy cooperatives while in the delivery of training and education offered by the dairy cooperatives, 40.9%, 20.83%, and 40.9% of respondents disagreed, neutral, and agreed. In the case of milk collection and processing, and performance of management body of the dairy cooperatives, more than 50% of the total respondents disagreed. Binary Logit model was employed to analyze the factors affecting dairy farmers' decision on cooperative membership. The result of the binary logit model showed that among 14 explanatory variables, Education, Active family members, Distance of the household residence from collection center, Access for information, Access for credit, Extension contact, and Average daily milk production had positive and significant influence on dairy farmers' decision to join dairy cooperatives while Age and Distance had negative and significant influence.

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Honeybee Production Practices in Sekota District, Northern Ethiopia

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Abstract

The study was conducted in Sekota District with the objectives of assessing honeybee production practices and to identify potentials and constraints of honeybee production in the District. The District comprises a total of 33 peasant associations (PAs) which were classified into three highlands, 24 midland and six lowland areas. From these two, three and four peasant associations were randomly taken from the highland, lowland and midland areas, respectively. Ninety beekeeping households were selected ten from each PAs purposively based on their experience in keeping honeybees and involvement in extension activities. The data generated was analyzed using the SPSS. Three types of honeybee production methods were identified (traditional, transitional and modern hives production systems) and the beehives were exclusively kept in backyards in all production systems. Even though modern hives were recently introduced in the area, modern hive beekeeping method attracted the attention of most beekeepers and as a result many farmers of the study area were shifting to box hive beekeeping activity. The overall number of honeybee colonies and productivity of honeybees have been declining over the past four years. On the other hand, an increasing trend in price of honey was observed in the last four production years. Major constraints for the development of apiculture were drought, pests and predators, shortage of bee colony, application of chemicals, high price and shortage of modern beehives, shortage of beekeeping equipment, shortage of bee forage, high ambient temperature, absconding, shortage of water and the prevalence of honeybee diseases. Whereas the opportunities for the development of the apiculture sub-sector include indigenous knowledge, experience of beekeepers and the attention given for the subsector by GOs and NGOs operating in the area. Thus, it can be concluded that conservation of natural resources, training on queen rearing technique, provision of scientific control measures for the major bee enemies and diseases and assessing market linkages with the processors and exporters should be made for sustainable development of the subsector in the area.

Keywords: apiculture, honey, honeybees, beehives

Introduction

Beekeeping is a very long-standing practice in the farming communities of Ethiopia. It is a promising sideline farm activity for the rural households. It directly and indirectly contributes to the income of households and the economy of the nation. Despite the long tradition of beekeeping in Ethiopia, having the highest bee density and being the leading honey producer as well as one of the largest beeswax exporting countries in Africa, the share of the sub-sector in the gross domestic product (GDP) has never been commensurate with the huge numbers of honeybee colonies and the country's potential for beekeeping. Productivity of the subsector has always been low, leading to low utilization of hive products domestically, and relatively low export earnings. Thus, the beekeepers in particular and the country in general are not benefiting from the subsector as expected (Gezahegne, 2001a; Nuru, 2002). This is because apiculture is one of the sub-sectors of agriculture that received limited attention in the country. Recently, the contribution of beekeeping for poverty reduction, sustainable development and conservation of natural resources have been recognized and well emphasized by the government of Ethiopia and Non-Governmental Organizations (NGOs) operating in the country. The Amhara regional government and the study area (Sekota District) in particular have recently put beekeeping as one of the important development strategies to reduce poverty and to diversify farmers' income as well as to diversify national export commodities.

In the eastern parts of the Amhara Regional State, in spite of scarcity of natural vegetation, large areas of inaccessible lands for cultivation and livestock grazing (along escarpments, hills and undulating mountains) are covered with various types of bushes and make this part of the region a relatively potential area for beekeeping (BoA, 2003). Sekota District which is located in the eastern part of the Amhara Region is identified to be potential area for beekeeping but the area is getting degraded and deforested from time to time which negatively affect the subsector. To date, there is no compiled and published information on production systems of honeybees and the associated constraints and opportunities of beekeeping in the study area. Hence, studying honeybee production practices is important to identify problems associated with honeybee production and to formulate appropriate development strategies pertinent to beekeeping in the study area. Thus, this study was designed to assess honeybee production practices and to identify the major constraints and potentials of honeybee production in Sekota District.

Materials and Methods

Sekota district comprises a total of 33 peasant associations (PAs) which were classified into three highlands, 24 midland and six lowland areas. From these two, three and four peasant associations were randomly taken from the highland, lowland and midland areas, respectively. From each selected peasant association ten beekeeping households with a total of ninety households (90) were selected purposefully based on their activity in extension service and experience in keeping honeybees. Primary data was collected from sample respondents through a semi-structured questionnaire, informal group discussions and by interviewing key informants.Secondary data, was obtained from reports of previous research findings and other published and unpublished materials. The data collected were analyzed by descriptive statistics using SPSS software version 12 (SPSS, 2002).

Results

Honeybee Production system

Based on the levels of technology and management practices used by the beekeepers, three beekeeping production methods were identified in the study area: traditional, transitional and modern honeybee production systems. Majority of the honeybee colonies of the area (72%) were kept in traditional hives . Although the numbers of honeybee colonies in traditional hives are still higher compared to the modern and transitional hives in Sekota District, the number is decreasing from year to year as the beekeepers are transferring their colonies to improved hives. The common type of traditional hive used in Sekota District was made from cattle dung. About 1% of the honeybee colonies were kept in transitional hives . The distribution and ownership of transitional hives by the interviewed respondents were very less compared to the modern hives. As the beekeepers of the study area were well introduced with modern hives there were fewer tendencies by the farmers to stick to the traditional and transitional production methods. About 27% of the honeybee colonies of the area were found in modern hives (Zander hives). It was also common to see a combination of the different production methods at the backyards of a beekeeper.

Table 1. Indigenous knowledge of the respondents on honey adulteration and diseases treated with honey

Indigenous knowledge of the beekeepers	Response[a] (%)	Signs observed when adulterated with sugar
Methods of identification of adulteration of honey		
Stretching capacity of honey	71.1	-Not stretched longer
Flavour of honey	62.2	-Burning effect on tongue and loss of natural flavor
Firing	28.9	-Heavy smoke
Immersing hot metal rode	8	-*Tit tit* sound
Kinds of diseases treated with honey		
Wounds (injuries) and *kurba*	90	
Septicemia, teeth and throat diseases	42.3	
Colic	33.4	
Common cold	12.3	
Hemorrhoids	6.7	

[a]The percentage results when added give more than 100 percent because more than one variable asked at a time and the beekeepers also replied more than one answers.

Trends in Honeybee Colony and Honey Yield

In the last four consecutive (2006, 2007, 2008 and 2009) production years, there were 1384, 3057, 3342 and 4602 modern hives in the District respectively SWARDO (2009). The mean distribution of modern hives per year in these four years was 1087. However, the demand of beekeepers of the study area for improved hives (which was more than 5,000) were much more than the distributed average in which the suppliers were unable to satisfy their demand. Based on this study, the number of honeybee colonies in modern and transitional hives was increasing while the numbers of colonies in traditional hives were decreasing (Figure 1). This is attributed to increase in the supply of improved hives by governmental and nongovernmental organizations and transferring colonies from the existing traditional hives to improved hives. But, the overall number of honeybee colonies over the past four years in Sekota District has been declining due to various reasons. The average productivity of honeybee colonies in 2007 production year was found to be lower than both 2006 and 2008 production years in all the hive types. The productivity of modern hives was higher than both the transitional and traditional hives (Figure 3). The average productivity of modern, transitional and traditional hives in the consecutive three years (2006 to 2008) of the study area was 16, 13 and 7.8 kg per hive, respectively. In genral, the number of honeybee colonies and productivity of honeybee colonies of the study area showed a declining trend over time. The major causes mentioned are drought, pests and predators, lack of bee forage and application of chemicals.

Marketing of Honey in the Study Area

About 59% of the respondents sell their honey directly to local and transit consumers (Table 5). So consumers are the most important customers for the beekeepers of the study area. Honey cooperatives (retailers) are the second most important customers of the beekeepers. A team of beekeepers specialized in honey marketing namely Sekota District Honey Marketing Cooperative was established by the District Agricultural and Rural Development Office at Kebele and District levels. The teams in the kebeles have their own beekeeper members that have a mandate of selling the honey they produce to the cooperative. The profit obtained by the cooperative will then be shared among the members. The major actors in the marketing of the study area's honey are cooperatives, local & transit consumers, tej brewers, local and neighbor District traders and village level collectors.

Table 2. Customers of the respondents (n=90)

Customers of the producer	Response[a] (%)
Middle men (village level collectors)	25.6
Cooperatives (retailers)	32.2
Consumers (local and transit)	58.9
Teji (local beverage) makers	25.6

n=number of respondents; [a]The percentage results when added give more than 100 percent because more than one variable asked at a time and the beekeepers also replied more than one answers.

The trend of price of honey is increasing from one production season to another very rapidly due to different reasons: advertisement of honey of the study area by Market-led Livelihoods for Vulnerable Population (MLVP), improvement in the quality of honey produced, i.e., producing pure honey using modern hives, increase in consumer number and inflation of the currency. The price of honey during the study period (2009) in the study area was 22 and 50 ETB/kg in the time of production season for the crude red honey (obtained from traditional and transitional hives) and pure white honey (obtained from modern hive), respectively (Table 6). The price for white honey for both the crude and pure forms was increasing at alarming rate (at a rate of 56.3% and 125% for pure white and crude white, respectively) from 2006 to 2009 production years (Table 6). This shows that consumers are highly attracted by the color of honey than any other characteristics. Even though the physico-chemical properties of local honey is important to determine the quality grade, at the moment, traditional quality indicators were used for grading and pricing honey in Sekota District. The traditional honey quality indicators are color, taste, purity and cleanliness. For all types of honey, prices were increasing over the four production years although the rates of increments were different. The rate of increment was very high for crude white honey (125%) (Table 6). The mean price of pure honey ranges from 29.3 to 41.7

ETB/kg while price of crude honey ranges from 16.7 to 34 ETB/kg over the last four consecutive years in the study area (Table 9).

Table 3. The average price (Birr/kg) of different honey types over four years in the study area

Type of honey		Production years				Mean price (Birr)
		2006	2007	2008	2009	
White						
Pure		32	34	42	50	39.5
Crude		20	24	38	45	31.8
Yellow						
Pure		30	32	38	40	35
Crude		18	26	30	35	27.3
Red						
Pure		26	26	28	35	28.8
Crude		12	14	20	22	17
Mean	Pure	29.3	30.7	36	41.7	34.4
	Crude	16.7	21.3	29.3	34	25.3

Major Constraints for the Production of Honey

Drought (shortage of rainfall) was the primary honeybee production constraint and a threatening factor for the interviewed beekeepers (52.2%) followed by pests and predators. The third limiting factor for the development of apiculture in the study area is shortage of bee colony and application of chemicals. High price and shortage of modern beehives, shortage of beekeeping equipment, shortage of bee forage, high temperature, absconding, shortage of water and the prevalence of honeybee diseases were also limiting factors for the development of apiculture in the area.

Pests and predators

The most important pests and predators identified by the sampled beekeepers in the area were wax moth, bee-eater birds, ants (black), spider, bee lice, honey bagher (*shelemetmat*), lizard and red ant . Honey bagher (*shelemetmat*) and bee lice were very common in the lowland and bee-eater birds in the highlands peasant associations. The others were equally important to all agro-ecologies. About 46% of the respondents claimed that the primary and most important pest in their apiaries was wax moth *(Galleria mellonella)*. About 29% and 19% of the interviewed beekeepers listed bee-eater birds and ants as the most noxious enemies to their honeybees. As a result, birds and ants are the second and third important enemies of honeybees in the study area, respectively. Spiders, bee lice (*Braula coecal)*, honey bagher (*Mellivora capensis*), lizard and red ant were also other most important pests and predators in the study area . These five honeybee enemies are relatively less threatening to honeybees as compared to pests and predators mentioned earlier.

Diseases

A sort of disease which respondents call locally as *mich* occasionally occurs in the colonies of the sample respondents. This disease is associated with rust disease of crops. According to the opinion of the interviewed beekeepers, *mich* usually occurs in the colonies between August and October at the time when crops are affected by rust. It is caused by a rain drop in May. When there is a rainfall in May (time of high temperature), the rain associated with the high temperature affects the soil that in turn affects the floras of the surroundings. These affected flora ('*mich* affected plants' as named by the respondents) grow unhealthy flowers. The honeybees when visiting these flowers are then attacked by this disease as described by the interviewed beekeepers. About 74% of the interviewed beekeepers claimed that their honeybee colonies had been affected by *mich* at least once in the last three years, while the rest (26%) did not encounter the disease in their honeybee colonies. The disease affects both adult and brood stages of honeybees.

Chemicals

List of agrochemicals officially distributed from the District agricultural office to the farmers are indicated in Table 4. In addition to these chemicals, there were unknown chemicals purchased from black markets. Pesticides applied to control pests of crops, external parasite of sheep and goats and parasites of the household pests (bugs and fleas) and malaria were the common chemicals used in the study area. Although the beekeepers of the area are still suffering from application of chemicals, however, there is a significant attitude change and awareness creation in the community of the District about the negative impact of chemicals on honeybees.

Table 4. Chemicals distributed to farmers of Sekota District

Name of chemicals	Used to control
Diaznole	Crop pests & external parasites of sheep & goats
Malathione	Crop pests
Sevien	Ants that attack teff and HH pests
2, 4-D	Weeds
DDT	HH pests and seed parasites

HH = household; the common household pests are bugs and fleas.

Toxic/poisonous plants

About 42% of the interviewed beekeepers reported the existence of toxic or poisonous plants in the study area (Table 9). Neem tree *(Azadirachta indica)*, *Bahirsuf (Helianthus annuus)*, *Tihan tila (Verbena officinalis)*, *Kinchib (Euphorbia tirucalli)*, *Ater (Pisum sativum)* and *Kalkalda (Euphorbia spp.*) were the major poisonous plants reported in the area (Table 9). Some of the above listed plants kill the bees by poisoning them and others by damaging their physical bodies. Honeys from some of these plants were also reported to cause irritation on consumers' throat, i.e., honey from such plants is unsuitable to consume. According to the respondents, *Azadirachta indica*, *Helianthus annuus*, *Verbena officinalis* and *Pisum sativum* have a damaging effect on honeybees while honey from *Euphorbia tirucalli* and *Euphorbia spp.* cause irritation on consumers' throat. Flowers of *Helianthus annuus* and *Verbena officinalis* have damaging effect on bodies of the honeybees whereas flowers of *Azadirachta indica* and *Pisum sativum* are reported as honeybee killers.

High price of modern hives and honeybee colonies

The price of these inputs is the major determining factor for the expansion of improved beekeeping in the study area. The costs of these materials are relatively very high and beyond the purchasing power of poor farmers in the study area. Fortunately, these inputs were supplied by governmental and nongovernmental organizations to the beekeepers of the area on credit bases so that the beekeepers will pay back in three years loan period. The price of a modern hive (zander hive) had risen from 283.26 to 571 ETB while honeybee colony on average had risen from 200 to 274 ETB over the three consecutive years (2007-2009) in the study area .

Major Honeybee Floras and their Flowering Calendar

According to the respondents the most important sources of honeybee forage (in terms of preference by honeybees and abundance) in the study area were: *mentesie* (*Becium grandiflorum*), *dedho* (*Euclea shimperi*), *mashila* (*Sorghum bicolor*), *kushashle* (*Echinops spp.*), *abika* (*Acacia tortolis*), *keyi girar* (*Acacia seyal*), *tsalwa* (*Acacia asak*), *ekima* (*Terminalia glaucescens*), *teji matebiya* (*Hypoestes trifolia*), *aba tsemare* (*Ocimum bacilicum*), *Eret* (*Aloe spp.*), *adey ababa* (*Bidens spp.*), *kalkalda* (*Euphorbia spp.*) and *bakela* (*Vicia faba*). Except *Euclea shimperi, Terminalia glaucescens, Aloe spp.* and *Euphorbia spp.,* the rest ten were mentioned by Abebe (2008) as top fifteen dominant (major) honeybee forages in his study of honeybee flora inventory in the study area (Sekota District). The major honeybee plants in the area and their flowering period are indicated in Table 10. In the lowland PAs of the study area, the most important sources of honeybee floras were: *Acacia asak*, *Terminalia glaucescens* and *Sorghum bicolor*. On the other hand, in the highland and midland peasant associations of the study area, the most important sources of honeybee flora (both in terms of abundance and preference by honeybees) were: *Becium grandiflorum*, *Euclea shimperi* and *Vicia faba*. The rest honeybee floras mentioned above were distributed in all agro-ecologies of the District. Availability of potential flowering plants is the main parameter for an area to be considered as potential for honey production but on the contrary honeybee flora is diminishing from time to time in the study area. From the major sources of honeybee forages indicated in Table 10, majority of the honeybee forages (62.9%) were shrubs, herbs and cultivated crops. Most important honeybee floras of the area flower August through September (Table 10). In this case the peak honey harvesting period is during October 15 to November 15. When there is minor rainfall (*Belg)*, though not frequent, some plants flower March through April and small quantity of honey is harvested in June. Thus, the study area has major and minor nectar flow seasons occurring during August to September and March to April, respectively.

Smoker Fuels Used in the Study Area

Beekeepers in the study area use cowdung, *Woira* (*Olea africana*), e*kima* (*Terminalia glaucescens*), corn comb, tid (*Juniperus procera*), seed of *noug (Guizotia abyssinica)*, k*alkalda* (*Euphorbia spp.*), old cotton cloth and *fatika* for smoking while colony inspection . But all these materials are not equally available in all agro-ecologies. Cow dung was used as smoking material by all interviewed respondents in the low-, mid- and highlands of the study area. In the lowland peasant associations (mainly Debre Birhan), *Terminalia glaucescens* was most commonly used smoker fuel and more preferred than any of the above listed smoking material. But in the mid- and highlands, *T. glaucescens* is not available. Like cow dung, seed of *G. abyssinica* was used by all interviewed respondents but its use was for a special purpose in a special time .

Controlling Swarms and Swarm Attractants

Although the swarming time of honeybee colonies in the study area is from July 15 to September 30, the peak time of occurrence is from August 15 to September 15. There are different methods of controlling swarming of honeybee colonies in the study area. The most important are: harvesting honey combs during brood rearing period, suppering for modern hives and adding *gushgusha* for traditional hives, i.e., extending the traditional hive with similar sized traditional hive horizontally, removal of queen cells and returning the swarm back to the colony. The interviewed beekeepers use all the above methods but returning the swarm back to colony was practiced rarely. Most of the respondents (97.8%) used suppering for modern hives and *gushgusha* for traditional hives to control reproductive swarming. In the study area there were many different floral species identified by the local beekeepers which attract swarms. Majority of the respondents (97.8%) use the plant, *Ocimum bacilicum,* as a swarm attractant. So the most common swarm attractant used in the study area is *Ocimum bacilicum*. According to the respondents, *Ocimum spp.* has the same power of attracting swarms as *Ocimum bacilicum* but it is not commonly available. *Lippia adoensis, Hypoestes trifolia*, *Gishra, Letrena, Chochona, Ankua* and *Hamhamgulmza* were used by few of the interviewed beekeepers. So these are considered as secondary swarm attractants in the study area.

Post-harvest Handling of Honey

Honey could be stored for different reasons. In the study area honey is stored for the following reasons: for medicinal value, to get higher price, for women who will give birth and to entertain respected guests. Majority of the sample beekeepers (55%) do not store their honey; they sale it immediately to their customers in less than one month time after harvest. The length of storage of honey by the sampled beekeepers ranged from less than a month to greater than two years. The beekeepers who store honey for one month to one year do so with the attention to get higher price for their honey. These groups of beekeepers store the whole honey they produce till the price of honey rises. On the other hand, the beekeepers who store honey for more than one year, store a portion of their produce and it is for the purpose of medicinal value, for women who will give birth and to entertain respected guests. Only a few beekeepers (4.4%) store honey for more than two years.Gourd (locally called *kil*), earthen pot (locally called *ensra)*, plastics and animal skins were the most important honey storage materials used by the respondents. Most of the respondents indicated that the former most common storage material for their honey was gourd but now plastic containers are replacing it. The reasons for adoption of plastics as honey containers in the study area were: the extension service provided by SWARDO (awareness creation on the effect of containers for honey quality), the preference of customers, relatively cheap price and availability of the container in the area. Majority of the interviewed beekeepers (67.8%) use plastic containers for storage of honey.

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Feed and Nutrition

Prioritizing Feed Technologies Using Techfit In Horro District, West Oromia, Ethiopia

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Abstract

Six potential feed technologies were identified for Gitlo, Leku and Oda Buluk kebeles of the Horro district of Oromia Region, West Ethiopia, after filtering and prioritizing among thirty eight feed technologies with TechFit tool to address the quantity, quality and seasonality issues of livestock feed supply. The six top ranked feed technologies were: 1) feeding of home grown legume residues (for Gitlo and Leku kebels) and feeding of fodder trees (for Oda Buluk), 2) hand chopping of crop residues, 3) generous feeding of crop residues, 4) re-threshing and mixing of crop residues before storage and feeding, 5) supplementation with agro-industrial by-products, and 6) use of weeds, cut grass and tree leaves. Benefit cost ratio (BCR) and returns on investment were computed for the identified feed technologies. The BCR ranged from 1.34 to 1.93 and net returns ranged from ETB 15.66 to ETB 43.80. Based on the results of the current study, smallholder households of the kebeles can use one or more of the identified feed technologies based on their own circumstances.

Key words: Benefit cost Ratio; Feed technologies; Horro district; TechFit;

Introduction

The livestock sector contributes about 45% to the Agricultural GDP in Ethiopia (Behnke and Fitaweke, 2011) without considering the contribution of manure, hides and skins. The sector plays important roles in providing draught power for traction and transport as well as export commodities in the form of live animals, meat, hides, skins and leather to earn foreign currencies. Moreover, livestock products provide animal proteins that contribute to the improvement of the nutritional status of the people. According to a recent assessment conducted in Horro district (Gemeda *et al*. 2012a, unpublished) the main uses of livestock in the area included provision of traction power, milk production, income generation, means of transport and manure production for fertilizing crop fields. The assessment also showed that cattle, sheep, horses, goats, donkeys, mules and chicken are the animals commonly produced in the district where the first three species are most important; and the contribution of livestock to household income ranges from 28 to 59%. However, livestock production in Horro district is constrained by shortage of feeds, diseases & parasites, and lack of knowledge on improved animal husbandry practices. Shortage of feeds is exacerbated by the ever increasing human, which entailed expansion of cropland, and livestock population resulting in shrinkage of grazing lands (Gemeda, 2010). In such a situation, feed technology options that address quantity, quality and seasonality issues are needed. A number of important feed technologies have been generated by the research systems over the last four to five decades, costing substantial amount of efforts and resources. However, adoption rate of the technologies has been very poor which could be because of different reasons like lack of awareness, prioritization of crop farming instead devoting farmland for feed production, lack of inputs (e.g. seeds). Above all, suitable mechanisms for filtering (selecting) and prioritizing the available feed technologies for specific locations and situations has not been even thought over. In order to fill this gap, the International Livestock Research Institute (ILRI) has recently developed a simple tool known as TechFit for prioritization of feed technology options to enable better targeted interventions to address livestock feed problems in specific locations. Thus this study was carried out with objectives of prioritizing suitable feed technologies from a basket of options for Gitlo, Leku, and Oda Buluk *kebeles* of Horro district, Horro Guduru Wollega zone of Oromia region, Ethiopia using TechFit.

Materials and methods

Description of the study areas

The study was conducted in Gitlo, Leku and Oda Buluk kebeles in Horro district of the Horro Guduru Wollegga zone of Oromia region, western Ethiopia in July 2012. Horro district is located at about 315 km west of Addis Ababa (at about 9º 34′N latitude and 37º 6′E longitude). The altitude of the district ranges from 1800 to 2835 meters above sea level (masl). The mean annual precipitation of about 1800 mm (Olana, 2006). The mean, average maximum and minimum temperatures of the district were reported to be about 22°C, 27°C and 11.7°C, respectively. Total livestock population of the district was about 346,917 head, which comprises cattle (152,180 head), sheep (59,118 head), goats (29,923 head), horses (29,247 head), donkeys (12,611 head), mules (4,180 head) and chicken (59,568 head).

Selection of *kebeles*, farmers and context attribute scoring

The three *kebeles* used in this study were selected by the research team of Bako Agricultural Research Center (BARC) and the staff of the Horro District Office of Agriculture based on sheep production potential and accessibility of the *kebeles*. About 15 farmers were identified from each *kebele* to assess feed resource availability using the Feed Resources Assessment Tool (FEAST) (Gemeda *et al*., 2012a) and Participatory Rural Appraisal (PRA) group discussions, that preceded the TechFit interview. Out of the 15 farmers who participated in the FEAST PRA group discussions in each *kebele*, 12 farmers were selected for the TechFit group discussions.

Table 1: Number of households, altitudes and geographical coordinates of the kebeles

Kebeles	№ of households	Altitudes (masl.)	GPS coordinates
Gitlo	501	2758	09⁰ 33′ N and 37⁰ 03′ E
Lakku	388	2710	09⁰ 34′ N and 37⁰ 03′ E
Oda Buluq	457	2490	09⁰ 38′ N and 37⁰ 04′ E

Intensive discussions were conducted between the researchers and farmers on issues that could help for scoring the context attributes of the farmers in the area using a checklist prepared for this purpose. Accordingly the farmers scored the five attributes (availability of land, labor, cash/credit, inputs and knowledge) on a 1-5 scale (Table 2) by giving justification. Experts also did their own scoring for the purpose of cross checking the reliability of the scores given by the farmers. The scores (availability) given for each attribute by each *kebele* were entered into an Excel template.

Results and discussion

Context attributes scores

Farmers' context attribute scores (scores for availability of land, labor, cash/credit, inputs delivery, and knowledge) in the three *kebeles* is indicated in Table 2 with justification for scores given. The lowest score was given for input delivery in Laku followed by cash/credit service. Cash/credit, input delivery and knowledge in Oda Buluk, and input delivery in Gitlo were given below average scores.

Table 2. Farmers' context attributes score for the different attributes in the three kebeles

№	Attributes (1- 5 scale)‡	Gitlo	Lakku	Oda Buluq	Justifications given by farmers
1.	Land	3	3	3	Sizable farmlands were owned by former elders; young farmers are emerging at alarming rate; parents share to their descendants upon good will
2.	Labor	3	3	3	Young children enroll to school; daily laborer is sometimes unavailable to hire
3.	Cash/credit	3	2	2	Though there is credit service, it is not flexible. Collateral is needed to access it which is actually difficult for farmers suitable collateral
4.	Inputs	2	1	2	Some of the inputs like plastic sheeting are not available to the area; some agricultural inputs lack quality (seeds) and others are becoming too expensive.
5.	Knowledge/skill	3	3	2	Knowledge/skill gap was reported as major issue by farmers in the three kebeles. The present knowledge/skill is too little.

‡1=lowest and 5 = highest

Regarding availability of land, the farmers indicated that many young farmers are emerging although the available land is limited. The shortage of land in the three kebeles resulted in a low context score for the availability of land in the kebeles. This warranted agricultural intensification in the kebeles. Labour availability was reported to be critical during peak agricultural activities such as harvesting as children from each family are enrolled in schools during such times and cannot contribute to farm work. The need of collateral to access the credit service lowered the score given to its availability. Some of the agricultural inputs were either very expensive or not readily available, which resulted in relatively low score. Farmers from the three kebeles noted that they had no tailor made training to fill the knowledge gap they had. This was worst in the case of Oda Buluq, which was not covered by the ICARDA-ILRI-BOKU community-based sheep breeding project. According to Duguma (2010), the ICARDA-ILRI-BOKU community-based sheep breeding project has more than 130 sheep producing households, in Gitlo and Lakku kebeles, as members which have frequently been exposed to several trainings related to improved livestock production and management in general and that of sheep in particular.

Pre-filter of technologies

Lists of technology options, which were categorized into six broad groups, to address the quality, quantity and seasonal issues of feeds are given in Annex 1. The six broad groups were: 1) improvements of crop residues, 2) supplementation, 3) feed conservation, 4) improved forages, 5) feeds from cropping systems, and 6) balanced feeds. Specific technologies unable to be carried forward are indicated with reasons for their failures in Table 3; and the top ranked technologies and reasons for their being ranked as such are depicted in Table 4. In general, the major reason for dropping a technology included was either unsuitability of the technology in the agro-ecology of the area or difficulties in making it available to the area.

Table 3. Feed technologies unable to pass the pre-filtering process and reasons for dropping

№	Technologies	Reason for dropping
I	**Improvement of Crop residues**	
	Feeding of bought in legume residues	In general, purchasing animal feeds is not a common practice in the three kebeles. The home produced legume residues will not reach the level of transaction being surplus from feeding own animals
	Supplementation	
	Supplementation of bought in local brewery wastes	The tradition of home brewing and distilling is significantly decreasing due to change of religion by most of the community members and hence availability of these products for sale and purchase is quite insignificant.
	Use of oats grain and hulls for supplementary feeding	Not known in the areas. Thus it is time demanding to convince farmers to allot the small plots of land they have for a crop that is not known in the area. This technology works better in areas where farmers grow oats and process the grain for human consumption.
	Use of urea molasses block	Molasses is not available in the area and that could be a stumbling block to promote the technology
	Use of poultry litter	Commercial poultry farm is not available in the area
	Feed conservation	
III	Making hay from cultivated perennial fodder with specialist seed (e.g. alfalfa, Rhodes)	Land demanding. Despite their contribution they are not relevant in the areas because they occupy lands for long period which farmers do not prefer and tolerate
	Buying baled hay (e.g. oats/vetch, Rhodes grass, meadow etc.)	Financial demanding and not available in the areas.
	Feed conservation (silage)	Inputs, labor and knowledge intensive
	Improved forages	
IV	Improved forage grasses (Napier grass, Rhodes grass)	Despite their high biomass yield, due to limitation of agro-ecology (not suitable to the areas)
	Improved forage legumes (Alfalfa, Desmodium spp.)	Despite their high biomass yield and suitability of alfalfa to the area, adoption could be a problem as both crops are perennial and occupy the limited land the farmers have
	Fodder trees - dual purpose (Pigeon pea)	Highland agro-ecology is not conducive for dual purpose fodder trees such as pigeon pea
	Use of improved perennial grass-legume mixture (e.g. Rhodes-alfalfa forage or hay)	Difficult and expensive to incorporate a legume every year into perennial grasses. Labor, land and skill demanding
	Feeds from cropping systems	
V	Thinning (e.g. maize and/or sorghum - cutting green at knee height)	Agro-ecological limitation (except for Oda Buluk where maize is grown to some extent, maize and sorghum are not produced in the areas)
	Use of tops, leaf strips (e.g. maize or sorghum)	Agro-ecological limitation; maize and sorghum are not grown in the areas
	Use of enset and/or banana leaves and by-products	Not available in the areas. Enset is not in the culture of the community and it may not be adopted as animal feed when it is not used as human food
	Crop/forage intercropping (sorghum/cowpea for dry areas and maize/lablab for wetter areas)	Agro-ecological limitation (crops are not produced there)
	Root and tubers - use of byproducts	Not available in the areas; except potato root and tuber crops are not grown in the area
	Root and tubers - dedicated use	Not available in the areas; except potato root and tuber crops are not grown in the area
	Vegetable wastes	Not available in the areas; no sufficient waste is found from vegetables

Table 4. Feed technologies carried forward, scores given to the scope for improvement of the technology attributes and major reasons for scores given

№	Technologies carried out to the main filter	Justifications for promoting for further processing
1.	Hand chopping of crop residues	Not affected by land and knowledge, but moderately affected by cash (eg. to buy some tools) and labor and slightly by input supply. If practiced it will largely improve the intake of the residues.
2.	Machine chopping of residues	Though machines which chop residues are not available in area the option can address the problem of residue refusal even more than hand chopping. It would be difficult to be used per farmer but farmers may come together and buy to use it in group.
3.	Generous feeding of crop residues	Ample crop residues are produced in the areas, but not properly utilized Not affected by cash/credit, input delivery system and knowledge Influenced by land (though land is not meant for production of crop residues the availability of land matters) and labor
4.	Treatment of crop residues (e.g. urea treatment)	This approach would help a lot in improving the inherently poor quality of crop residues. However, the technology is much affected by availability of input and knowledge/skill
5.	Feeding of home grown legume residues	Same as other crop residues, but has great potential in improving the nutrient contents of feeds (eg. crude protein)
6.	Re-threshing and mixing of crop residues before storage and feeding	Not influenced by inputs, cash/credit and knowledge, but affected by labor availability Considering land issue, same as other crop residues
7.	Supplementation of home produced local brewery wastes	From the beginning the amount of brewers waste produced are reported to be small. However, that amount can be utilized for own animals.
8.	Supplement with oilseed cakes	The presence oil seed processors in the area favored the promotion of this technology.
9.	Supplement with pulse crop milling by-products (e.g., lentil hulls and/or brans etc.)	As the crop grinder machines are found in nearby towns and in the villages also the option can be opted
10.	Use of leave/pods of farm trees	Though not available in the required amount, it does not mean that it does not work. In Oda Buluq kebele, for example, it may work well.
11.	Fodder tree leaf meal	Though not available in the required amount, it does not mean that it does not work. In Oda Buluk *kebele*, for example, it may work well.
12.	Supplement with agro-industrial by-products	Not affected by land , but moderately influenced by knowledge Agro-industries are not available in the areas, other than local oil meals Dependent on cash/credit and inputs delivery system
13.	Commercial dairy supplements	These may be obtained through cooperatives and traders to those who can afford.
14.	Fodder beets for cooler highlands	The Horro district seems an ideal location for the fodder beet as it is quite highland.
15.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia)	Requires land. Though they can be planted on crop boundaries and as live fence, usually no impact is expected with few trees They require a lot of labor for establishment, protection

№	Technologies carried out to the main filter	Justifications for promoting for further processing
		(particularly for young trees) and harvesting – particularly in areas like Horro where animals are left free to roam, their scope for improvement might be low Some of the technologies are determined by agro-ecologies
16.	Use of weeds, cut grass, tree leaves	Only slightly influenced by labor, but the use of herbicides for weeds control may influence its future application
17.	Use of improved annual grass-legume mixture (e.g. oat-vetch forage or hay)	After filling the knowledge gap the farmers have and convincing, farmers could assign part of their land for such alternatives.
18.	Feed conservation of private natural pasture (surplus) (HAY)	The present initiatives by the community could be more optimized
19.	Making hay from cultivated annual fodder with readily available seed (e.g. oats/vetch)	The present initiatives by the community could be more optimized
20.	Complete feed-TMR (mash, block, pellet)	The technology can be tried out though it is capital and knowledge intensive.
21.	Smart feeding (targeted use of bought-in concentrates to target productive animals)	Affected by cash/credit, input delivery system and knowledge In relation to the unavailability of feeds processing industries, the scope of improvement for technology might be constrained

Selection of top ranked technologies

Among the promoted technologies for further filtering seven, six and six top ranked feed intervention technologies were identified for Gitlo, Lakku and Oda Buluq, respectively (Tables 5, 6 and 7). The top ranked feed technologies included supplement with home-produced local brewers waste, feeding of home grown legume residues, re-threshing and mixing of crop residues before storage and feeding, use of weeds, cut grass, tree leaves, use leaves and/or pods of farm trees, generous feeding of residues, hand chopping of residues and fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia). In general, these technologies were ranked highly based on the scores given for the technology and context attributes. Some of the feed intervention technologies selected were those related to crop residues and supplementation. Hand chopping of residues was the least ranked in Gitlo whereas the fodder trees were least ranked in Lakku and Oda Buluq. From crop production potential of the areas, one can be sure that feed intervention technologies related to crop residues could reasonably address the feed problem prevailing in the areas. Estimates of annual production of crop residues, based on harvest index of each crop, is around 6.3, 8.7 and 11.7 tons per household for Gitlo, Lakku and Oda Buluq, respectively. In both Gitlo and Lakku kebeles, home grown legume residues received the highest total score followed by re-threshing and mixing of crop residues before storage and feeding (Table 5 and 6). Supplement with home-produced local brewers waste was first ranked in all the three kebeles followed by feeding of home grown legumes. Except for the differences in the scores given for each feed intervention technology, technologies selected for Gitlo and Lakku were almost the same, which indicates their similarity in production system.

Table 5. List of top ranked feed technologies filtered from a basket of options for Gitlo

№	List of feed technologies tope ranked with the TechFit tool	Total score	Rank
1.	Supplement with home-produced local brewers waste	68	1
2.	Feeding of home grown legume residues	67	2
3.	Use of weeds, cut grass, tree leaves	61	3
4.	Re-threshing and mixing of crop residues before storage and feeding	60	4
5.	Use leaves and/or pods of farm trees	59	5
6.	Generous feeding of Crop residues	53	6
7.	Hand chopping of residues	53	6

The lowest total score and hence rank of fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia) and hand chopping was associated with their labor and cash demanding nature. Other technologies like use of weeds, cut grass, tree leaves, re-threshing and mixing of crop residues before storage and feeding, use of leaves and/or pods of farm trees and generous feeding of crop residues were among the top ranking technologies because of their moderate requirement for attributes such as land, cash/credit and inputs.

Table 6. List of top ranked feed technologies filtered from a basket of options for Laku

№	List of feed technologies tope ranked with the TechFit tool	Total score	Rank
1.	Supplement with home-produced local brewers waste	58	1
2.	Feeding of home grown legume residues	57	2
3.	Re-threshing and mixing of crop residues before storage and feeding	50	3
4.	Use leaves and/or pods of farm trees (e.g. Acacias, Milletia	49	4
5.	Generous feeding of crop residues	44	5
6.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia .	43	6

Table 7. List of top ranked feed technologies filtered from a basket of options for Oda Buluq

№	List of feed technologies tope ranked with the TechFit tool	Total score	Rank
1.	Supplement with home-produced local brewers waste	59	1
2.	Feeding of home grown legume residues	58	2
3.	Re-threshing and mixing of crop residues before storage and feeding	51	3
4.	Use leaves and/or pods of farm trees (e.g. Acacias, Milletia etc)	50	4
5.	Generous feeding of crop residues	45	5
6.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia etc.)	44	6

Cost benefit analysis

The economic analyses for the top ranked feed intervention technologies were based on benefit cost ratio (BCR); and, accompanied by net returns (Table 8). If the benefit is higher than cost and the quotient is greater than unity, it means that use of the technology is considered to be economical. All top ranked technologies, except hand chopping of crop residues at Gitlo, were found to be economical at the three kebeles. The BCR value for economically feasible technologies ranged from 1.43 to 1.93 at the three kebeles. As the value of the BCR only indicated the feasibility of a technology, net returns were also presented for respective technologies. The net return per animal in ETB ranged from 20.18 to ETB 38.95 at Gitlo/Lakku. At Oda Buluq the net return ranged from ETB 15.66 from fodder trees to ETB 43.80 from supplement with home-produced local brewers wastes. The higher net return at Oda Buluq kebele was due to the assumption of more weight gain in line with its warmer weather condition compared to the other kebeles.

Table 8: Cost benefit analysis for the technologies top ranked at the three kebeles in terms of benefit cost ratio (BCR)

№	Technology options to address quantity, quality, seasonality issues	Gitlo		Laku		Oda Buluk	
		BCR	NRT	BCR	NRT	BCR	NRT
1.	Hand chopping of residues	0.93	-5.15	-	-	-	-
2.	Generous feeding of crop residues	1.81	24.18	1.81	24.18	1.93	28.01
3.	Re-threshing and mixing of crop residues before storage and feeding	1.53	21.43	1.53	21.43	1.72	29.05
4.	Supplement with home-produced local brewers waste	1.62	38.95	1.62	38.95	1.70	43.80
5.	Feeding of home grown legume residues	1.93	28.01	1.93	28.01	1.70	43.80
6.	Use leaves and/or pods of farm trees	1.34	15.66	1.34	15.66	1.34	15.66
7.	Use of weeds, cut grass, tree leaves	1.43	20.18	-	-	-	-
8.	Fodder trees (Sesbania, Leucaena, Tagasaste, Gliricidia)	-	-	1.34	15.66	1.34	15.66

BRC=Benefit cost ratio; NRT=Net return in ETB.

Conclusions

Livestock production is one of the major contributors to the livelihood of the smallholder households of the kebeles considered in the present study. They are mainly raised for traction, milk production, income generation and transportation. However, the sector is constrained by different problems; and one of these problems is feed (both quantity and quality). Various feed intervention technologies were generated by research systems of the country during the past three or four decades. Nevertheless, the adoption rate was insignificant probably due to lack of targeting to assess the relevance of the technologies to specific locations. The top ranked feed technologies included supplement with home-produced local brewery waste, feeding of home grown legume residues, re-threshing and mixing of crop residues before storage and feeding, use of weeds, cut grass, tree leaves, use of leaves and/or pods of farm trees, generous feeding of residues, hand chopping of residues and fodder trees such as Sesbania, Leucaena, Tagasaste etc. The BCR value for economically feasible technologies ranged from 1.43 for use of leaves and/or pods of farm trees to 1.93 for supplement with home-produced local brewers waste at the three kebeles. Additionally, the returns for economical feed technologies were also computed for each technology which ranged from ETB 20.18 to 38.95 at Gitlo/Lakku and from ETB 15.66 to ETB 43.80 at Oda Buluq. Based on the benefit cost ratio and net return computed, all of the top ranked feed intervention technologies, except hand chopping of residues, were economical.

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Advanced Screening of Napier grass genotypes under Bako condition, west Ethiopia

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Abstract

The present study was conducted with the objective of screening top performing Napier grass genotype(s) under Bako condition from previously selected at preliminary screening. The genotypes tested included accession ILRI 16804, ILRI 16801, ILRI 16800, ILRI 16792, ILRI 16798, ILRI 16840, ILRI 15743, ILRI 16787, ILRI 14389 and ILRI 16785. Herbage dry matter yield in t/ha, leaf to stem ratio, number of tillers and plant height in cm were the dependent variables measured to screen the genotypes. The overall means for these parameters were 23.4 t/ha, 1.9, 8.6 and 141.9cm, respectively. From the analysis result, all the yield parameters of were linearly affected by the fitted model (P=0.000 for all parameters). In general, the herbage dry matter yield from all the genotypes was above 18 t/ha per harvest per year except from the ILRI 16801. Napier grass genotypes labeled ILRI 14389 (28.9t/ha), ILRI 16804 (28.1t/ha), ILRI 16792 (26.5t/ha) and ILRI 16840 (25.9t/ha) performed nicely in terms of herbage dry matter yield. Hence it is concluded that these genotypes are suitable for use as animal feeds, mitigation of soil erosion and rehabilitation of degraded areas under Bako and similar agro ecologies.

Key words: Herbage dry matter yield; Leaf to stem ratio; Napier grass genotype; Screening

Introduction

Inadequacy of feeds is a major constraint to dairy cattle and other livestock productivity on small scale crop-livestock mixed farms. Most of the natural grassland of the western region of Ethiopia has shrunk due to the need for wider cultivation of food crops, the consequence of which resulted in palm-sized grazing land and thus feed shortage. To cope with such challenging scenario, the use of high yielding forage crops like Napier grass is advisable. Napier grass (*Pennisetum purpureum*) has been identified as high yielding forage on smallholder farms (Orodho, 1990). Napier grass is a native perennial forage crop to tropical Africa and grows more suitably in the warmer weather regions than cool areas (Martin et al, 1976). It gives high herbage yields throughout the year compared to other grasses. Napier grass also controls maize stalk borer by trapping the ovipositing moths if planted round the maize moths; protects the maize from strong winds if planted round a maize field; holds soil together and prevents runoff and erosion; it can also be sold as green fodder. Its leafy nature, considerable plant height, high tiller and re-growth ability made it a highly productive feed crop per unit area of land as compared to other grass species (Whiteman, 1980; Martin *et al*, 1976). Flexibility on utilization (either rotationally grazed or cut and hand-fed), its palatability, nutritive value and greenness for long periods of dry season enhanced its acceptance by many farmers compared to other grass. Napier grass become ready for harvesting within 3-4 months after planting and harvesting can continue at an interval of 6-8 weeks for more than five years where there is no soil moisture and fertility is not a problem. Yields depend on agro-ecological zone and management but on average Napier grass can give 12 to 25 t/ha of dry matter yield. Napier grass can be harvested leaving about 10 cm stem from the ground and fed green to livestock whereas excess green feed can be preserved in the form of silage. Mindful of Napier grass benefits, about 58 accessions of Napier grass obtained from ILRI were screened for one year during the 2003 at Bako Agricultural Research Center (BARC) and ten top performers were selected based on the biomass and visual judgment. Hence the objective of the present study was to identify top performing genotypes, of the ten, under Bako condition.

Materials and methods

Descreption of the study area

The study was conducted at Bako Agricultural Research Center (BARC). The center is located 258 km west of Addis Ababa at an altitude of 1650 meters above sea level (masl). It lies at about 09°6'N and 37°09'E. The area has a hot and humid climate and receives a mean annual rainfall of about 1220 mm, of which more than 80% falls in the months of May to September. Mean monthly minimum and maximum temperatures are about 14°C and 28°C, respectively with an average monthly temperature of 21°C. The mean daily minimum and maximum temperatures are 9.4°C and 31.3°C, respectively. The soil belongs to Alfisols series and it is clay in texture (Piccolo and Assefa, 1983), reddish brown in color with pH ranging from 5.3-6 (Dawit and Leggesse, 1987) and cation exchange capacity of 18.3 me/100g (Sahlemdhin and Ahmed, 1983). Total (Piccolo and Assefa, 1983) and available (Sahlemdhin and Ahmed, 1983) phosphorous content of the soil was estimated to be about 475 parts per million (ppm) and 2.2ppm, respectively.

Land preparation and establishment: the field was well ploughed and harrowed before planting. The seedbed was almost as good as that for planting maize. Cuttings having three nods were prepared from each accession. Each cutting was planted in rows where the intra and inter row spacing were 50 cm and 60 cm, respectively at about 45^{o} slanting. Two nods were completely covered by soil whereas the other nod remained above the ground. The materials were established on 9-June-2004 on a plot of 3m by 5m size. The distances between blocks and plot were 2m, each.

Genotypes tested, fertilizer applied and weeding: the genotypes tested included Napier grass accession number ILRI 16804, ILRI 16801, ILRI 16800, ILRI 16792, ILRI 16798, ILRI 16840, ILRI 15743, ILRI 16787, ILRI 14389 and ILRI 16785. Urea and DAP fertilizers were applied to the plots every year at the rate of 200 kg per hectare each. Urea was applied in split where half was applied during establishment and the other half was applied just before cease of rain fall. Weeding was done as required.

The total annual rain fall during the three years was almost followed the same trend where the peak rainy months were May to September. However, maximum rainfall was recorded in the month of August during 2006. Even though the variability in mean maximum and minimum monthly temperatures were about the same for the three years, the year 2006 was characterized by about lower mean maximum temperature and higher mean minimum temperature.

Data: Herbage dry matter yield in t/ha, leaf to stem ratio, number of tillers and plant height in cm were the dependent variables measured to screen the Napier grass genotypes. Herbage dry matter yield and leaf to stem ratio were determined from two middle rows (one middle row was used for herbage dry matter yield and the other one was used for leaf to stem ratio). Measurements were taken twice in 2005 (on 26/07/2005 and on 20/10/2005) and 2006 (on 19/07/2006 and 16/10/2006) but only once during 2004 (on 13/10/2004). Average of the two times measurements were taken in 2005 and 2006. For the herbage dry matter yield the main plants plus tillers were used. For the leaf to stem ratio calculation the whole plants from one of the middle two rows were divided in to leaf and stem. A composite sample of 200 g leaf and a composite sample of 200 g stem were taken from the three replications for leaf and stem dry matter percentage determination for each Napier grass genotype. In similar fashion, a composite of 200 g whole plant sample was taken from the three replications for each Napier grass genotype dry matter percentage determination. Then after herbage, leaf and stem dry matter yields in t/ha were determined. The leaf to stem ratio calculation was, then, done just by dividing the leaf dry matter yield by the stem dry matter yield in ton per hectare. Numbers of tillers were determined just by counting the number of new growing shoots other than the main plant. Plant height was taken in cm to the shoot of the plant not to the end of the tallest leaf.

Data analysis

The design used in the present study was randomized complete block. Three levels of block/replication, three levels of year and ten levels of Napier grass genotypes were used as independent variables in the model for the dependent variables. The general linear model of Statistical Analysis System (SAS, 2002) was used to analyze the data. Significantly differing least squares means were separated using Tukey-Kramer where necessary.

Results and Discussion

Summary of the generalized linear model for explaining variability in Napier grass herbage dry matter yield, leaf to stem ratio, number of tillers and plant height are given, together with R-squared and coefficient of variation, in Table 1. All the yield parameters of Napier grass were linearly affected by the fitted model ($P=0.000$ for all parameters). From the coefficient of determination, R-squared, it can be seen that the variability in all the traits were fairly explained by the fitted model, and from the C.V. value, it can be seen that measurement/manmade errors were minimized. Specifically, the effects of production year and Napier grass genotypes on herbage dry matter yield, leaf to stem ratio, number of tillers and plant height were significant ($P<0.05$) (Table 1). Additionally, it was seen that blocking was efficient as its effect was significant ($P<0.05$) on all the Napier grass yield parameters indicating the variability in soil fertility among the blocks. Napier grass herbage dry matter yield (t/ha), leaf to stem ratio, number of tillers and plant height in cm were significantly ($P<0.05$) variable for the different Napier grass genotypes.

Table 1. Summary of the generalized liner model for explaining the variability in Napier grass dry matter yield, leaf to stem ratio, number of tillers and the plant height. R-squared and coefficient of variation were also given along with.

Model	F value	P value*	DF	R-squared	C.V.
Herbage dry matter yield	23.01	0.000	13	80	21
Production year	71.76	0.000	2		
Block	46.61	0.000	2		
Napier grass genotypes	6.94	0.000	9		
Leaf to stem ratio	4.72	0.000	13	45	21
Production year	10.46	0.000	2		
Block	4.55	0.014	2		
Napier grass genotypes	3.44	0.001	9		
Number of tillers	12.69	0.000	13	68	23
Production year	9.54	0.000	2		
Block	15.65	0.000	2		
Napier grass genotypes	12.72	0.000	9		
Plant height	30.51	0.000	13	84	13
Production year	171.62	0.000	2		
Block	15.32	0.000	2		
Napier grass genotypes	2.53	0.014	9		

*Values less than 0.05 means the effect of the factor(s) was statistically significant on the measurements, DF= Degree of freedom, R-squared was obtained by dividing the model sum of squares to the total sum of squares and was the amount of variation explained by the fitted model.

Least squares means of Napier grass herbage dry matter yield (t/ha), leaf to stem ratio, number of tillers and plant height in cm over the three years were given in Table 2. The overall means for these parameters were 23.4 t/ha, 1.9, 8.6 and 141.9cm, respectively. The herbage dry matter yield increased with the advancement of the production year (from 16.6 t/ha in 2004 to 31.7 t/ha in 2006). The leaf to stem ratio was maximum (2.2) during 2005 and minimum (1.3) during establishment year (2004). The number of tillers was found to be minimum (7.6) during the 2005 and maximum (9.8) during the 2006 production year. Tallest plants of Napier grass were recorded during the 2005 (126.3 cm) and that was diminished (106.1 cm) during 2006.

Table 2. Lest squares means of Napier grass herbage dry matter yield (t/ha), leaf to stem ratio, number of tillers and plat height (cm) over three production years at Bako Agricultural research Center*

Production year* *	Herbage dry matter yield	Leaf to stem ratio	Number of tillers	Plant height
Overall mean	**23.4**	**1.9**	**8.6**	**141.9**
2004	16.6^{a}	1.3^{a}	8.3^{a}	193.2^{a}
2005	21.9^{b}	2.2^{b}	7.6^{a}	126.3^{b}
2006	31.7^{c}	1.7^{c}	9.8^{b}	106.1^{c}
S.E.	0.91	0.08	0.36	3.50

S.E. = standard Error for least squares means for year of production; means with different letters are significantly different; *=the measurements were per harvest, **=number of observations within each production year was 30.

Least squares means of Napier grass herbage dry matter yield (t/ha), leaf to stem ratio, number of tillers and plant height in cm for the ten Napier grass genotypes are given in Table 3. In general, the herbage dry matter yield was above 18 t/ha per harvest per year except for the ILRI 16801which resulted in about 15 t/ha per year. Napier grass genotypes labeled ILRI 14389 (28.9t/ha), ILRI 16804 (28.1t/ha), ILRI 16792 (26.5t/ha) and ILRI 16840 (25.9t/ha) performed nicely in terms of herbage dry matter yield. The leaf to stem ratio and number of tillers for these genotypes were 1.7, 1.8, 2.0 & 2.5 and 12.2, 12.4, 10.4 and 7.6, respectively (Table 3). The heights of the plants, in respective order, were 133.2 cm, 130.8 cm, 134.6 cm and 150.5 cm. From the pair mean comparisons the herbage dry matter yields of ILRI 14389 and ILRI 16804 were not significantly different but from that of ILRI 16792 and 16840. The same phenomenon was observed for the leaf to stem ratio and number of tillers. Out of the four tope performed Napier grass genotypes ILRI 16840 was significantly different from the rest.

Table 3. Lest squares means of Napier grass herbage dry matter yield (t/ha), leaf to stem ratio, number of tillers and plat height (cm) for the 10 Napier grass genotypes at Bako Agricultural research Center*

Napier grass Genotypes**	Herbage dry matter yield	Leaf to stem ratio	Number of tillers	Plant height
ILRI 16804	28.1^{a}	1.8^{ae}	12.4^{a}	130.8^{ac}
ILRI 16801	14.7^{b}	1.8^{ae}	6.3^{b}	145.6^{a}
ILRI 16800	22.7^{ce}	1.8^{ae}	9.5^{c}	125.0^{c}
ILRI 16792	26.5^{a}	2.0^{b}	10.4^{dc}	134.6^{ac}
ILRI 16798	21.4^{de}	2.2^{b}	7.3^{eb}	143.1^{ad}
ILRI 16840	25.9^{ae}	2.5^{c}	7.6^{fb}	150.5^{bd}
ILRI 15743	23.8^{ae}	1.8^{ae}	7.0^{hb}	152.8^{bd}
ILRI 16787	23.1^{e}	1.7^{e}	6.6^{ib}	152.3^{bd}
ILRI 14389	28.9^{a}	1.7^{e}	12.2^{ad}	133.2^{e}
ILRI 16785	18.7^{ef}	1.8^{ae}	6.6^{ib}	150.0^{bd}
S.E.	1.66	0.14	0.66	6.34

S.E. = Standard Error of Napier grass genotypes least squares means; means with different letters are significantly different; *=the measurements were per harvest, **=number of observations for each Napier grass genotypes were nine.

Highest herbage dry matter yields during the 2006 could be related to high rain fall during the year compared to other years and lowest yield during the 2004 might be due to the low rainfall during the year 2004. Additional justification for Napier grass yield parameters being lowest during the year 2004 production year could be due to the fact that the it was establishment year. On top of this, the mean minimum temperatures were recorded during the 2004 production year compared to the rest which must have resulted in lowest herbage dry matter yield during 2004. The lowest leaf to stem ratio during the 2004 was probably due the fact that the measurements were made after plants were matured (as can be calculated from date of establishment and harvest for each year) while the second harvests were made after 86 and 89 days during the 2005 and 2006 from the first harvests in the respective years, and this might have improved the average leaf to stem ratio during the 2005 and 2006. Leaf to stem ratio influences both intake and digestibility (Popi et al., 1985) and the leaf to stem ratio is normally high in immature herbages and low in more mature herbage (Albrech et al., 1987). From the different Napier grass genotypes studied under Bako condition genotypes ILRI 14389, ILRI 16804, ILRI 16792, 16840 and ILRI 15743 performed very well and can be used for wider use either as animal feed or for mitigation of soil erosion and rehabilitation of the degraded lands. The leaf to stem ratio of the genotype ILRI 46840 was maximum (2.5) indicating that this genotype was leafier and has high feed value compared to the rest but has significantly lower tiller number compared to the aforementioned materials. The tiller number of genotype ILRI 16804 was significantly ($p<0.05$) highest compared to the rest except with ILRI 14389.

Conclusions and recommendations

From the present study it can be concluded that Napier grass genotype ILRI 14389, ILRI 16804, ILRI 16792, 16840 and ILRI 15743 are suitable for use as animal feeds, mitigation of soil erosion and rehabilitation of degraded areas under Bako and similar agro ecologies. The higher leaf to stem ratio being more than unity indicated that all of the materials had higher feed value if fed to livestock. The high tiller number indicated that if seed production is the purpose all the ten materials could be opted.

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Evaluation of Potential Yield and Chemical Composition of Selected Indigenous Multi-Purpose Fodder Trees in Three Districts of Wolayta Zone, Southern Ethiopia

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Abstract

Ethiopia is believed to have the largest livestock population in Africa and the major limiting factor among others for livestock production is nutrition both in terms of quantity and quality. To curb the problem of feed availability, use of indigenous multipurpose fodder trees would be regarded as good option. In this study, we were evaluated the potential yield and chemical composition of selected indigenous multi-purpose fodder trees in three districts of Wolayta zone, Southern Ethiopia. The five MPFT species from identified indigenous fodder were important and taken in this study for biomass estimation and laboratory analysis were E. brucei, V. amygalina, E. cymosa, C. africana and D. abyssinica. Potential yield of the selected MPFTs ranges from 25 kg for D. abssinica in Humbo district to 959 kg for E. brucei in Sodo Zuria district, and vary significantly ($P < 0.05$) among the selected MPFTs and among the districts. The five selected indigenous MPFT species had chemical composition ranges of 11–21% CP, 8-14% ash, 38-56% NDF, 33-51% ADF and 9-17% lignin, indicating their wide variability among species ($P < 0.05$). It can be concluded that the indigenous MPFT species can be considered to be a potential source of CP to supplement poor quality roughages to fill the gap especially in dry season.

Key words: potential yield, Chemical composition, Multipurpose fodder trees, Wolayta Zone

Introduction

Ethiopia is believed to have the largest livestock population in Africa (CSA, 2010). This livestock sector has been contributing a considerable portion to national economy and 26% for agricultural GDP production (Mekonen *et al*., 2012), and still promising to rally round the economic development of the country. The major limiting factor among others for livestock production is nutrition both in terms of quantity and quality. To curb the problem of feed availability, use of indigenous multipurpose fodder trees would be regarded as good option. Indigenous multipurpose fodder trees is potentially inexpensive, locally produced protein supplement for ruminants, particularly during the critical periods of the year when the quantity and quality of herbage is limited (Salem *et al*., 2006). Multipurpose fodder plant have high crude protein content, ranging from 10 to more than 25% on dry matter basis and may be considered as a more reliable feed resource of high quality to develop sustainable feeding systems and in increasing livestock productivity (Okoli *et al*., 2003; Aynalem and Taye, 2008). Indigenous MPFTs are grown naturally on smallholder farms and are an integral part of the farming system. Most of the indigenous fodder tree species are not primarily grown for fodder but for other purposes (Gintzburger, *et al*., 2000). Several studies on multi-purpose fodder trees (MPFTs) have been conducted in different parts of Ethiopia on different aspects (Abebe *et al.,* 2000; Tilahun *et al*., 2006; Adugna, 2007; Getnet, 2007; Abebe *et al*., 2008; Aynalem and Taye, 2008). However, most deal with introduced or exotic tree fodder species and very meagre information is available about the chemical composition of indigenous MPFTs. The significance of this study gives insight to chemical composition of indigenous MPFTs as animal feed. Moreover, site specific evaluation of these species can contribute to further establishment, adaptation and utilization as fodder. It is, therefore, imperative to evaluate potential yield and chemical composition of the indigenous MPFTs in order to provide best indigenous MPFTs to alleviate feed shortage in the Wolayta zone and in areas with similar agro-ecologies. Therefore, the objective of this study was to evaluate the potential yield and chemical composition of the indigenous multipurpose trees for sustainable animal production in the study districts.

Materials and Methods

Study Location

The three districts were selected based on the potential of livestock production and were in different altitudinal ranges. The districts were Soddo Zuria (highland), Damot Woyde (mid altitude) and Humbo district (lowland) and were located at 330 km, 356 km and 347 km South of capital city, Addis Ababa, and at altitude between of 1950-2400, 1400-1750 and 750-1100 meters above sea level, respectively. All areas experiences 8 to 10 months of rainfall and bimodal rainfall is common (Tsedeke and Endrias, 2011). The main rainy season extends from May to September and the small rainy season is in February to April but the amount is variable in the three districts (Adisu *et al.*, 2011).

The Sodo Zuria is located approximately at $6^o50'$N-$7^o53'$N and $37^o36'$E-$37^o53'$E, Damot Woyde is located approximately at $6^o43'$N-$7^o33'$N and $37^o28'$E-$37^o43'$E and Humbo districts is located approximately at $6^o34'$N and $37^o43'$E latitude and longitude, respectively. The soil types of the three districts were Vertisoil and nitosoil. The annual maximum rainfall of the study districts are 1300 mm, 1100 mm and 900 mm and the minimum rainfall are 1150 mm, 1000 mm, and 650 mm for Sodo Zuria, Damote Woyde and Humbo districts, respectively. Temperature range 13-26^{o}C, 17-24^{o}C and 18-30^{o}C for Sodo Zuria, Damote Woyde and Humbo districts, *respectively* (Beranu, 2012; Fanuel and Gifole, 2012). The agricultural production and land use systems are dominantly mixed crop-livestock farming system. Crops and livestock husbandry were common practices in the three districts where an extensive livestock production mainly depend on free grazing and cut and carry (in-door/out-door stall) feeding systems. Pastures and hay from hedgerows, pastureland, crop residues and crop left over on farm land, agro-industrial by-products like furishika and furishikelo, false banana or enset and its by-products and browses are all feed resources in the study districts.

Sampling and Data Collection

The five MPFTs leaves were selected for potential yield and evaluation through chemical analysis, and. From each browse tree selected for chemical analysis, a separate sample of leaves from three *Kebeles* of each district was harvested. From each *kebele,* leaf samples were collected from at least ten randomly selected trees and bulked to have one leaf sample for each MPFT species per *Kebele.* Thus, there were a total of 15 leaf samples of fodder trees for chemical analysis at Holeta Agricultural Research center.

Predicting Potential Yield of Selected Fodder Trees

Potential yield of browses is the foliage available for defoliation (Nitis, 1992). Using measuring tape, the circumference of trunk or stem of each selected MPFT species was measured and recorded. Fifteen circumference measurements for each selected MPFT species in each *kebele* were taken and the diameter was calculated as: D = 0.636C, where D=diameter C= circumference. The potential yield of the MPFT species was then estimated by entering the diameter value in the equation developed by Petmak (1983) as: Log W= 2.24Log DT-1.50 where W= leaf yield in kilograms of dry weight and DT= trunk diameter (cm) at 130cm height.

Chemical Analysis

Leaf samples were dried in air at the field and then oven dried at 65°C for about 24 hours for dry matter determination and samples were ground to pass 2 mm screen for in-sacco analysis and 1mm for other chemical analysis procedures. All fodder samples collected for feed evaluation were subjected for the analysis of dry matter (DM), ash and CP (AOAC, 1980). Samples were also analysed for neutral detergent fiber (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) (Van Soest and Robertson, 1985).

Statistical Analysis

Data on potential yield and chemical analysis were analyzed using analysis of variance employing the general linear model procedure of SAS software (SAS, 2000). Mean separation was tested using the least significant difference (LSD). The model for the potential yield and chemical analysis was; Yij = μ+Ai +eij   Where, Yij = response variable, μ = overall mean, Ai = fodder tree species effect and eij = random error

Results and Discussion

Potential Yield of the Selected Indigenous Fodder Trees

Foliage biomass yield that can be defoliated for animal feeding differed ($P < 0.05$) among the five selected MPFT species in all the three study districts (Table 3). Biomass yield for all districts were greatest ($P < 0.05$) for *E. brucei* followed by *C. africana.* In Sodo Zuria and Humbo districts biomass yield was the lowest ($P < 0.05$) for *D. abssinica, b*ut the value for *D. abssinica* was similar ($P > 0.05$) with that of *E. cymosa* for Damot Woyde district. Biomass yield for *V. amygdalina* was greater than *E. cymosa* ($P < 0.05$) in Sodo Zuria and Damot Woyde districts but values were similar ($P > 0.05$) in Humbo district. Generally biomass yield of the selected MPFTs ranges from 25 kg for *D. abssinica in* Humbo district to 959 kg for *E. brucei in* Sodo Zuria district.

Table 1. Leaf biomass yields (kg) of the five selected indigenous MPTs at the 130cm height of the three districts

	Multipurpose tree species per 3 *kebeles*					
District	***E. brucei***	***C. africana***	***V. amygdalina***	***E. cymosa***	***D. abssinica***	**SEM**
Sodo Zuria	958.76^{a}	925.53^{b}	95.577^{d}	96.539^{c}	39.60^{e}	9.12
Damot Woyde	529.12^{a}	512.59^{b}	97.64^{c}	51.06^{d}	47.09^{d}	5.91
Humbo	68.53^{a}	53.228^{b}	43.947^{c}	36.63^{c}	24.55^{d}	3.31

^{abcde} Means in a row with different superscript are significant at p<0.05; SEM= standard error of the mean

Chemical Composition of Selected Indigenous MPFTs Trees

The chemical composition and in vitro dry matter degradability (IVDMD) of the selected indigenous MPFTs in study districts is presented in Table 4. The five selected indigenous MPFT species had chemical composition ranges of 11–21% CP, 8-14% ash, 38-56% NDF, 33-51% ADF and 9-17% lignin, indicating their wide variability in chemical composition. All chemical composition values were varying significantly (P < 0.05) among the five species of MPFTs. The CP content was in the order of *E. brucei* = *C. africana* > *V. amygdalina* = *E. cymosa* > *D. abssinica.* Ash content was lowest (P < 0.05) for *D. abssinica,* and values for other species were similar (P > 0.05). The content of NDF and ADF was greater for *E. brucei* and *C. africana* than the other three species which were similar among each other. The lignin content was higher for *C. africana* than other species having similar lignin with each other. The relatively low IVDMD of *C. africana* could be attributed by relatively higher NDF, ADF and lignin contents, which might have limited microbial access to degrade the organic matter as fiber content and digestibility are negatively correlated (McDonald *et al*., 2002).

Table 2. Nutrient composition (% for DM and % DM for others) and in-vitro DM digestibility (%) of leaves of five selected indigenous multipurpose tree species of the study districts

	Fodder tree species					
Parameter	*E. brucei*	*V. amygdalina*	*E. cymosa*	*C. africana*	*D. abssinica*	SEM
DM	95.13	94.24	94.253	94.31	95.35	0.43
CP	21.30^{a}	19.25^{a}	15.67^{b}	15.55^{b}	11.34^{c}	0.95
Ash	13.42^{a}	13.31^{a}	13.83^{a}	14.11^{a}	8.39^{b}	0.82
OM	86.57^{b}	86.69^{b}	86.17^{b}	85.89^{b}	91.61^{a}	0.82
NDF	53.5^{a}	38.33^{b}	42.75^{b}	55.52^{a}	40.67^{b}	2.19
ADF	43.05^{ab}	34.51^{c}	39.95^{bc}	50.65^{a}	33.56^{c}	2.57
Lignin	9.56^{b}	8.47^{b}	10.92^{b}	16.99^{a}	9.104^{b}	1.26

[abc]Means in a row with different subscripts are significantly different (p<0.05); DM = dry matter; CP = crude protein; OM = organic matter; NDF = neutral detergent fiber; ADF = acid detergent fiber

Discussion

Similar to the finding by Tsedeke and Endrias (2011), respondents showed that the shortage of feed resource has been an immense constraint due to high human population in three districts that convert pasture and grazing land to agricultural field. In the study districts, the respondents indicated that shortage of feed/grazing land and water followed by animal disease were the major constraints to animal production to the three districts and these constraints were similar to the constraints faced by farmers in other parts of similar agro-ecology (Tsedeke and Endrias, 2011).

The variation among species in biomass yield suggests differences in potential biomass yield that may be associated with differences in growth of the species. It also appears that there is variation in biomass yield among districts within each species, which may be related to spatial differences and associated variation in climatic factors and soil fertility. As such biomass yield of each of the selected MPFTs appeared to decline with a decrease in altitude of the districts. Generally, the result revealed that highest weight yield recorded in *E.brucei* followed by *C.africana* in three districts and lowest in *D.abssinica* in three districts. Without due consideration the differences among the five selected species, the chemical composition values suggest the potential of the indigenous MPFTs as a possible supplement to roughage based diets like crop residues consistent with that has been noted before (Salem *et al*., 2006;

Abebe *et al*., 2008; Osuga *et al*., 2008). Most can serve as good sources of CP. The relatively low level of NDF in the fodder trees also suggests their potential as a supplement. The CP content of the selected MPFTs was within the range of 10-25% reported by others (Solomon, 2002; Okoli *et al*., 2003; Abebe *et al*., 2008; Osuga *et al*., 2008). The ash content of MPFTs considered in this work was similar with the reports of Okoli *et al*. (2003) and Aynalem and Taye (2008). The ash contents of *V. amygdalina, E. cymosa* and *C. africana* of this study were comparable to the report of Abebe *et al*. (2008).

NDF content of MPFTs in this study was similar to the report of Abebe *et al*. (2008). The current result also agrees with other reports (Kaitho, 1997; Solomon, 2002; Solomon *et al*., 2003) that noted NDF and ADF contents below 30% and 40%, respectively for different MPFTs, which was similar for the values observed for *E. cymosa, V. amygdalina* and *D. abssinica.* Variations in the chemical composition of the fodder trees considered in this study could probably be due to difference in their ability to accumulate proteins at the stage of their sampling, growth potential of the plant, and possible differences in the amounts of minerals or nutrient in the soil (Salem *et al*., 2006). Some possible inconsistencies in chemical composition values reported by other studies could be due to variations in season of samples collected, environmental and climatic influences on foliage growth and altitudinal differences of the sampling site.

Conclusion

This study focused that the indigenous MPFT have supplementary feed to livestock production for the poor quality and quantity basal diet during dry season as indigenous MPFTs are believed as nutritious to animal. The five MPFT species identified as important in the study area based on their abundance and utilization as animal feed are *E. brucei*, *V. amygalina*, *E. cymosa*, *C. africana* and *D. abyssinica.* These five MPFT species were for their feeding values in the laboratory. Thus, the indigenous MPFT species can be considered to be a potential source of CP to supplement poor quality roughages to fill the gap especially in dry season, and *E.brucei, E. cymosa* and *V. amygdalina* were better in their chemical compositions like CP. So, farmers should select these valuable indigenous MPFT trees for sustainable animal production at dry seasons.

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On-farm Demonstration and Benefit of Urea Molasses and Cactus Blocks in Small Scale Dairy Farms. The Case of Souththern Zone of Tigray Region

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Abstract

The on farm Demonstration Trial was undertaking under the mandate area of Alamata agricultural research center southern zone of Tigray region under small scale dairy farmers. The blocks were made up of different ingredients such as wheat bran, noug cake, salt, and cement and molasses/cactus fruit juice. The ingredients such as wheat bran and nuge cake, salt, molasses and cement was purchased from Alamata town flour factory and market place, while the cactus fruit juice was collected from the communal hill side found in between Endamekhoni woreda and Raya Azebo Woredas' of the zone. Then all materials were easily available in the area. The Urea molasses's block and urea cactus blocks were manufactured in Alamata agricultural research center and supplied to the beneficiary farmers who have dairy cows and volunteer to feed their cows. In these study 18 farmers was participated. Farmers were getting practical training about urea molasses/cactus block manufacturing and feeding in their farmers training center. The result of the demonstration trial indicated that UMB and UCB supplement cows increased Average milk yield of 1.08 and 1.26 litter per day per cow respectively as compare to non supplemented ones. This result indicated that supplementing with urea molasses and urea cactus block can show 21.6 and 22.7% milk yield increment per day per cow and the UCB which is manufacturing from the locally available cactus fruit is more profitable and economically feasible to small scale farmers as compare to UMB as well. Then the UCB need to be scale up to the whole farmers of the zone and other zones of the region that have cactus potential area.

Key: *Southern Zone, Dairy Cows, Cactus, UCB/UMB, Supplement, Milk yield*

Introduction

Tropical Ruminant production is basically dependent on fibrous feeds like mature pastures and crop residue. These feeds are mostly deficient in protein, energy, minerals and vitamins concentration and animal cannot maintain positive nitrogen and other nutrient balance. Among other nutrients, protein deficiency is a constraint of practical significance in livestock productivity. Maximization of livestock productivity in Ethiopia largely depends on the efficient utilization of local protein sources (Seyoum *et al*., 1996). Moreover, as human population increases more and more land will be devoted to grain production and only marginal lands will be left for feed production. The ruminants will therefore, depend on crop residues for their basal diet. In Tigray region in general and in southern zone in particular, crop residues form an integral part of feed resources especially during the dry season. Straw alone is a poor quality feed. It is deficient in the soluble nitrogen and minerals needed to support an active and efficient rumen microbial ecosystem and a high feed intake and digestibility. Hence, supplementation with urea molasses block (UMB) and urea cactus block (UCB) can be preferred for increase digestibility of fibrous feeds and improve the nutritional quality of low quality roughages (LQR) such as crop residue. The UMB and UCB are a convenient way to make and store molasses, cactus, noug cake, wheat bran and urea to be used as animal feed during the dry period. They can be easily made and used in villages. A person or any private sector can make and sell different size and type of blocks to farmers as a source of income. Therefore, these feed improvement technologies was designed and introduced through farmers research extension group (FREG). These technologies was evaluated under farmer's condition with farmer's participation to create forum for effective communication of information and create dialogue among farmers, researchers and extension workers so as to empower farmers capacity and to bring pressure to bear on the public sector research system and enhance dairy productivity of the small scale dairy farms .The study objective was to enhance the productivity of dairy cows through UMB and UCB supplementations during the dry season, empower the skill of farmers in using different feed supplementation practice, improve farmers, research and extension linkage in technology dissemination.

Material and Methods

Area Description

The on farm demonstration trial was carried out in the mandate area of Alamata, Agricultural Research Center (AARC) woredas of E/Alaje, Raya-Azebo and Ray-Alamata, Southern Zone of Tigray region, and Northern Ethiopia. The study was done for a period of 60 days with 18 (local with Holstein) cross breed dairy cows to study the effect of urea molasses and urea cactus blocks on milk yield and economic importance of small scale dairy farms. In each woreda farmers research extension group (FREG) was established based on their dairy cow availability. The FREG group consisted of male and female household heads. Participation of farmers was based on their willingness to participate in the on-farm developmental research and who had common problems. Animals were selected based on milk production and stage of lactation. They were grouped in to three groups having 6 animals. The basal feed of the animals were crop residue and greed feed. Animals feed with crop residue and green feed was considered as local practice (T1), animals fed with straw and green feed and supplemented with Urea molasses block (UMB) was considered as (T2) and animals feed with crop residue and green feed and supplemented with urea cactus block (UCB) was considered as (T3). This was done in a random manner. The design was randomized complete block design (RCBD). Initially, the farmer research extension group members was provided with full theoretical and practical training at farmers training center of each woreda on how to manufacture the urea molasses and urea cactus blocks and they were immediately start working practically with the nearby follow up of researchers, experts and DA's.

Preparation of Urea molasses and Urea cactus blocks

The amount of the different ingredients depends on the size of the block to be manufactured and the formula to be used is indicated below in the following table

Table 1. Amounts of ingredients to mix and to make different sizes of UMB and UCB

Ingredient	UMB %	UCB%	Manufacturing of 5 kg size of	
			Urea molasses Block (UMB)	Urea Cactus Block (UCB)
Molasses	40	0	2Kg	0kg
Cactus juice	0	40	0	2kg
Urea	10	10	0.5 kg	0.5 kg
Bran	25	25	1.25 kg	1.25 kg
Cement	8	8	0.4 kg	0.4 kg
Oil cake	10	10	0.5 kg	0.5 kg
Salt	7	7	0.35 kg	0.35 kg
Water (to mix the cement)	0.2 kg		0.2kg	0.2kg

Feeding and Management of Animals

All animals was feed at farmers home by providing the Urea molasses block to one group and cactus block to the other group, while the control group was not. The data of supplemented animals was collected after 15 days of adaptation period. The block was provided to the animals in a plastic/wooden box for proper liking. All animals were get basal diet and water adlibitum. The block supplemented animals were let to lick the block after they feed the straw. Animals were milk twice per day at morning and evening.

Sampling and Analysis

Milk data of individual animal were recorded daily. The amount and cost of the urea molasses block and urea cactus block ingredients, manufacturing cost and milk cost per litter, was recorded to evaluate the economical advantage of the block supplementation as compare to non supplemented animals. Sample of the UMB and UCB was send to Holleta Agricultural Research center for the analysis of DM, CP, ADF NDF and Lignin content.

Results and Discussion

The Importance of Feed Blocks

Feed-block technology is simple and does not require sophisticated equipment. Manufacturing and handling is also easy and can be done at the farm level using family labor. Producing feed blocks at the farm level is however labor-intensive and may therefore result to low rates of adoption.

Chemical composition of supplement Feeds

Chemical composition of the urea molasses block and urea cactus block that was manufactured in the study area and used on the demonstration trial is indicated in the following table

Table 2. The chemical composition of UCB and UMB

Feed Type	DM	CP	NDF	ADF	Lignin
UCB	87.79	44.70	37.31	27.36	6.59
UMB	87.95	36.20	27.82	19.85	4.79

NB. UCB= urea cactus block, UMB=urea molasses block, DM= dry matter, CP=Crude protein, NDF=Neutral detergent fiber, ADF=Acid detergent fiber

The laboratory chemical analysis of urea molasses block and urea cactus block in table-1 indicated that the DM content of the UCB and UMB was 87.79 and 87.95 respectively while, the UCB have better CP as compare to the UMB. The UMB and UCB have CP content of 36.20 and 44.70 respectively. This condition can be due to high protein content of the urea cactus fruit and its cover coat that was used to manufacturing the urea cactus block as compare to the molasses. The CP content result of UMB of this study was in line with the CP result of Misra A.K etal. 2006. As report of Firew Tegegne (2001) indicated that the grand mean CP contents of the cactus fruits was 12.7% which were above the level (6-7%) reported as the limit to microbial activity, and thus productivity and feed utilization efficiency (Minson, 1990b; Cited in Firew Tegegne, 2001). Tesfay 2007 report on Afar ram concentrate supplementation also indicated that the CP composition of noug seed cake and wheat bran concentrate feed ingredients was 34.5 and 16.8% respectively.

Effect of UMB and UCB on Milk Yield

Effect of feeding urea cactus block and urea molasses block on milk yield of cross breed dairy cows at farmers level was indicated in the table 3. The average milk yield of non-supplemented cows was significant different than the UMB/UCB supplemented cows. The non-supplemented cross dairy cows was recorded daily milk yield of 7.05 litter/day/cow; while the UMB and UCB supplemented cows were recorded 8. 13 and 8.31milk yield/day cow respectively. So this result indicated that supplementing of UMB and UCB have 1.08 (21.6%) and 1.26 (22.7%) milk yield increment per day per cow as compare to the non-supplemented cows. But there was no significant difference observed on the milk yield of the UMB and UCB supplemented dairy cows.

Table 3. The effect of UMB and UCB supplementation on milk yield of local and Holstein Cross breed dairy cows at farmer's level

Parameters	Treatments			SEM	SL
	Control (T1)	UMB supplementation (T2)	UCB supplementation (T3)		
No. of dairy cows	6	6	6	-	-
Milk yield litter/day/head	7.05 ± 0.44^{b}	8.13 ± 0.46^{a}	8.31 ± 0.71^{a}	0.27	*
[1]Feed intake	Low	High	high		
[1]Water intake	Low	High	high		

[a, b, c] = means within a row not bearing a common superscript letter differ significantly. * =P<0.05); ** =P<0.01); ***=P<0.001); ns= not significant; SEM = standard error of mean; SL= significant level, [1] as per farmers observation on their cows

The milk yield increment indicated in this study was in line with the result of Misra A K et.al. 2006 that reported 1.37 (27.9%) milk yield increment per day per cow of Urea mineral molasses mineral block supplmentated dairy cows as camper to non-supplemented ones. Another on farm experiment conducted in India by (Singh and Singh 2003) indicated that the feeding of urea molasses multi-nutrient block (UMMB) increased milk production by about 37% in buffaloes and 34% in local cows respectively. The beneficiary farmers was also observed that besides to milk production , good external body appearance (shiny and smooth skin) of their animals due to the result of better feed and water intake characteristics of the UMB and UCB supplements.

Partial Budget analysis

The partial budget analysis for the feeding trial was reported in Table 3, which involved the evaluation of overall profitability. During the data collection period the cost of UMB and UCB, concentrate and other ingredients was considered since all other variable costs (grazing, crop residue, green fodder and labor) was the same for all the treatment groups. Following this assumptions concentrate cost calculation was made based on the basis of market rate prevalent during the experimental period. The result of the partial budget analysis for dairy cows fed on UCB and UMB indicated that the UMB and UCB supplemented animals returned a higher net benefit of Birr 97.2/head and Birr 113.4/head over control group and higher profit margin of Birr 3.16/head and Birr 6.76/head for UMB and UCB respectively.

Table 4. Partial budget analysis of Urea molasses block and Urea cactus block upplementation of cross dairy cows as compare to local feeding practice

Specific Items and their cost	Local feeding practice as Control (T1)	UMB Supplementation (T2)	UCB Supplementation (T3)
UMB consumed kg/ head/10days	0	5	0
UCB consumed kg/head/10 days	0	0	5
UMB cost (ETH Birr/head)	0	25.78	0
UCB cost (ETH Birr/head)	0	0	11.78
Total Cost (ETH Birr/head)	0	30.78	16.78
Milk yield litter per head of 10 days	70.5	81.3	83.1
Cost of Milk per litter	10	10	10
Gross Return of 10 days (ETH/head)	705	813	831
Net Return of 10 days (ETB/Head)	634.5	731.7	747.9
ΔNR	0	97.2	113.4
ΔNR/NROC	0	0.14	0.18
ΔTVC	0	30.78	16.78
MRR (Ratio)	0	3.16	6.76
MRR (%)	0	315.79	675.80

NB: - ΔNR = change in net return; ΔTVC = change in total variable cost; MRR = marginal rate of revenue. The feed cost was taken as constant cost to all treatments

The partial budget analysis for the feeding trial was reported in Table 3, which involved the evaluation of overall profitability. The result of the partial budget analysis for dairy cows fed on UCB and UMB indicated that the UMB and UCB supplemented animals returned a higher net benefit of Birr 97.2/head and Birr 113.4/head over control group and higher profit margin of Birr 3.16/head and Birr 6.76/head for UMB and UCB respectively. Now adays the cost of 1 kg molasses is raising from 1-2 birr to 6-7birr per kg within the past three years and it is difficult to afford it in this situation of radical cost increment and then subsisting of the molasses ingredient of the block with the cactus fruit juice which is found easily in the farmers back yard and hill sides near their home without any cost is vital to be sustainably used by the small scale dairy farms. From This result considering the existing supplement concentrate feed cost and the milk demand and price, supplementation of the dairy cow using UCB become economically profitable and cost effective for the small scale dairy farms of the region.

Conclusion and Recommendations

The on-farm demonstration result showed a positive effect of UMB and UCB supplementation on the milk productivity. It can also help to increase roughage intake and water intake during the dry season and resulted the dairy cow's good external appearance (shiny and smooth skin hair), good health condition. Considering the existing supplement concentrate feed cost and the milk demand and price, supplementation of the dairy cow using UCB become economically profitable and cost effective for the small scale dairy farms of the region

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On-farm Evaluation and Demonstration of Improved Forage Crops in Small Scale Model Dairy Villages of Bahir Dar Milk Shed

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Abstract

This study was conducted in Koga irrigation Scheme of Mecha district, Ethiopia in 2011 and 2012, since the inception of EAAP project. In this study three varieties of oat, vetch and Napier were evaluated under on-farm condition with the objective of evaluating and demonstrating suitable forage species and assessing farmers' perception on improved forage production and utilization. Twelve farmers were selected for this study. Samples of Napier were collected and analyzed for chemical composition. Oat variety-CI-8235(1041t/ha), Vetch variety-Vicia Dasycarpa (5.14 t/ha) and Napier accession number-16791(9.09 t/ha) were found be the best in terms of Dry matter Yield (DMY). Farmers selected Vicia vilosa from vetch variety and 1786 from Napier variety based on their own criteria during participatory variety selection. CI-8235, Vicia Vilosa and Accession 16786 were recommended for further scaling up.

Key words: Accession, DMY, Forage, Improved, and varieties

Introduction

This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. Amhara Region has a total population of 13,766,923 million heads of cattle, 8,825,061 million sheep, 5,102,580 million goats, 2.25 million equines, 0.05 million camels, over 12.36 million chicken. The livestock sub-sector contributes about 33% of the region's GDP and 15% of its agricultural GDP (CSA, 2008). One of the bottlenecks of livestock production in Amhara National Regional State (ANRS) is feed shortage in terms of quantity and quality. Animals hardly meet their nutritional requirements and livestock productivity, in terms of meat and milk and draft power from oxen. Seasonal variation in feed quality and quantity is the main limitation to animal production in the region. Crop residues from cereals and pasture roughages are the main source of forage but these are low in crude protein and have poor digestibility. Therefore production of adequate quantities of good quality dry season forages to supplement crop residues and pasture roughages is the way to overcome the dry season constraints affecting livestock production in Ethiopia (Alemayehu, 2004). In this regard, development of improved forages to improve animal productivity is crucial. It is therefore with this background that this study was initiated in EAAPP project areas with the following specific objectives of evaluate and demonstrate suitable forage species that do perform well under various biophysical niches, and assess farmers perception on improved forage production and utilization

Materials and Methods

This study was conducted in Koga irrigation Scheme of Mecha district, Ethiopia under rain-fed conditions. In this study three varieties of oat, vetch and napier were evaluated under on-farm condition. The experiment was carried out on 12 farmers' fields for each forage crop. The plot size was 4 m × 5 m. The space between blocks was 1.5m and between row and plots 1m. For Napier planting the space between plants were 0.5 m. Row planting was used for Napier, while, broadcasting was done for oat and vetch. The design used was randomized complete block design (RCBD) with four replications. The treatments consisted of three oat (CI-8251, CI-8235 and Jassary), three vetches (*Vicia villosa, Vicia dasycarpa, Vicia atropurpurea)* and napier varieties and (14984, 16786 and 16791). The seeding rate of oats and vetches were 100 and 25 kg/ha, respectively. DAP and urea fertilizer were applied at the rate of 100 kg/ha. Urea was applied for oats in split application at planting and after establishment. Harvesting was done at 50% flowering for oats and vetch. Half plot was harvested and sample of 1kg was taken for DMY determination. Forage samples were taken from half part of the plot harvested at maturity at 10 cm above the ground and air dried for dry matter determination. Chemical composition analysis was only done for napier varieties as there are similar works for oat and vetch forage crops. The data were analyzed using SAS computer software (1999-2000).

Field day was conducted to demonstrate the performance of the planted improved forage verities under farmers' condition for this purpose about 60 farmers and other stake holders from office of Agriculture and EAAPP extension office were involved in the demonstration. During the technology demonstration, farmer and other stakeholders evaluated visually the performance of planted annual and perennial forage plants.

Results

Dry Matter Yield per hectare

The dry matter yield analysis of fodder oat varieties, CI-8251 and CI-8235 showed significantly (P < 0. 05) higher dry matter yield compared to Jassarri (table 1). The summary of analysis of variance for the performance of different fodder oat varieties on DM yield is given in Table 1. In contrast, there was no significant difference (P<0.05) between the height of the three oat varieties.

Table 1: Yields (t/ha) for oat varieties evaluated at Mecha District 2011

Treatments	DMY (t/ha)	Height(Cm)
CI-8251	10.16^{a}	162.47^{a}
CI-8235	10.43^{a}	158.80^{a}
Jassarri	8.53^{b}	153.20^{a}
Mean	9.71	158.16
Lsd(0.05)	1.29	0.055
CV (%)	7.70	6.75

Columns with means with the same superscript are not significantly different

The summary of analysis of variance for the performance of different forage vetch varieties on DMY is given in Table 2. The highest DM yield was recorded for *Vicia dasycarpa* (5.14 t/ha) followed by *Vicia vilosa (4.32*t/ha) and *Vicia atropurpurea*(3.36 t/ha). Similarly total DMY for dasycarpa and villosa were significantly (P<0.01) higher for atropurpuria. According to AARC (2002), forage vetch selection studies done for three years (1987-1989) at Adet showed that *Vicia villosa* (10.04 t/ha) perform similarly. In contrast, at woreta location reported lower yield than the present study under rain fed conditions.

Table 2: Yields (t/ha) for oat varieties evaluated at Mecha District 2011

Treatments	DMY t/ha
Vicia Villosa	4.32[a]
Vicia dasycarpa	5.14[a]
Vicia atropurpurea	3.36[b]
Mean	4.28
CV	8.1

Analysis of variance for herbage DMY of Napier accessions is given in Table 3. In 2011 unlike for the second year, higher total herbage dry matter yield was recorded for 16791(9.09 t/ha) followed by 16786 (7.00t/ha) which also had the highest leaf to stem ratio (2.15). In the first year, 16786 score the highest tiller number (17). In the second year, 14984 was found to be the best in tiller number (110) followed by 16786 (107 tillers) even though there was no significant difference between accessions.

Table 3: Yields (t/ha) for Napier grass accessions evaluated in 2011 and 2012

Treat	**2011 DMY**	**2012 DMY**	Total DMY (t/ha)	2011 L:S	**2011 Tiller no.**	**2012 Tiller no.**
14984	1.81[a]	4.03[b]	5.70[b]	0.94[b]	15[a]	110[a]
16786	1.88[a]	5.18[ab]	7.00[b]	2.15[a]	17[a]	107[a]
16791	2.21[a]	6.71[a]	9.09[a]	1.19[b]	15[a]	99[a]
Mean	1.97	5.29	7.26	1.43	18	105
LSD (0.05)	0.88	2.10	1.95	0.83	2	30
CV (%)	25.72	24.79	16.75	33.49	9	18

Chemical Composition of Napier

The Analysis of Variance for the chemical composition of samples collected for respective accessions are presented in Table 4. There was no significance difference in DM, Ash, Om, CP and DOM content of the respective accessions. The only difference was with 16786 which had the lowest ADF (43.3) and lignin fraction (3.83).

Table 4: Chemical composition air dried Napier accessions samples planted on red soil at Mecha district, Bahir Dar milkshed.

Accession No.	% DM	Ash	OM	NDF	ADF	HC	Lignin	CP	DOMD
14984	93.91[a]	15.28[a]	85.65[a]	75.03	55.91[a]	20.72[a]	4.67[a]	9.59[a]	54.56[a]
16786	93.64[a]	14.35[a]	84.71[a]	64.02	43.30[b]	17.55[a]	3.83[b]	9.11[a]	51.93[a]
16791	93.83[a]	15.20[a]	84.79[a]	73.46	54.31[a]	20.72[a]	4.16[a]	9.59[a]	54.23[a]
LSD(0.05)	0.96	0.51	0.51	0.23	0.05	0.74	0.01	0.69	0.69
CV	6.56	6.71	1.17	8.94	6.75	27.72	11.73	19.33	7.44

Participatory Variety Selection

Farmers selected CI-8235 from oat, Vicia Vilosa from vetch and 16786 from napier based on their observation.

Table 5: Participatory variety selection of forage crops by stakeholders

No.	Variety	Rank	Observed biology
Oat			
1	CI8235	1	broader leaf, high biomass and higher growth rate
2	CI8251	2	Mild wilt problem and moderate n performance
3	Jassary	3	Low germination, low adaptation, lower biomass
Vetch			
4	*Vicia Vilosa*	1	Leafy, dense and smooth texture, high biomass, higher height
5	*Vicia Dasycarpa*	2	Moderate growth
6	*Vicia Atropurpuria*	3	Slow growth rate, wilt problem, low germination
Napier			
7	*14984*	3	Very stemy, less biomass
8	*16786*	1	Green, smooth texture, higher biomass and leafy
9	*16791*	2	Stemy , highest in biomass

Discussion

Dry matter yield per hectare of introduce forage species

CI-8251and CI-8235 were high yielders with a dry matter yield of 9.82, and 8.71 t /ha, respectively, under rain fed conditions (AARC,2002). The highest result in this study might be due to the variation in soil fertility, geographical location and entry point as this experiment was planted in back yard fields where farmers used to manure.The total herbage dry matter yield in this study was lower than the findings of Tessema (2005) who obtained 12.24 t/ha, 10.30 t/ha, 14.29 t/ha for 14984, 16786, 16791, respectively. Mwenda et al., (2010) also reported higher dry matter yield in kenya for 16791(68.3t/ha) and 16786(85.35 t/ha). Unlike the previous study, 16786 ranked second in terms of dry matter yield in this study. But similar to this study, Mwendia et al., in his study reported 1786 ranked first. The result of this study in terms of leaf to stem ratio was similar to the findings of Tesemma (2005) for the three cultivars in red soils of north western Ethiopia. In his study, the average leaf to stem ratio for 14984, 16786, 16791, were 3.2, 3.4, and 1.2. In a similar fashion, the current study also showed the highest leaf to stem ratio for accession number 16786 followed by accession number 16791. The CP compositions for the three accessions were comparable highest in this study than what was recorded by Nyambati *et al*., (2010). In this study accession number 16786 was found to have the lowest lignin number as it is leafier and greenier, while the highest was recorded for accession number 14984. Considering the existing result, there was no significance difference between napier 16791 and 16786 despite numerical differences. The lowest lignin content also renders and preference by the farmers lets us to select the later for further expansion. Most of the participants selected CI-8235, Vicia villosa and 16786 as the best performer compared to oat, vetch and napier. The overall assessments of the farmers were also concurrent with the experimental results. Since the inception of EAAPP about 100 farmers have cultivated napier grasses, and they are exchanging napier germplasms. Besides, these farmers are also becoming a source of napier germplasm with cash for those Research centers working for EAAPP project. Farmers have also adapted to the practice of developing the annual forage species using irrigation during the dry season.

Conclusions

This study showed that fodder oat and vetch varieties Napier accessions gave optimum DM yield, so that they are a potentially useful source of animal feed during dry season under proper management. The introduced forage crops are suitable to the area and are highly accepted by farmers. In this regard, it can be inferred that the objective of this study was met.

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Economic Benefit of Smallholder farmers through Dried *Acacia saligna* Leaves and Wheat bran supplementation of Tigray highland sheep in Ethiopia

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Abstract

The study was carried out at Atsbi-Wemberta, Wukro-Kilte-Awlaelo and Saesie Tsaeda Enba Weredas of Tigray. The study was carried out with the following objectives; to scale up/out the best supplementation practice of dried Acacia saligna leaves and wheat bran to highland sheep rams, to evaluate body weight gain of highland sheep rams supplemented with Acacia saligna and wheat bran at farm level, to establish linear body measurement of highland sheep and to evaluate cost benefit analysis. A total of 120 farmers from the three Weredas included and 240 highland sheep rams were art of the study. The treatments are farmers practice (grazing only) and farmers practice + 200 g d^{-1} dried Acacia Saligna + 200 g d^{-1} wheat bran. The crude protein content of Acacia salgna and wheat bran is 14.84 and 16.20, respectively. The live weight gain for highland sheep ram is 59.2 and 19.49 g d^{-1} for the supplement and control group, respectively. Higher daily weight gain of rams achieved at Abrha-Atsbeha 86.76 g d^{-1} followed by 70.29 g d^{-1} Hayelom. Rams in Mariam-Agamet and Barka-Adi-Sibuh also exhibit gain of 46.14 and 35.45 g d^{-1}, respectively. The supplement group also exhibits significant difference ($P<0.05$) before and after the supplementation in heart girth, height at withers, body length and weight change. The financial recompense obtained from the supplement and control is positive but higher return obtains from the supplemented rams than the control one.

Introduction

Tigray region is one of the potential sources for small ruminant in Ethiopia. But the output in terms of meat and milk is below its expectation. This is because of poor feeding management of the available feed resources. Feed takes a greater portion than their genetic potential as the major portion of the production covered by feed. To achieve the desired benefit from these animals, feeding consideration is crucial (Alemu, 2008). Increased profitability of lamb production is dependent on reducing input costs and/or increasing production output (Snowder & Van Vleck, 2003). Any reduction in feed intake or the increase in feed efficiency without compromising growth rate or carcass quality can have a significant positive economic impact on lamb production (Snowder & Van Vleck, 2003). Currently, there is a tendency to rehabilitate the degraded area by constructing water harvesting structures, exclosure areas, reseeding and seedling plantation and other conservation activities. This force makes farmers to confine their animals at their home with the feeding of crop residues and the poorly prepared hay and; these feeds are not in a position to support even the maintenance requirement of the animals. As reported by (Alemu, 2008) ruminant diets are generally based on fibrous feeds that have low digestibility and are deficient in protein, minerals and vitamins.

Acacia saligna serve as environmental rehabilitation, windbreak, fuel wood, and as soil and water conservation. They also added that the leaves of *Acacia saligna* could provide the source of fodder, particularly for small ruminant production (Maslin & MacDonald, 2004). *Acacia saligna* leaves could serve as a dual purpose of soil conservation and source of animal feed. (Shumuye & Yayneshet, 2011) also reported that *Acacia saligna* is one of the introduced browse shrub or tree species, which is widely grown and distributed in different agro-ecological zones of Tigray region (Berhane & Getachew, 2009). *Acacia saligna* could be better if it provided to ruminants with other energy sources as it is potential for protein sources (Gebreslassie, 2013). A supplementary is a semi-concentrated source of one or more nutrient used to improve the nutritional value of a basal feed (Alemu, 2008). For this wheat bran is the best solution as it has extra advantages. Wheat bran is one of the feed resources low in cost and easily accessible because different milling factories are blooming in the whole country (Gebreslassie, 2013). Furthermore, wheat is produced throughout the Tigray region and many of the households uses this wheat following milling or making flour for bread making, enjera (local food), porridge and the like. This makes to easily avail of the residue of wheat or wheat bran. In addition to the accessibility and low cost wheat bran contains both protein and energy to support ruminants (Gebreslassie, 2013). According to (David, et al., 1999) report, 14% of the weight of wheat bran or 27% of its energy content is protein. Studies which increase wheat bran intake may therefore increase protein intake as wheat protein. As a result, increased intake of cereal fiber in wheat bran products is also likely to increase wheat-protein intake. Completed research activities should be problem solving and further disseminated to the final beneficiaries. It could not be shelved it should be scaled out. Hence this research work was embarking on the following objectives; to scale up/out the best supplementation practice of dried *Acacia saligna* leaves and wheat bran to highland sheep rams, to evaluate body weight gain of highland sheep rams supplemented with *Acacia saligna* and wheat bran at farm level, to establish linear body measurement of highland sheep and to evaluate the cost benefit analysis.

Material and Methods

Area Description

The research was carried out at three Acacia project sites Weredas namely Wukro-Kilte-Awlaelo, Atsbi-Wemberta and Saesie Tsaeda Enba. These areas are located at 46 km North, 65 km North West and 78 km North of the Tigray Regional State capital city Mekelle, respectively. The altitude of Wukro-Kilte-Awlaelo ranges (1940 - 2160 m.a.s.l). The mean annual rainfall of Wukro-Kilte-Awlaelo area is 639.2 mm. The annual mean temperature also ranges between 14°C to 20°C. The soil is generally developed on sedimentary igneous rocks and the major soil types are Lithosols and Regosols on the steep slopes. On flat lands Luvisols, Fluvisols, Calcisols and Cambisols are the dominant soil types. Altitude of Atsbi-Wemberta Wereda ranges from 918 to 3069 m and 5% of the Wereda is upper highlands (2600 masl or above) and only 25% is found in midlands (between 1500 and 2600 masl) and the remaining is lowlands (below 1500 masl). The average annual rainfall is (1995/96 to 2002/03 E.C) was 642 mm. Saesie Tsaeda Enba found at altitude range of 2256-2954 masl. The Wereda have average 10 years annual rain fall of 350-500 mm. The district has temperature range between 12°C to 28 °C. The soil type coverage and distribution of the Wereda is dominated by Haplic Lixisols, Lithic leptosols and Eutric Fluvisols. Four peasant associations (tabias) of the project area were selected. Namely, Abrha-Atsbeha Peasant Association from Wukro-Kilte-Awlaelo Wereda, Barka-Adi Sibuh and Hayelom Peasant Associations from Atsbi Wereda and Mariam-Agamet Peasant Association from Saesie Tsaeda Enba Wereda.

Chemical Composition of experimental feed

Nitrogen (N) content of the Acacia Saligna and wheat bran were analyzed according (AOAC, 1990). The CP was calculated as N x 6.25. The fiber content dry matter (DM), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and Ash of the experimental feeds were examined according to (Van Soest, Robertson, & Lewis, 1991) and the condensed tannin content was determined according to (Burns, 1971).

Sampling method

The scaling out was carried out on farmers' field level with the active participation of farmers. A total of 120 sample farmers; from four woredas including Wukro-Kilte-Awlaelo, Atsbi Saesie, Tsaeda Enba Wereda and Atsbi were selected. Each farmer provides two ram. A total of 240 highland sheep rams were used in this scaling out. 120 rams were allocated for the control and the remaining 120 rams were allocated for the supplement group. Selection of participant farmers were done based on the following criteria; those farmers who are members of FRG (Farmer Research Group) of Acacia saligna plantation established by Acacia project that is four FRGs in three Weredas, farmers who were willing to allocate 2 two male rams with an age of 8-12 months relatively similar body weight, female headed households were given priority to participate in this scaling out (41% of the participants were female headed households), having good experience in sheep raring, construct barn for the treatment rams, own *Acacia saligna* trees either in their back yard or able to utilize from area exclosures, able to implement according to guidance of the researchers and positive thinking to new technology. They were selected in collaboration with the livestock, natural resource, forestry experts and DAs (Development Agents) of the respective project site Weredas. The experiment was carried out for 60 days following two weeks of adaptation period.

Preparation of the feeds

Acacia saligna leaves were collected by hand plucking from farmers' backyard, exclosure areas around the project site and communal areas that have good potential to *Acacia saligna* leaves with an age of 2 to 4 years. The collected leaves were air dried for 4 to 6 days till easily crushed by hand twisting, kept in sacks and stored in a place not exposed to moisture and sun. Each farmer collected 11 kg of dried *Acacia saligna* leaves before starting to fed the experimental ram whereas; wheat bran was purchased from flour factories in Mekelle city and transported to each site before the commencing of the trial.

Experimental design and Treatments

The rams were divided into two groups in each farmer based on their interest of the farmers. Each feeding contains 120 rams to scale out the recommended best practice. The first group kept their rams on free grazing only (T1) and the second group were supplemented their rams with 200 g $^{d-1}$ dried *A. saligna* and 200 g $^{d-1}$ wheat bran (T2) soon when they return from field grazing.

Treatments

T1=Farmers practice (grazing only)
T2= Farmers practice + 200 g d^{-1} dried *Acacia Saligna* + 200 g d^{-1} wheat bran

Training

Farmers and DAs were given training on housing, husbandry, preparation and handling of *Acacia Saligna leaves,* plantation and management as it helps for further continuation, ways of adapting the rams to the experimental diets, how to follow their health condition of rams as well as their herd, how to measure body linear measurement and estimate weight of rams, market oriented strategy for the fattening of rams, data collection, how to utilize the available feed for fattening of rams and activities related to the topic.

Management of experimental rams

Rams selected for the scaling out were tagged for identification. The rams were treated against internal and external parasite using anti-helminths (Albendazole) and anti-external parasite (Ivermectine), respectively as per the recommended dosage before starting of the actual experiment. The house for the rams was constructed by the farmers before starting of the scaling out program. Water was provided as free choice.

Measurement

Feed intake

The amount of supplemental feed offered and refused was measured every day for the whole 40 days. Refusal feed was collected in the sack for a week; then the total amount of refusal was divided by the number of days that are seven days. As rams were allowed to graze in the field basal diet was considered as constant for every sheep. To correct this, the observation number rises to 120 rams for a single treatment. The feed intake of the supplemented group was calculated by subtracting the refusal from the offered feed using the following formula: Feed intake = Amount of feed offered – Amount of feed refused

Live weight gain

Weight gain was taken every ten days for both treatments because of farm measurement are very difficult to undertake every week. The measurement was expressed in kilogram and measured using spring balance that measured 50 kg and each kg separated with 200 gram difference. This was continued for the whole 40 days but not for the adaptation period of two weeks.

The record of each ram was collected and summarized for both treatments separately. The live weight gain was expressed with the following formula;

$$\text{Live weight gain (LWG)} = \frac{\text{Final weight - Initial weight}}{\text{Number of days}}$$

Linear body measurement

At field level where scale measurements are not possible linear body measurement could be a good solution. Simultaneously as there was no information on this measurement by the farmers during the scaling out the best practice of feeding *Acacia Saligna* leaves, the linear body measurement also expanded to the farmers. Measurements such as heart girth (chest girth), height at wither and body length were taken according to (Alemu, 2008). Chest girth or circumference, sometimes called heart girth, was measured just behind the front legs. Wither height was measured the highest point as the vertical distance from the ground to the tip of the shoulder. This was measured by stick made with two arms, one which was held vertically and the other at the right angles to it and sliding along it (firmly not loosely). For higher reputability, the measurement was best taken on a firm and level ground. Body length was measured from base of tail (where it joins the body) to the first thoracic vertebrae or to the front of the chest.

Data analysis

The collected data on live weight change, body linear measurement on chest girth, wither height and body length was subjected to analysis of variance (ANOVA) using JMP5 (SAS Institute Inc., 2002) and mean comparison was done using each pair of student's t test for the comparison of supplemented and control groups at $P \leq 0.05$ for comparison of means by Peasant association. The correlation was held for heart girth, body length, wither height and weight on basic statistics correlation Multivariate JMP5 (SAS Institute Inc., 2002). Regression was done for weight and heart girth measurement (heart girth, body length, wither height and daily body weight gain) and DBWG fit line of JMP5 (SAS Institute Inc., 2002).

Model of the scaling out (body weight gain)

$Y_{ij} = \mu + \tau_i + \epsilon_{ij}$

Where; Y_{ij} = the overall response

μ=over all mean

τ_i = ith treatment effect (i= 1,2,)

ϵ_{ij} = overall treatment and error effect

Model for body linear measurement

$Y_{ij} = \mu + \tau_i + \beta_j + \acute{C}_k + \check{E}_l + \epsilon_{ijkl}$

μ=over all mean

τ_i = ith treatment effect (i= 1,2)

β_j = jth heart girth effect

$\acute{C}_k$ = body length

$\check{E}_l$ = wither height effect

ϵ_{ijkl} = overall treatment and error effect

Result and discussion

Chemical composition and nutrient intake of supplemented feed

The chemical composition of *Acacia saligna* leaves and wheat bran are presented in Error! Reference source not found.. The nutrient content of feed varies as they came from different sources. The OM content of the *A. Saligna* is relatively lower than wheat bran but the soluble matter exceeds than wheat bran. Wheat bran exhibited higher in CP content than *A. Saligna*. The NDF content of *A. Saligna* was lower than wheat bran.

Tabel 6. Chemical composition and nutrient intake of supplemental feeds

Composition	Feeds		Supplemental feed
	Wheat bran	AS	
DM (%)	93.58	92.03	371.22
OM (%)	93.73	84.91	357.28
CP (%)	16.20	14.84	62.08
NDF (%)	48.01	43.39	182.8
ADF (%)	15.52	30.56	92.16
ADL (%)	3.52	8.04	23.12
Ash (%)	6.27	15.09	42.72
Soluble matter (%) [a']	51.99	56.61	217.2
Hemicelluloses (%) [b']	32.49	12.83	90.64
Cellulose (%) [c']	5.73	7.43	26.32
CT (%)	-	13.78	25.32

DM= dry matter; OM= organic matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; AS= *Acacia saligna*; [a'] = 100%-NDF; [b'] = NDF-ADF; [c'] = ADF-(ADL+Ash); CT= Condensed Tannin; - = value not found; Supplement feed = grazing, 200 g of air dried *A. Saligna* leaves and 200 g wheat bran; Supplemental feeds (Acacia saligna and wheat bran)

Table 6: Average daily dry matter and nutrient intake of highland sheep rams fed on free grazing land as basal diet and supplemented with wheat bran and dried of *Acacia saligna* leaves

Parameters (%)	Supplemented feed intake
DMI (AS)	184.06
DMI (WB)	187.16
Total DMI	371.22
OMI (AS)	169.82
OMI(WB)	187.46
Total OMI	357.28
CPI (AS)	29.68
CPI (WB)	32.4
Total CPI	62.08
NDFI (AS)	86.78
NDFI (WB)	96.02
Total NDFI	182.8
ADFI (AS)	61.12
ADF (WB)	31.04
Total ADFI	92.16
ADL (AS)	16.08
ADL (WB)	7.04
Total ADLI	23.12

DMI= Dry matter intake; SEM= Standard error of mean; OMI=Organic matter intake; CPI= Crude protein intake; NDFI= neutral detergent fiber intake; ADFI= acid detergent fiber intake; ADLI= acid detergent lignin intake; AS= *Acacia saligna*; WB= Wheat bran;

Body weight change of Highland sheep ram supplemented with Acacia saligna leaves and wheat bran

The average initial body weight of the supplemented group was significant difference ($p>0.05$) from the control group Table 7. Similarly, the final live weight was also highly significant different for the supplemented group than the control group. The average daily live weight change was incredibly significant different ($P>0.0001$) for the *Acacia saligna* leaves and wheat bran feeding rams than the rams depend on only on free grazing leave to graze only. Even if, the supplement rams performed better than the control ram, the control sheep also exhibited higher live body weight gains. That's rams that don't provide supplement feed were exhibited weight loss. The higher live weight gain found in this study was consistent with the previous on station research which showed weight gain of 63.89 g d^{-1} for highland sheep ram fed on grass hay supplemented with 200 g d^{-1} dried *Acacia saligna* leaf and 200 g d^{-1} wheat bran (Gebreslassie, 2013). Similarly, Farat sheep fed on grass hay supplemented with concentrated feed showed weight gain of 42.78 to 72.2 g d^{-1} (Bimrew, Solomon, & Kurt, 2010). However, this result is much higher than (Brhane and Getachew, 2009) reported 22 g d^{-1} live weight gain of lambs fed on basal diet of grass hay and supplemented with 300 g d^{-1} dried Acacia saligna leaves this might be happened due to the additional wheat bran supplementation to the rams that provide them energy that lack in Acacia saligna leaves. The superior performances of the highland sheep rams in this study may arise from rams were free to exercise and addition of wheat bran.

Unlike other studies, rams in the control group also show weight gain for instance Brhane and Getachew, (2009) reported loss of 4 g d^{-1} for lambs fed on grass hay only. However, the result in the control group is allied with a gain of 7.8 g d^{-1} for highland sheep rams fed on grass hay alone (Gebreslassie, 2013). The previous experimental research held at station level describes rams fed on grass hay as basal diet and supplemented with Acacia saligna leaves and wheat bran exhibit higher libido and higher sperm volume. This might be affected growth performance of growing rams. Especially, this leads to reduce in live weight production if they exposed to breeding ewes. But fortunately weight loss didn't display in this study as the rams show higher live weight gain in the control group. This may be due to sheep are seasonal breeders and at the time of the experiment is not an appropriate time for breeding.

Table 7: Average Body weight change of Highland sheep rams supplemented with *Acacia saligna* leaves and wheat bran

Body weight measurements	Treatment		SEM	P
	T1	T2		
Initial weight (kg)	21.6^{a}	18.99^{b}	0.455	0.05
Final weight (kg)	23.99^{a}	19.76^{b}	0.53	0.0001
DLWG (g d^{-1})	59.2^{a}	19.49^{b}	0.19	0.0001

DLWG = Daily live weight gain; SEM = Standard error mean; P= P Value; LS = Level of significance; g d^{-1} = gram per day

The initial weight of the control (unsupplemented) rams was insignificantly different (P>0.05) in the four study Peasant associations Table 8. Unlike to the control group the initial weight of the supplemented rams was significantly different (P<0.05) across the four Peasant associations. The higher weight was in Peasant association Abraha-Atsbeha followed by Mariam-Agamet, Hayelom and Barka-Adi-Sibuh Peasant associations. The final weight of both the supplement and control rams were significantly different (P<0.001) in the study Peasant association. Rams that are supplemented in Peasant association Abraha-Atsbeha was significantly higher final weight than rams in Peasant association Hayelom and Barka-Adi-Sibuh but not significantly different from rams in Peasant association Mariam-Agamet. The daily live weight gain of the supplemented and control rams was a significant difference (P<0.001) in Peasant association Abraha-Atsbeha and Hayelom than in Peasant association Mariam-Agamet and Barka-Adi-Sibuh. Similar, to the supplement group the daily live weight gain of the control group also significant difference (P<0.001) that is rams in Peasant association Abraha-Atsbeha was higher than rams found in the rest Peasant association.

The daily live weight gain found in Peasant association Abraha-Atsbeha 86.76 g d^{-1} was outstanding and unexpected to get such gain at farm level and also higher than the previous on station study 63.89 g d^{-1} for rams fed on grass hay and supplemented with 200 g d^{-1} *Acacia saligna* leaves and 200 g d^{-1} wheat bran (Gebreslassie, 2013) and 73.2 g d^{-1} gain for of sheep fed on *Acacia Saligna* field-dried foliage ad libitum plus 400 g d^{-1} barley plus 30 g d^{-1} commercial mineral and vitamin supplement (Salem, *et al*., 1999). This indicates how much local feed resources can replace commercial feed resources and applications at farm level. Beside to this higher weight gain can be achieved on farm level as the experimental result brought significant improvement on the rams. The daily live weight gain found in Peasant association Hayelom 70.29 g d^{-1} is not as such significantly different from previous study but it has relatively higher numerical. Even if the daily live weight gain found in Peasant association Mariam-Agamet and Barka-Adi-Sibuh were relatively lower gains than the previous study, it has its own green light as means of enhancing better weight gain at farm level. Their performances of the rams are also comparable to commercial feeding system. The difference in live weight gain from Peasant association to Peasant association may arise from the difference in Agro ecology that brought different in vegetative, differences in the management of the farming community, initial weight difference and others.

Table 8: Body weight change of Highland sheep ram supplemented with *Acacia saligna* leaves and wheat bran at different Peasant associations

Body weight measurements	B/A/Sibuh	A/Astbeha	M/Agamet	Hayelom	SEM	P
Initial weight - Supp	20.74^{bc}	22.91^{a}	22.28^{ab}	19.34^{c}	0.34	0.03
- Control	17.89	19.77	19.65	18.56	0.30	0.052
Final weightt - Supp	22.12^{c}	26.38^{a}	24.12^{ab}	22.15^{c}	0.40	0.001
- Control	18.04^{b}	21.53^{a}	20.23^{ab}	18.70^{b}	0.35	0.001
DLWG - Supp	35.45^{b}	86.76^{a}	46.14^{b}	70.29^{a}	3.67	0.001
- Control	3.71^{b}	44.11^{a}	14.62^{b}	3.75^{b}	3.12	0.001

DLWG = Daily live weight gain; SEM = Standard error mean; P= P Value; LS = Level of significance; B/A/Sibuh = Barka Adi sibuh; A/Atsbeha = Abrha Atsbeha; M/Agamet = Mariam Agamet

Body linear measurement of Highland sheep supplemented with air dried Acacia saligna leaves and wheat bran

The body linear measurement of highland sheep grazes in the field and supplemented with Acacia saligna leaves and wheat bran is presented in
Table 9. Supplemental feed has a positive impact on the rams as they show higher body linear measurement and weight than the control one. The supplement group also exhibits significant difference ($P<0.05$) before and after the supplementation in heart girth, height at withers, body length and weight change. Similarly the control group also exhibited significant change in height at withers and body length but not at heart girth and weight. The significant improvement in heart girth and weight in the supplemented group might be arising from the supplemental feed. This is because the control group doesn't show any difference in heart girth and weight. Height at withers and body length both in the supplemented and control rams had significant improvement. This might be especially related to age. As supplemented rams had higher improvement than the control one in both height at withers and body length. This might be linked to the supplementary feed. Rams in the supplement group had significant difference ($P<0.0001$) in weight before and after feeding. The weight change in the control group was insignificant difference ($P>0.05$). Even the control rams had significant improvement in height at withers and body length they doesn't have an impact on weight change this may indicate that body weight change is a result of the heart girth change. The highest weight gain found in the supplement group is higher than the result reported by (Seare, Gangwar, & Kefelegn, 2011) 18.92 kg for the Abergelle sheep herd by farmers but the result is consistent with the control group. Unsupplemented highland sheep rams are relatively higher HG and HTW 64.13±4.07 to 64.27±4.53 cm than 58.90 cm reported (Seare, Gangwar, & Kefelegn, 2011) for Abergelle sheep. The HG measurement of this study is lesser than 78.2 cm for Ghana sheep reported by (Baffour-Awuah, Ampofo, & Rdodoo, 2000) this might be due to breed difference but the two sheep exhibit similar HTW as highland sheep rams were reaching 65.53±3.17 cm and the Ghana rams also reached 67.3 cm (Baffour-Awuah, Ampofo, & Rdodoo, 2000).

Table 9: Body linear measurement of highland sheep supplemented with Acacia saligna and wheat bran

Parameters	Sex	N	Supplement		P value	Control		P value
			Initial (age 8 – 12 M) in cm	Final (age 10-14 M) in cm		Initial (age 8 – 12 M) in cm	Final (age 10- 14 M) in cm	
HG	M	120	66.49±3.96b	67.75±3.92a	0.013	64.13±4.07	64.27±4.53	0.80
Height at withers	M	120	63.53±3.70b	65.37±3.17a	0.0002	61.15±3.38b	62.67±3.17a	0.001
BL	M	120	54.87±4.26b	57.72±3.66a	0.0001	52.07±4.19b	53.82±4.24a	0.004
Weight	M	120	21.63±3.43b	23.99±4.08a	0.0001	18.99±3.09	19.77±3.54	0.09

Values within each age group with different superscript differ are significantly different ($P<0.05$)

The regression equation of body weight for highland sheep supplemented with Acacia saligna and wheat bran from body linear measurement. The initial and final weight of the control rams has positive correlation with heart girth, height at withers and body length
Table **10** and Table 11. However, in the supplemented rams the initial heart girth and initial body length were negatively correlated even it's not a significant difference. Heart girth had relatively significant correlation with weight as compared to height at withers and body length

for both the supplemented and control groups. Similarly, (Seare, Gangwar, & Kefelegn, 2011) also reported that heart girth and height at withers are positive correlation with body weight for Abergelle sheep for both male and female. The model for highland sheep rams graze on the field and supplemented with dried Acacia saligna and wheat bran is presented in **Error! Reference source not found.**. The formula of weight for highland sheep ram with an age of 10 to 14 months supplemented with dried Acacia saligna is Weight = -32.55355 + 0.8346539 (Final HG) and R^2=0.64. Similarly, the formula for highland sheep rams that doesn't provide any supplemental feed at an age of 10 to 14 months is Weight = -22.10876 + 0.651526 (Final HG) and the R^2 = 0.70.

Table 10: Correlation coefficients showing interrelationships between various measurements of initial weight for control rams with an age of 8 to 12 months

	Initial wt	Initial HG	Initial Ht	Initial BL
Initial wt	1			
Initial HG	0.5899	1		
Initial Ht	0.4531	0.0301	1	
Initial BL	0.3495	0.0953	0.0076	1

Initial wt= initial weight; Initial HG= Initial heart girth; Initial Ht= Initial height at withers; Initial body length

Table 11: Correlation coefficients showing interrelationships between various measurements of final weight for control rams with an age of 10 to 14 months

	Final wt	Final HG	Final Ht	Final BL
Final wt	1			
Final HG	0.6570	1		
Final Ht	0.0865	0.3818	1	
Final BL	0.1900	0.0527	0.3193	1

Final wt= Final weight; Final HG= Final heart girth; Final Ht= Final height at withers; Final body length

Table 12: Correlation coefficients showing interrelationships between various measurements of initial weight for supplement rams with an age of 8 to 12 months

	Initial wt	Initial HG	Initial Ht	Initial BL
Initial wt	1			
Initial HG	0.7064	1		
Initial Height	0.4032	0.0246	1	
Initial BL	0.4499	-0.1994	0.0836	1

Initial wt= initial weight; Initial HG= Initil heart girth; Initial Ht= Initial height at withers; Initial body lengt

Table 13: Correlation coefficients showing interrelationships between various measurements of final weight for supplement rams with an age of 10 to 14 months

	Final wt	Final HG	Final Ht	Final BL
Final wt	1			
Final HG	0.6060	1		
Final Height	0.2434	0.1842	1	
Final BL	0.3471	0.0327	0.2494	1

	Final wt	Final HG	Final Ht	Final BL

Final wt= Final weight; Final HG= Final heart girth; Final Ht= Final height at withers; Final body length

Table 15: Regression model for predicting body weight of highland sheep rams using body linear measurements: Partial budget analysis

Parameters	Age (Mo)	Sex	N	Wt by HG	Wt by Ht	Wt by BL
Supplement initial	8-12	M	120	Wt = -25.30799 + 0.7059175(initial HG) (R^2=0.67) (P=0.0001)	Wt = -19.96326 + 0.6545868(initial Ht) (R^2= 0.50) (P=0.0001)	wt = -5.536255 + 0.4949813 (initial BL) (R^2=0.12) (P=0.0001)
Supplement final	10-14	M	120	Wt = -32.55355 + 0.8346539 (Final HG) (R^2=0.64) (P=0.0001)	Wt = -32.37969 + 0.8623657 (Final Ht) (R^2=0.45) (P=0.0001)	wt = -19.43398 + 0.7523802 (Final BL) (R^2=0.45) (P=0.0001)
Control initial	8-12	M	120	Wt = -1923702 + 0.5960655(initial HG) (R^2=0.61) (P=0.0001)	Wt= -19.24202 + 0.625103(initial Ht) (R^2= 0.47) (P=0.0001)	Wt= -5.261108 + 0.4656029(initial BL) (R^2=0.40) (P=0.0001)
Control Final	10-14	M	120	Wt = -22.10876 + 0.651526(Final HG) (R^2=0.70) (P=0.0001)	Wt = -27.03878 + 0.7468466(Final Ht) (R^2=0.45) (P=0.0001)	Wt = -6.583053 + 0.4896183(Final BL) (R^2=0.34) (P=0.0001)

Mo= Month; M= Male; Wt by HG= Weight by heart girth; Wt by Ht= Weight by height at withers; Wt by BL= Weight by body length; Wt= weight; HG= Heart girth, Ht= Height; BL= Body length

The partial budget analysis of this study provides information about the feasibility of the study and helps for further utilization of the finding of the study. The return obtained from the difference between the variable cost and return obtains from the estimated final price of rams described in Table 14. The financial recompense obtained from the supplement and control is positive but higher return obtains from the supplemented rams than the control one. Even the control rams show positive return but that is not comparable with the supplemented once. For instance the supplement rams on Peasant associations Barka-Adi-Sibuh, Abraha-Atsbeha, Mariam-Agamet and Hayelom were fetching 53.2, 236.93, 172.96 and 101.68 Birr from a single ram, respectively. The positive return from the control rams may arise from the marketing time that is the rams were sold at the festivity of eastern. However the return obtains from the supplemented rams were barely credible as it can obtain up to 236.93 Birr from a single ram with 60 days at Peasant association Abraha-Atsbeha.

Rams supplemented in Peasant association Abraha-Atsbeha had a higher economical return followed by Mariam-Agamet, Hayelom and Barka-Adi-Sibuh. The feed cost incurred for single ram was 64 Birr but the economic return was beyond. The MRR for the supplemented rams were 83, 370, 270 and 159 for Peasant associations Barka-Adi-Sibuh, Abraha-Atsbeha and Hayelom, respectively. This explains for every spending of 100 Birr in supplementing *Acacia saligna* and wheat bran they can generate the money described in MRR. Even higher return obtained at Abraha-Atsbeha the return obtained at the other Peasant associations also magnificent. Both the weight change and MRR describe how much providing supplemental feed (200 g d^{-1} *Acacia Saligna* and 200 g d^{-1} wheat Bran) brought a higher economic return to the farmers and help to provide to the country the required standard rams to the world. The experimental study also brought awareness of marketing time to the farmers for selling of their rams as they can get a higher return during the festive period.

Table 14: Partial budget analysis

Description	Control				Supplement			
	B/A/Sibuh	A/Astbeha	M/Agamet	Hayelom	B/A/Sibuh	A/Astbeha	M/Agamet	Hayelom
Purchase price of sheep, ETB/head	550	530.88	547.83	550	607.8	560.29	563.04	542.86
Total acacia leaf consumed (kg/head)	00.00	00.00	00.00	00.00	8	8	8	8
Total wheat bran consumed (kg/head)	00.00	00.00	00.00	00.00	8	8	8	8
Cost for acacia leaf, ETB	00.00	00.00	00.00	00.00	32	32	32	32
Cost for wheat bran, ETB	00.00	00.00	00.00	00.00	32	32	32	32
Total variable (feed) cost	00.00	00.00	00.00	00.00	64	64	64	64
Gross income, ETB/head	662.5	852.94	804.35	722.86	837.5	1183.82	1056.52	883.57
Total return, ETB/head	112.5	322.6	256.52	175.03	229.7	623.53	493.48	340.71
Net return, ETB/head	112.5	322.6	256.52	175.03	165.7	559.53	429.48	276.71
Δ NI	-	-	-	-	53.2	236.93	172.96	101.68
Δ TVC	-	-	-	-	64	64	64	64
MRR(Ratio)	-	-	-	-	0.83	3.70	2.70	1.59
MRR (%)	-	-	-	-	83	370	270	159

Conclusion

Supplementation of highland sheep rams with dried Acacia saligna leaves and wheat bran is demonstrated to farmers during the scaling out and farmers manage all the activities. This on farm research brings better body weight gain especially at Abraha-Atsbeha rams gain up to 86.76 g d^{-1} when rams supplemented with 200 g d^{-1} Acacia saligna and 200 g d^{-1} wheat bran. Beside to weight improvement their body linear measurement result also indicates supplementation has impact on heart girth, height at withers and body length. The overall partial budget analysis also indicates supplementation of highland sheep rams have higher profit than letting the rams to graze and the fattening system should in lined with market.

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Determinants of the Use of Indigenous Rangeland Management Practices in Pastoral Communities: The Case of Yabello Woreda, Borana Zone, Ormia Regional State, Ethiopia

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Abstract

Looking into indigenous rangeland management practices of pastoral community is a useful way to develop sustainable rangeland productivity. Rangeland plays an essential role in the livelihood activities of Ethiopian pastoralists as well as Ethiopian economy. Numerous researches have been done on rangeland management practices, but little study has been done with respect to the determinants of indigenous rangeland management in specific social, economic and ecological context. In this case, we studied the determinants of the use of indigenous rangeland management practices of pastoral communities of Borana, Ethiopia regarding the use of indigenous rangeland management practices and their determinants. We looked at knowledge of indigenous practices, education level of household heads, livestock ownership, ownership of private enclosures, illegal extension of farm land on communal lands, access to credit service, distance from the market center, and participation position in traditional institution, perceptions towards current condition of rangelands, and perception towards the possible attributing causes of rangeland degradation. The results showed that the decline in indigenous rangeland management practices, the decreased pastoralists' rangeland productivity. This indicates that the indigenous practice accurately reflects the productivity of the rangeland since the Borana area is unpredictable environment and victim for severe drought every year. This assessment of the indigenous practices of Borana rangeland provides a base for ecological sound and culturally appropriate rangeland management.

Keywords: *Range; Rangeland degradation; Herd mobility; Commons*

Introduction

In Ethiopia, rangeland covers about 61 to 65% of the total area of the country that are characterized by arid and semi-arid agro-ecologies. These arid and semi-arid agro-ecologies experience a relatively harsh climate with low, unreliable, and erratic rainfall. These areas are home to 12%-15% and 26% of the human and total livestock population respectively (Teshome *et al.,* 2009). In Borana, the breeds of cattle make up over 90% of the legal export of live animal and lowland cattle provide around 20% of the drought animals for the highlands or livestock play a significant role in the national economy. Even though, the contribution of pastoralism to the national economy is about 16 % (Ayele *et al.,* 2003), the rangelands and rangeland based lifestyle at present are shrinking (PADP, 2004). In many pastoral areas of Ethiopia, the rangeland is degrading from time to time due to extreme climatic variations and land-use changes (Solomon and Coppock, 2003; Ayana and Gufu, 2007). Borana pastoralists operate over a limited area of increasingly degraded and poor rangeland (ELSEP/RELPA, 2008). The main problems were down ward trends of indigenous practices, drought and expansion of uncontrolled crop production (Ayana and Fekadu, 2003). Furthermore, the seasonal grazing system is breaking up and herd movements become short-term oriented to follow scattered forage resources. This reduced and poorly coordinated mobility implies negative effects on rangeland condition (Homann et al., 2005). Traditionally, pastoral communities usually have a detailed knowledge to classify rangelands which is acquired through extensive observation and continuous herding practices. These traditional practices provide a useful source of information for the sustainable use and conservation of natural resources (Gufu et al., 2008). The need for incorporating community based knowledge in assessing rangelands has been widely acknowledged (Gimenez and Maria, 2000). In order to understand the indigenous management practice (i.e. communal grazing system) and facilitate for under performance of the rangeland resources, it is important to promote utilizing traditional strategies of management (PFE *et al.,* 2010). Moreover, it needs emphasis on sustaining of customarily institutional development and rangeland resource management practices (Homann and Rischkowsky**, 2005)**. Although the problem associated with indigenous rangeland management and rangeland degradation is widely researched, much is still needed to do with respect to the determinants of the use of indigenous rangeland management and their determinants in specific social, economic and ecological context.

Material and methods

Study Area

The study was conducted in southern Ethiopia, Yabello Woreda of the Borena Zone; it borders the Dire Woreda in the south, the Teltele woreda in the west, the Bule Hora Woreda in the north and the Arero Woreda in the east. Yabello town, the capital of the Woreda is 570 kms far from Addis Ababa the capital city of Ethiopia. Out of the total land area, 10% is arable, 60% pasture, 10% forest (5.5% state forests) and the remaining 20% is considered swampy, degraded or otherwise unusable. In the district, about 70% of the households are pastoralists. The total livestock population of the Disrict is estimated to 232,949 cattle, 22,972 camels, 39,043 sheep and 99,681 goats from a total of 394,645 this is only of milk producing livestock this makes the District the highest in the total livestock population. Population in terms of total TLU, Yabello district is the playing the leading role by about 222,008 TLU and followed by Dire, Taltale, Miyo and with total livestock population of 170,740, 145,372, and 127,014 TLU, respectively. Moyale district is the ranking the least population having only 51,076 TLU (CARE-Ethiopia, 2009).

Sample Size and Method of Sampling

The study population of the selected five kebeles was 779 household heads and probability sampling techniques were employed to select representative kebeles and respondents. Accordingly, lottery methods were employed to draw five representative kebeles among the 10 pastoralists' kebeles of the woreda since these kebeles have uniform characteristics (only livestock rearing). The household heads size varied across the five kebeles; hence, PPS techniques were used. After sampling frame from all the kebeles, systematic sampling techniques were employed to select 120 respondents from the sampled kebeles. Sample size determination formula was employed to avoid under sampling problem. Based on this, 120 respondents were selected. Sample size was determined by using (Yemane, 1967) formulas at 90% confidence interval. By using this formula, the exact number of sample size was 89. But, 31 respondents were added to increase representativeness of the sample.

$$n = \frac{N}{1 + N(e)^2}$$

Where,

n = Sample size

N = Pastoralists of the Woreda
e: Error terms (0.1)

Sources and Types of Data

Both primary and secondary types of data were collected. The primary data related to demographic, socio-economic, institutional factors and psychological related variables were collected mainly from the respondents whereas secondary data published and unpublished documents like symposiums, proceedings and reports from different organizations and internet sources.

Methods of Data Collection

The study employed a combination of data collection techniques like semi-structured interview questionnaires, focus group discussion and key informant interview. Focus group discussion was undertaken at all the five sampled PAs (i.e., each FGD from all PAs) and the participants of group discussion were selected based on their position of participation in indigenous institutions. The group discussions focused on rangeland condition and management, causes of rangeland degradation and the encroaching woody species that affect traditional rangelands management. Eight household heads were involved in each of the five focus group discussions. Accordingly, a total of forty households participated in focus group discussion. Key informants like local elders, *abba herrega*, *abba olla,* and development agents working on the sites were interviewed. A total of twelve key informants invited for discussion across the five kebeles.

Methods of Data Analysis

The collected data were coded, entered and edited before running of analysis. Both descriptive analysis and inferential analysis were used for data analysis. Qualitative types of data were analyzed by using explanation, narration, and interpretation and ranking order. Econometrics model (Binary logistic regression model) was also employed.

Results and Discussion

Level of household heads' indigenous rangeland management practices

The result of frequency analysis showed that the majority of respondents 88 (73.33%) were highly practicers traditional rangeland management while the rest 32 (26.67) of the respondents were low practicers of traditional rangeland management (Table 1).

Table 1: Extent of indigenous rangeland management practice of the sample respondents

Level of practicing	Proportion of responses in percentages	
	Frequency (n)	Proportion %
Highly practicing	88	73.33
Low practicing	32	26.67
Total	120	100

Knowledge of indigenous practices

The mean of years of experience of indigenous practice of the total sample respondents is 42.97. The study also analyzed the relationship between knowledge of indigenous practices of household heads and collective grazing practice. Based on Pearson's correlation analysis result, there is positive relationship between years of experience of household heads and indigenous management practices. When experience of indigenous practice increases, households may become more knowledgeable and are responsible for indigenous management practices. The results of t-test indicates that there is statistical significance difference between the years of experience of highly and low practice at 1% ($t= 5.79$, $p= 0.000$) significant level. Similar report with the findings of (Homann and Rischkowsky, **2005**) in their study on integrating the indigenous knowledge of Borana pastoralists into rangeland management strategies in southern Ethiopia.

Table 15: Experience of indigenous practice and differences by level of management practices

Particulars	Respondents	N	Mean	St.dev	Mean difference	t- value	P-value
Knowledge of indigenous practices	Highly practicing	88	46.72	11.33	-14.03	5.79	000***
	Low practicing	32	32.68	12.78			
	Total	120	42.97	13.24			

Note: *** 1% level of significance respectively

Education level of the sample household heads

The education level of the respondents those highly practice traditional rangeland management is 79.5%, 13.64% and 6.82% for illiterate, read and write, and elementary school (1-8) respectively. The corresponding number of low practicing respondents is 46.9%, 18.75 and 34.4% for illiterate, read and write, and elementary school (1-8) respectively (Table 3). From the result, the total sample respondents 70.83% for illiterate, 15% could read and write, and 14.16% have attained primary education (1-8). There were no household heads who attained high school and above among the selected respondents. Generally, it was found that the majority respondents were illiterate. Educated are young people than old. The chi-square test shows that there is statistically significant difference between high and low practicing respondents of traditional rangeland management at 1% (χ^2= 20.35, P= .000) significant level. Similar report with the findings of (Tahir, 1991; Kratli, 2000) in their study on education and pastoralism in Nigeria, and education provision to nomadic pastoralists in Brighton institute of development studies respectively.

Table 16: Education level and differences by level of indigenous management practices

Particulars	Response	Respondents: Highly practicing		Low practicing		Total		Chi-square (χ^2)	P-value
		n	%	n	%	n	%		
Education level	Illiterate	70	79.5	15	46.9	85	70.83	20.35	.000***
	Read and write	12	13.64	6	18.75	18	15		
	Elementary school (1-8)	6	6.82	11	34.4	17	14.16		
	Total	88	100	32	100	120	100		

Note: *** indicates 1% level of significance

Socio- economic Characteristics of the Respondents

Livestock holding is one of the main livelihood assets in pastoral area. The minimum and maximum livestock unit of the sample household heads highly practice traditional rangeland management is 4.25 TLU and 49.61 TLU respectively. The minimum and maximum livestock unit of sample household heads low practice traditional rangeland management is 0 TLU and 4.18 TLU respectively. The mean livestock holding of the total sample respondents was 10.20 TLU. The mean livestock unit of the respondents highly practice traditional rangeland management is 18.75 TLU and low practice is traditional rangeland management 1.54 TLU. Livestock holding of highly and low practicing group has statistically significant difference with indigenous rangeland management practices from the survey result, it presents livestock holding is one of the important livelihood assets in pastoral area. Agreement with the findings of (Fikre et al., 2010) in his study on community based rangeland management in Somali region. The respondents recognize the allocation of vast area of rangeland for non-pastoral use and increase in the size of illegal cropland was the major reasons for the poor condition of the rangeland. The overall problems have thus increased the degrees of harshness of feed shortages, and severely affect the rangeland as the same time livestock productivity consistent with the study of (Amaha, 2006).

Table 4: Livestock holdings and differences by level of indigenous management practices

Particulars	Respondents	n	Max.	Min.	Mean	St.dev	Mean differ.	t- value	p-value
Livestock holding	Highly practicing	88	49.61	4.25	18.75	9.52	17.21	2.86	.029**
	Low practicing	32	4.18	0	1.54	0.78			
	Total	120	49.61	0	10.20	10.93			

Note: ** indicates at 5% significance level

Ownership of private enclosure *'kallo'*

The minimum and maximum private enclosure for the sample highly practicing respondent is 0 and .73 hectare respectively. The minimum and maximum private enclosure in hectare for the sample low practicing respondent is 0 and 1.56 hectares respectively. The mean private enclosure in hectares for high and low practicing respondents is 0.66 and 1.06 hectares respectively. The mean private enclosure of the total sample respondents in the study area is .86 hectare. The t-test shows that there is statistically significant difference between highly and low practicing respondents of indigenous rangeland management at 1% (t= -8.94, p= .000) significant level and it has some negative correlation with communal rangeland management practices. The involvement of new patterns of private enclosures intensifies conflicts among communities and increasing competition over resources. Similar report with the findings of (Oba, 1998) in his study on indigenous range management knowledge of the Borana pastoralists of southern Ethiopia.

Table 5: Ownership of private enclosures and differences by level of indigenous management practices

Particulars	Respondents	n	Max.	Min.	Mean	St.dev	Mean Differe.	t- value	p-value
Ownership of private enclosures	Highly practicing	88	.73	0	.66	.53	.403	-8.94	.000***
	Low practicing	32	1.56	0	1.06	1.43			
	Total	120	1.56	0	.86	1.07			

Note: *** 1% level of significance respectively

Uncontrolled extension of farm land

The minimum and maximum uncontrolled farm land size for the sample respondents highly practicing indigenous rangeland management is 0 and .55 hectare respectively. The minimum and maximum farmland size for the sample respondents' low practicing traditional rangeland management is 0 and 1 hectare respectively. The mean farmland of highly and low practicing respondent is .25 and .67 hectare respectively. The mean of uncontrolled farmland for the total sample pastoral respondents in the study area is .46 hectare. The t-test shows that there is statically significant difference between highly and low practicing respondent of communal pasture management at 5% (t= -2.21, p= .029) significant level. Similar report with (Ayana and Fekadu, 2003) in their study on current range condition in southern Ethiopia in relation to traditional management strategies. It has some negative correlation with traditional rangeland management practices, because households are faced with the challenge of developing more efficient and sustainable use of natural resources (Homann *et al.*, 2008).

Table 6: Uncontrolled crop production and differences by level of indigenous management practices

Particulars	Respondents	n	Max.	Min.	Mean	St.dev	Mean differe	t- value	p-value
Illegal farm land size	Highly practicing	88	.55	0	.25	.45	0.47	-2.21	.029**
	Low practicing	32	1	0	.67	.73			
	Total	120	1	0	.46	.68			

Note: ** indicates 5% level of significance respectively

Institutional Factors

Access to credit service

Formal microfinance institutions are not as much available in pastoral areas in general and Borana pastoral area in particular. When members faced cash shortage or hard-time they borrow the required amount of money from the saving and credit account of their group (CARE-Ethiopia, 2009). From the survey result (Table 7), 44% and 56% of the sample respondents' highly practicing traditional rangeland management have access and have not access to credit services respectively. 62.5% and 37.5% of the sample respondents' low practicing traditional rangeland management have access and have not access to credit services respectively. From the result, 49.17% and 50.83% of total sample respondents have access and have not access to credit services respectively. The households use the traditional *'Busa Gonofa'* and are recognized it as a safeguard for them whenever they face cash shortage for different purposes. Such common event also in pastoral area as reported during group discussion held with some households. The Chi-square test shows that there is statically significant difference between high and low practicing respondents at 10% (χ^2= 3.14, P= .078) significant level. A similar report is with the findings of (CARE-Ethiopia, 2009) study on value chain analysis of milk and milk products in Borana pastoralist area.

Table 17: Access to credit service and differences by level of indigenous management practices

Particulars	Response	Respondents						Chi-square (χ^2)	P-value
		Highly practicing		Low practicing		Total			
		n	%	n	%	n	%		
Access to credit service	Yes	39	44	20	62.5	59	49.17	3.104	.078*
	No	49	56	12	37.5	61	50.83		
	Total	88	100	32	100	120	100		

Note: * indicates 10% level of significance

Distance from the market center

The study also analyzed the relationship between distance from market of household heads and indigenous rangeland management practice. The total mean distance from market center of the total sample respondents is 17.82. Based on Pearson's correlation analysis result, there is positive relationship between distance from market of household heads and indigenous management practices. The result of t-test indicates that there is no statistical significance difference between the distances from market of highly and low practicers of indigenous rangeland management. Even though there is no statistical difference between high and low practices of traditional management, close to market and strengthening access to markets, and natural resource access (such as water access), results to strengthening traditional institutions and improving rangeland management a similar report with findings of (Skinner, 2010) in his study on rangeland management for improved Pastoralists Livelihoods the Borana of Southern Ethiopia.

Table 8: Distance from the market center and differences by level of indigenous management practice (in Kms)

Particulars	Respondents	n	Mean	St.dev	Mean difference	t- value	P-value
Distance from market center	Highly practicing	88	17.59	5.21	.47	.43	.668NS
	Low practicing	32	18.06	5.57			
	Total	120	17.82	5.37			

Participation position in traditional institution

The participation position in traditional institution of the respondents those highly practice indigenous rangeland management is 86.36%, 10.23% and 3.41% member, committee, and leader respectively. The corresponding number of low practicing respondents is 71.87%, 15.62 and 12.5% member, committee, and leader respectively (Table 9). From the result, the total sample respondents 82.5% members, 11.67% committee, and 5.83% leaders. Generally, it was found that the majority respondents were members of the customarily institutions. The chi-square test shows that there is no statistically significant difference between high and low practicing respondents of traditional rangeland management.

Table 9: Participation position in traditional institution and differences by level of indigenous management practices

Particulars	Response	Respondents						Chi-square (χ^2)	P-value
		Highly practicing		Low practicing		Total			
		n	%	n	%	n	%		
Participation position in traditional institution	Member	76	86.36	23	71.87	99	82.50	2.51	.105NS
	Committee	9	10.23	5	15.62	14	11.67		
	Leader	3	3.41	4	12.50	7	5.83		
	Total	88	100	32	100	120	100		

Note: NS indicates not significant

Determinants of the Use of Indigenous Rangeland Management Practices

Table 10. Estimation of binary logistic regression model

Variables	Coefficient (B)	S.E.	Wald	Significance	Odds Ratio
KIP	.097	.043	7.006	.003***	2.006
EDUC	.139	.970	.036	.876	1.182
TLU	.019	.0029	.078	.805	1.129
OPE	-.681	.258	15.008	.000***	.913
PPTI	1.931	.508	9.521	.008***	6.800
ACS	1.030	.315	3.009	.075*	.292
UCFSize	-.450	.751	.489	.331	.373
DFMC	1.008	.672	2.006	.1006	3.907
Constant	-1.352	1.331	.986	.4310	.253

Pearson Chi-square= 76.94, significance = 000***, Pseudo R^2 = 0.35
Correctly predicted= 89.3
-2Log likelihood= 67.33
Sensitivity= 93.7
Specificity= 65.8
Note: ***, and * significant at 1%, and 10% level of significance respectively.
-2log likelihood is the maximum likelihood of model coefficient

Eight variables were entered for analysis; out of these variables four were found to be statistically significant at different levels. These variables are knowledge of indigenous practices, ownership of private enclosures, participation position in traditional institutions and access to credit services have found to be significantly affect the indigenous rangeland management practices.

Knowledge of indigenous practices (KIP): As the model estimates confirm that the knowledge of indigenous practices of household head is found to be significantly influence traditional management practice of the respondents at 1% significance level ($p < 0.01$). This indicates that, a unit increase in year of experience of the household head, the odds ratio in favor of practicing in indigenous rangeland management increase by 2.006. This is due to the fact that, a household head with long year experience indigenous practice has accumulated customarily knowledge and skills related to traditional management activities. Hence, these household heads tend to have more experiences in indigenous management practices. This report is consistent with the findings of (Homann and Rischkowsky, **2005) on** integrating the indigenous knowledge of Borana pastoralists into rangeland management strategies in southern Ethiopia.

Ownership of private enclosures (OPE): This variable was significant at 1% significance level ($p < 0.01$) and negatively related with indigenous rangeland management practices. Holding other variables constant, a unit increase in this explanatory variable would decrease the odds ratio in favor of practicing traditional management by a factor of 0.37. An increase in private enclosure decreases the indigenous ways of rangeland management practices. Expansion of private enclosures on communally used grazing areas flames conflicts between groups of resource users with a specific concern about the ever declining access of weaker groups such as pastoralists to productive resources. Privately owned grazing land and water points that disturbs patterns of mobility in a way grazing land use becomes inefficient as grazing concentrates close to the water points, leading to degradation of the rangelands (Kejela *et al.,* 2005). Increasing of private enclosure into common property rangeland is twisting somebody's arm to marginal and fragile land areas (Bassett, 1993; Kirk, 1996; Hogg, 1997).

Participation position in traditional institution (PPTI): According to the analysis result, participation of position of the sample household heads in traditional institution has significant influence on indigenous management practices at 1% significance level ($p < 0.01$). From this point of view, participation in collective resource use will enable the households to maximize the use of resources. In Borana area, grazing land and water resources are jointly used. The odds ratio result indicates that, collaboration of the sample household heads in communally resource uses will have the probability of increasing their traditional management practices. Pastoralists are organized as resource use cooperation to take full advantage of the optimum utilization of resources. Consistent with the study of (Roe *et al.,* 2009) on community management of natural resources in Africa.

Access to credit services (ACS): This variable was also found to be significant influence on households' indigenous rangeland management practices at 10% significance level ($p < 0.1$). On the other hand, the result of odd-ratio indicates that, access to credit service will increase the probability of indigenous management practice by .292 percent. It is positively correlated with indigenous rangeland management practices. Access to credit service is strongly determining the effectiveness of risk-coping strategies among the poor pastoralists, whose access to financial savings and credit is extremely limited. The combination of lack of access credit services and severe drought can thereby hamper the self-insurance role of livestock (Fafchamps *et al.,* 1998).

Conclusions

It has been indicated that most of the interviewed household heads perceived that the indigenous management of resources have relative advantages than any other systems. Even though, the elders have their own indigenous knowledge, education has also its own positive impact on the decision making of natural resource management especially for pastoralists, can help ease dependence on livestock production. When education level of household heads increase more emphasis for promoting traditional management practices, sustaining of resources and improving rangeland management practices. Educated are young people than old. Knowledge from formal school increases. In pastoral area, livestock holding is one of the important livelihood assets. The large herds are sighted as the result of the pastoralists' with reputation and status, supposedly being their main concerns. Then the high number of livestock unit, the high coming to practice indigenous rangeland management practices whereas the low livestock owned by the household heads, the low participating in practices of pastoralism. Expansion of private enclosures and uncontrolled farmland size is a serious constraint to indigenous rangeland management practices and livestock production. The more the private enclosures and uncontrolled cultivated land size the more negatively affecting the indigenous management practices of the pastoral communities, due to this reasons there is shrinkage of communal rangelands. Such issues need the attention of development planners, policy makers and government bodies to promote indigenous management practices in the area.

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Intercropping of maize (*Zea mays*) and different accessions of Dolichos lablab at different maize plant population density at Bako area, Western Ethiopia

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Abstract

Maize (BH-660) and four Dolichos lablab accessions (ILRI 14614, ILRI 14461, ILRI 11631 and ILRI 14550) were intercropped at Bako Agricultural Research Center during the 2008-2010 cropping season with the objectives of investigating effect of legume on maize attributes and the advantage of intercropping. The intercropping was on the additive serious basis (without altering maize seed rate) at 25%, 50% and 75% of the maize plant population density. Maize biomass yield (ton/ha), grain yield (Qnt/ha) and plant height (cm) were maize attributes investigated. Dolichos lablab herbage yield (ton/ha) and its height in cm were also investigated. Partial maize (MLER) and Dolichos lablab (DLER) and total land equivalent ratios (TLER) were calculated. From the analyses results, there were no significant (p>0.05) difference among the treatments on maize attributes considered whereas, the Dolichos lablab herbage dry matter yield and its height significantly (p<0.05) differed for the treatments. The overall means of maize biomass yield, maize grain yield and maize plant height were 15.24 ton/ha, 71.73 Qnt/ha and 277.04 cm, respectively whereas the overall mean of the MLER, DLER and TLER were 0.94, 0.55 and 1.49, respectively. The present study revealed that intercropping of maize with Dolichos lablab not only improved the yield parameters of maize but also found to be advantageous based on the land equivalent ratio results. There was a non significant (p>0.05) difference among the different Dolichos lablab accessions on yield attributes of maize suggesting that any of the material can be used. However, Dolichos lablab ILRI 14614 was found to best on the maize yields and the TLER. On the other hand, the rate of intercropping should be at 50% of maize plant population density as the smaller rate resulted in small amount of the legume yield and the higher rate tended to decline the maize yields. Future works should focus on the nutrient content improvement due to the intercropping on the maize Stover.

Key words: Intercropping; Dolichos lablab; maize; land equivalent ratio; Additive serious

Introduction

In general, intercropping of cereals with legumes has been popular in tropics (Hauggaard-Nielsen et al., 2001; Tsubo et al., 2005) and rain-fed areas of the world (Banik et al., 2000; Agegnehu et al., 2006; Dhima et al., 2007) due to its advantages for soil conservation (Anil et al., 1998), weed control (Poggio, 2005; Banik et al., 2006), yield increment (Anil et al., 1998; Chen et al., 2004), and hay curing, forage preservation over pure legumes, high crude protein percentage and protein yield (Qamar et al., 1999; Karadag and Buyukburc, 2004). In attempts to meet the increasing food demands, farmers are putting more land under food crop production and as a consequence grazing lands have diminished. However, the contribution of animals to the crop in Ethiopian context is immense. The potential feed resource for animals where grazing area is shrinking could be, crop residues. Crop residues are inherently low in quality and can be improved if intercropped with legumes. Maize forage quality in terms of crude protein improved when maize was intercropped with cowpea because of more nitrogen availability for maize in the intercropping (Eskandarri and Ghanbari, 2009).

Maize is predominantly cultivated crop in western part of Ethiopia sustaining considerable number of the households. However, its mono cropping has been criticized as it led to depletion of soil fertility. Intercropping of maize with legume crops is, therefore, coming on the foreground now a day. So far, little studies on compatibility and herbage production dynamics were conducted. On the other hand, intercropping of forage legumes with food crops is another strategy for intensifying feed production in mixed crop livestock production systems (Kouame et al, 1993) like at Bako and similar agro ecologies. Previous studies at the center indicated that integration of Dolichos lablab, which has been known for its use as a green manure, adding organic matter as well as nitrogen and minerals to the soil (Andrea and Colucci, 1999), with maize to be one of the candidate alternatives but aggressiveness of the legume component in the intercropping system has caused significant yield reduction of the staple crop that could minimize the possibility of adoption of the technology under small-scale farmers particularly when the legume is simultaneously planted with maize. Delayed planting of the legume, on the other hand has resulted in insignificant yield reduction of the legume component for sizeable impact on animal production and this led the researchers to embark on germplasm screening activities. It was hypothesized in this particular work that through integrating non-aggressive accessions of Dolichos lablab genotypes/accessions with maize, it is possible to achieve compatible Dolichos lablab/maize systems that could be exploited for intensifying feed production in maize-livestock systems. Hence, the objective of the present study was to evaluate the productivity and compatibility maize and different accessions of Dolichos lablab under Bako condition.

Materials and methods

Description of the study area

The field experiment was conducted during the 2008 – 2010 growing season at Bako Agricultural Research Center, western Oromia. The center is located 258km west of Addis Ababa at an altitude of 1650 masl. It lies at about 09°6'N and 37°09'E. Administratively, it is found in Gobu Sayo district, East Wollega Zone, Oromiaa. The area has a hot and humid climate and receives a mean annual rainfall of about 1220 mm, of which more than 80% falls in the months of May to September. Mean monthly minimum and maximum temperatures are about 14°C and 28°C, respectively with an average monthly temperature of 21°C. The mean daily minimum and maximum temperatures are 9.4°C and 31.3°C, respectively. The soil belongs to Alfisols series and it is clay in texture (Piccolo and Assefa, 1983), reddish brown in color with pH ranging from 5.3-6 (Dawit and Leggesse, 1987) and cation exchange capacity of 18.3 me/100g (Sahlemdhin and Ahmed, 1983). Total (Piccolo and Assefa, 1983) and available (Sahlemdhin and Ahmed, 1983) phosphorous content of the soil was estimated to be about 475 parts per million (ppm) and 2.2ppm, respectively.

Field operations and Treatments

Land preparation was done following usual practice being used in the center through tractor drawn implements. Additive series mixtures design was used in which the recommended maize plant density was kept as recommended for grain production but the density of the legume component was imposed at incremental (25, 50 and 75% of maize population) proportions. Thirteen treatments (Table 1) were included and investigated for the maize biomass, maize grain and maize plant height investigations while 12 treatments were included for the investigation of the land equivalent ratio. Four different accessions of Dolichos lablab and maize were also produced in sole. Additionally, each material (maize BH-660) and the four Dolichos lablab accessions (ILRI 14614, ILRI 14461, ILRI 11631 and ILRI 14550) were mono cultured at the recommended agronomic practice.

Fertilizer applications

DAP was applied to the experimental plots at the rate of 150 kg/ha at planting in the case of both intercrops and mono culture. No urea fertilizer was applied to legume and whereas plots on which maize was established received urea at the rate of 200 kg/ha. Maize and Dolichos lablab were planted at a depth of 7 and 5 cm, respectively on a pre prepared plots in early June every year

Table 1. The description of the experimental treatments

Treatments	Description
T1	Maize + ILRI 14614, 25% of maize plant density.
T2	Maize + ILRI 14614, 50% of maize plant density.
T3	Maize + ILRI 14614, 75% of maize plant density.
T4	Maize + ILRI 14461, 25% maize plant density.
T5	Maize + ILRI 14461, 50% of maize plant density.
T6	Maize + ILRI 14461, 75% of maize plant density.
T7	Maize + ILRI 11631, 25% of maize plant density.
T8	Maize + ILRI 11631, 50% of maize plant density.
T9	Maize + ILRI 11631, 75% of maize plant density.
T10	Maize + ILRI 14550, 25% of maize plant density
T11	Maize + ILRI 14550, 50% of maize plant density.
T12	Maize + ILRI 14550, 75% of maize plant density.

Maize and Dolichos lablab were harvested simultaneously. Plants were cut separately at about one centimeter above soil surface. Biomasses of maize and Dolichos lablab were determined after drying in the oven for 48 hrs at 70°C. Maize biomass was obtained by summing dry matter yields of grain, sheath, Stake, husk and cob, and that of Dolichos lablab was determined from the sample taken of the whole plant parts. Maize plant heights were taken to tip of maize tassel. The analysis of variance of the data was made using SAS (2002). Treatment least squares means were separated adjusted Tukey where necessary.

Results and Discussion

Maize biomass yield in ton/ha, maize grain yield in quintal/hectare, and maize plant height in cm are presented in Table 2. The analysis of variance showed that there were no significant difference ($p>0.05$) between monoculture and intercropping of maize with different Dolichos lablab accessions at different rate of maize plant population densities regarding the aforementioned maize attributes. This means that intercropping of maize with different accretions of Dolichos lablab (ILRI 14614, ILRI 14461, ILRI 11631 and ILRI 14550) at different maize population density (25%, 50% and 75%) did not significantly ($p>0.05$) altered the maize biomass yield, maize grain yield and maize plant height when compared to the maize monoculture. The R-square, which indicated the amount of variation explained by the fitted model, was 45%, 41% and 45% for maize biomass, maize grain yield and maize plant height (Table 2). This means that 45%, 41% and 45% of variations in maize biomass yields, maize grain yield, and maize plant height, respectively were due to three levels of year, three levels of replication and 13 levels of treatments. The remaining variations were accounted for random errors. On the other hand the coefficients of variations were below 20% in all for the traits which indicated that errors due to manmade were minimized.

The overall means of maize biomass yield, maize grain yield and maize plant height were 15.24 ton/ha, 71.73 Qnt/ha and 277.04 cm, respectively. The overall mean of maize biomass yield was below the sole maize cultivation by 6% and the maize grain yield was below the sole maize production by about 7% (Table 2). This was probably due to the competition of the intercrops for nutrients and moisture with maize which otherwise used only by sole maize. However, from viewpoint of the advantage of legumes to the soil and to the animals as feed, that may be tolerable. The overall means were including these all, hence the result was found to be below the yield from monoculture. Though application of chemical fertilizers is expensive, it is always advantageous to grow legumes in association with grasses so that part of their nitrogen requirement maybe met from legume root nodules (Narayanan and Dabadghoo, 1972) and there is no nitrogen return to the soil; whereas Dolichos can fix about 20 kg N/ha under drought conditions similar to the ones prevailing in the study area (Rochester et al., 1998).

Table 2. The effect of Dolichos lablab accessions and its population density on maize biomass (ton/ha), maize grain yield (Qnt/ha) and plant height (cm)

No	Description of the treatments	Maize biomass yield	Maize grain yield	Maize plant height
	Overall mean	15.24	71.73	277.04
1	Sole maize	16.20	76.74	279
2	Maize + ILRI 14614, 25% of maize plant density.	16.38	72.84	280.66
3	Maize + ILRI 14614, 50% of maize plant density.	16.02	78.18	279.22
4	Maize + ILRI 14614, 75% of maize plant density.	15.50	73.58	284.22
5	Maize + ILRI 14461, 25% maize plant density.	16.48	70.46	270.33
6	Maize + ILRI 14461, 50% of maize plant density.	14.78	71.05	276.55
7	Maize + ILRI 14461, 75% of maize plant density.	14.38	70.47	277.88
8	Maize + ILRI 11631, 25% of maize plant density.	14.79	70.74	273.00
9	Maize + ILRI 11631, 50% of maize plant density.	14.85	68.72	287.77
10	Maize + ILRI 11631, 75% of maize plant density.	15.00	70.45	281.00
11	Maize + ILRI 14550, 25% of maize plant density	14.90	71.50	275.66
12	Maize + ILRI 14550, 50% of maize plant density.	14.30	69.37	264.33
13	Maize + ILRI 14550 ,75% of maize plant density.	14.47	68.36	271.88
	S.E.	0.74	4.4	7.5
	R^2	0.45	0.41	0.45
	C.V.	14.60	18.41	8.17
	P value	P>0.05	P>0.05	P>0.05

R^2=model sum of squares divided by corrected total sum of squares (the amount of variations explained by the fitted model); S.E. standard error of treatment means; C.V. = coefficient of variation; probability difference; 1Qnt = 100 kg.

As the differences between sole maize cultivation and intercropping, when Dolichos was planted at different maize population density, were not significantly different particularly for the maize biomass yields and maize grain yields, any of the Dolichose lablab accession can be used for intercropping with maize. However, regarding maize biomass yield, Dolichose lablab accession ILRI 14614 was found to be promising (Table 3) as the values were nearly equal to the maize biomass yield from sole cultivation. When the maize biomass yield from intercrop was nearly equal to the maize biomass yield from sole production, legume biomass is the advantage which could serve as soil fertilizer and also as animal feeds. Regarding the effect of rate of the Dolichos lablab accessions on maize plant population density in a given unit area, a non significant reduction of maize biomass was observed when the population of Dolichos lablab was increased from 25% to 75% of maize plant population density. That revealed the competition for soil nutrients and moisture was increased when the amount of Dolichos lablab added to maize plant population increased which is in line with the reality. Regarding the maize grain yield, Dolichos lablab accession ILRI 14614 when planted at 50% of the maize plant population was found to be higher by about 2% and 8% than mean of maize grain from sole and overall, respectively.

Generally, even though the there was no significant difference among the treatments regarding the biomass yields and the maize grain yield, Dolichos lablab accession ILRI 14614 at 50% maize plant population density may be proffered to the rest Dolichos lablab accessions based on the quantity of biomass and maize grain. From Table 3 it can be seen that there was significant ($p<0.01$) difference of Dolichos lablab herbage yield from the described treatments. Obviously, the biomass where the rate of dolichos lablab was at 25% was less than the other. On the other hand, the difference in Dholichos lablab plant height was probably due to the difference in the Dolichos labalab accessions as cultivar selections, seeding ratios, and competition capability within mixtures may affect the growth of the species used in intercropping systems in rain-fed areas (Santalla et al., 2001; Karadag and Buyukburc, 2004; Carr et al., 2004; Agegnehu et al., 2006; Banik et al., 2006; Dhima et al., 2007).

Table 3. Dolichos lablab herbage yield (ton/ha) and height (cm) from different accessions and plant density intercropped under maize

No.	Treatments	Dolichos lablab herbage yield	Dolichos lablab height
T1	Maize + ILRI 14614, 25% of maize plant density.	2.01±0.3	278.78±12.7
T2	Maize + ILRI 14614, 50% of maize plant density.	1.65±0.3	272.78±12.7
T3	Maize + ILRI 14614, 75% of maize plant density.	1.77±0.3	253.22±12.7
T4	Maize + ILRI 14461, 25% maize plant density.	0.93±0.3	250.55±12.7
T5	Maize + ILRI 14461, 50% of maize plant density.	0.70±0.3	204.66±12.7
T6	Maize + ILRI 14461, 75% of maize plant density.	1.12±0.3	247.33±12.7
T7	Maize + ILRI 11631, 25% of maize plant density.	0.63±0.3	293.89±12.7
T8	Maize + ILRI 11631, 50% of maize plant density.	0.75±0.3	283.33±12.7
T9	Maize + ILRI 11631, 75% of maize plant density.	0.95±0.3	289.33±12.7
T10	Maize + ILRI 14550, 25% of maize plant density	1.76±0.3	270.00±12.7
T11	Maize + ILRI 14550 ,50% of maize plant density.	1.28±0.3	267.00±12.7
T12	Maize + ILRI 14550 ,75% of maize plant density.	1.41±0.3	267.67±12.7
	R^2	0.56	0.34
	C.V.	40	14
	P value	$P<0.01$	$P<0.01$

Partial and total land equivalent ratios were also calculated to assess the advantage of intercropping. When LER is greater than 1, the intercropping favors the growth and yield of the species. In contrast, when LER is lower than 1, the intercropping negatively affects the growth and yield of plants grown in mixtures (Dhima et al., 2007). The maize partial land equivalent ratio (MLER), Dolichos lablab partial land equivalent ratio (DLER) and total land equivalent ratio (TLER) are presented in Table 4. The analysis of variance showed that there was no significant difference ($P>0.05$) among the treatments for MLER, DLER and TLER. The R-square for the traits were more than 40%, while the C.V. was inflated for the DLER probably due to the difference in proportion of the Dolichos lablab at the beginning. The overall mean of the MLER, DLER and TLER were 0.94, 0.55 and 1.49, respectively.

From the overall means it can be seen that about 49% of land can be saved when maize and Dolichos lablab were intercropped to produce the same amount of biomass from pure stands. Even though the difference among the treatments were not statistically significant, the maximum TLER for the biomass yields (1.70) was obtained from maize + Dolichos lablab accession number ILRI 14614 when intercropped with maize at 75% of the maize plant population where the minimum TLER was when Dolichos lablab accession number ILRI 14461 was intercropped with maize at 50% maize plant population density. The possible reason for the differences in TLER for different Dolichos lablab accessions at different rate could be differences in compatibility of the Dolichos lablab materials and the differences in the Dolichos lablab population. Regarding the TLER, Dolichos lablab accession number ILRI 14614 was the best when compared with the rest Dolichos lablab accessions. Therefore, it is concluded that Dolichos lablab accession number ILRI 14614 when intercropped at 50% of the maize plant population was found to be best from maize grain production (78.18 Qnt/ha) viewpoint and also fair in terms of maize biomass yield (16.02 ton/ha) since LER verifies the effectiveness of intercropping for using the resources of the environment compared to sole cropping (Dhima et al., 2007). Additionally, fair TLER was found when maize was intercropped with Dolichos lablab accession number ILRI 14614. Therefore, Dolichos lablab accession number ILRI 14614 was found to be best for intercropping with maize BH-660 at about 50% of maize plant population at which maize grain production was not penalized; rather improved.

Table 4. Evaluation of the benefit of maize Dolichose lablab intercropping

Treatments	MLER	DLER	TLER
Overall mean	0.94	0.55	1.49
Maize + dolichose var.14614, 25% of maize plant density.	1.02±0.1	0.59±0.1	1.61±0.16
Maize + dolichose var.14614, 50% of maize plant density.	1.00±0.1	0.67±0.1	1.68±0.16
Maize + dolichose var.14614, 75% of maize plant density.	0.97±0.1	0.73±0.1	1.70±0.16
Maize + dolichose var.14461, 25% maize plant density.	1.02±0.1	0.41±0.1	1.44±0.16
Maize + dolichose var.14461, 50% of plant density.	0.91±0.1	0.33±0.1	1.24±0.16
Maize + dolichose var.14461, 75% of plant density.	0.89±0.1	0.61±0.1	1.49±0.16
Maize + dolichose var.11631, 25% of plant density.	0.92±0.1	0.47±0.1	1.39±0.16
Maize + dolichose var.11631, 50% of plant density.	0.92±0.1	0.51±0.1	1.43±0.16
Maize + dolichose var, 11631, 75% of plant density.	0.93±0.1	0.72±0.1	1.64±0.16
Maize + dolichose var, 14550, 25% of plant density	0.93±0.1	0.49±0.1	1.42±0.16
Maize + dolichose var,14550 ,50% of plant density.	0.88±0.1	0.51±0.1	1.39±0.16
Maize + dolichose var,14550 ,75% of plant density.	0.90±0.1	0.54±0.1	1.45±0.16
R2	0.40	0.40	0.46
C.V.	15.75	78.00	31.68
P value	P>0.05	P>0.05	P>0.05

From studies conducted on Dolichos lablab and maize intercropping in Kenya, the Dolichos lablab suppressed weeds and increased the maize Stover yield (Anne et al., 2011). This has been mentioned as one of the advantages of using cover crops in Conservation Agriculture (FAO, 2008). From our result, the increment of maize grain production from intercropping when compared to monoculture may be due to reduction of soil erosion and runoff by the under sown legume as the cover is able to conserve soil, improve organic matter content and compete with weeds (Humphreys 1995). With its deep tap root, Dolichos lablab is not only drought resistant, but is able to bring minerals, otherwise not available for annual crops, from the depths to the top soil (Schaaffhausen 1963).

Conclusion and recommendation

The present study revealed that intercropping of maize with Dolichos lablab not only improved the yield parameters of maize but also found to be advantageous based on the land equivalent ratio results. There was a non significant variation among the different Dolichos lablab accessions on yield attributes of maize suggesting that any of the material can be used. However, Dolichos lablab ILRI 14614 was found to favor the maize yields and the intercropping advantage. On the other hand, the rate of intercropping should be at 50% of maize plant population density as the smaller rate resulted in small amount of the legume yield and the higher rate tended to reduce the maize grain and biomass. Future works should focus the nutrient content improvement due to the intercropping.

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Evaluation of Dry season supplementation of oat-vetch hay for yearling lambs under farmers' management condition, North Shoa

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Abstract

The experiment was conducted in the peak of the dry season (February to May) to verify on station developed technologies on-farm at Meha Meda, North Shoa. Three groups of sheep each containing 10 yearling lambs were constructed and allotted to three feed treatments randomly. The treatments were T1: Farmers practice (control); T2: T1+ 500gm oats/vetch hay mixture$d^{-1}h^{-1}$; T3: T1+ 300gm oat grain/noug cake mixture $d^{-1}h^{-1}$. Final body weight and average daily weight gain of supplemented sheep were significantly different ($P < 0.01$) from the un-supplemented ones. No significant weight difference was noted in average daily gain, total and final weight gain between oats/vetch hay and oat grain/nougcake mixture supplemented groups. Price estimation done by a group of local traders at the end of the experiment showed that, sheep on oats/vetch hay fetch more money (47 birr) followed byoat grain/noug cake (17 birr) while the un-supplemented lambs group losst on the average -7.00 birr per sheep. Oat/vetch hay mixture can be used as a substitute for concentrates to supplement yearling Menz sheepin the dry season. The technology could be scaled up to similar oat/vetch growing areas.

Key words: Lambs, Dry season, Fattening, Supplementation, Highland

Introduction

In North Shoa, sheep are raised traditionally by subsistence farmers and form an important component of the livestock industry in the region.More than 888,095 head of sheep (CSA, 2003) are distributed over 876,700 ha of natural grass and bush land (SAERP, 1996). In terms of area, the natural pasture seems quite large to sustain the ruminant productivity. However, periodic drought and communal ownership associated with mismanagement has led to serious degradation of pasture. To feed the ever increasing human population land under natural pastures is shrinking years after year. Livestock productivity in the central highlands of Ethiopia is low. Available data on local breeds of sheep indicate low levels of lambing rates (1 lamb per year), high lamb mortality rates of 22 - 27% and an off take rate of only 30 - 32% (Zelalem and Fletcher, 1993). To improve the current productionlevel and to cope up with the demand products by ever increasing human population, productivity of animals should be raised through the proper utilization of available resources. In North Shoa, the economic importance of sheep is well known by the farming community as sheep keeping requires small establishment capital, less feed,while the ease of liquidation whenever the need arise is an additional factor for making sheep rearing a component of the mixed farming system. The current scenario of the zone (obligatory primary education and expansion of arable lands) is forcing the traditional animal keeping system to change into semi- intensive ones leading to the use of productive breeds and high inputs. Extensive use of industrially processed feeds is not an option for the resource-poor farmers due to high cost and unavailability (Zinash and Seyoum, 1991).Cultivated forages can be used as an alternative to minimize the dependency on concentrates (Abebe*et al* 2006a). In the zone sheep fatteninghas been an attractive enterprise in the area. The local farmers often fatten a few heads of sheep to sell during holidays. Sheep kept for this purpose are supplemented with surplus grain, leftover food, native legumes and concentrates for undetermined period of time (Anteneh*et al*; 2006). The great majority of sheep sent to market is the area using this system are unfinished milk teeth lambs of less than 20 kg (Galal, 1982) though some findings (Solomon *et al*, 2006) demonstrated the possibility of attaining 30 kg with supplementation.

Well conditioned sheep attract good prices during the holiday season as opposed to the poor ones. Natural pasture becomes insufficient in terms of quantity and quality during the dry season and as a result, sheep lose weight. Research findings reveled that feed supplementation during this period could avid the weight loss resulting in more income for the farmers. This experiment therefore, was conducted to verify the on-station developed dry season feeding technologies on-farm to increase farmers' income.

Materials and Methods

The experiment was undertaken at MehalMeda of North Shoa, located at 10^{o} 30' N and 39^{o} 65' E. Annual rainfall of the area averages at 900.6 mm with maximum and minimum temperature of $17.65^{o}C$ and $6.85^{o}C$, respectively. The soil is classified as Vertisol, characterized by shrinking when it dries and swelling when it is moist. Volunteer farmers were selected to produce experimental feed and animals, while the research center provides of forage seeds, medicines, ear tags, commercial feeds and covered enumerators' wages. Oats and vetch were planted on a gently slopping farm land following recommendations of the center (100 kg oat and 30 kg vetch $ha^{-1}$and 100 $kgha^{-1}$DAP at planting). The forage was harvested at 10% flowering stage, cured (turning, early in the morning and late in the afternoon) and stacked in conical shape and covered with a grass to protect it from rain and direct sun heat damage.

The sheep were let to graze natural pasture for eight hours a day and then separated into their treatment groups during the enclosure time. Vaccination and anti-helmentic were given to all lambs before the commencement of the experiment. Three groups of lambs were formed (ten lambs per group) and each lamb was allocatedrandomly to one of the three dietary groups. The three feed treatments were: (i) farmers practice (control), (ii) grazing + 500 g of oats vetch hay, (iii) grazing + 300 g of noug cake and oat grain at the ratio of 1:1. The supplemental feed was supplemented individually during the enclosure time. Before each meal, the refusal from the previous meal (if any) was removed and weighed. The difference between the amount offered and refused was taken as quantity consumed. The sheep were weighed fortnightly in the morning before grazing. No experimental lamb died during the experimental period. Records were taken on feed offered and left over, body weight, price estimate of each lamb and farmers' perceptions towards the end of the experiment. For market value assessment, price estimation was made by two local live sheep dealers; the average of the two was used for cost estimation.

Results and Discussion

The performance of the supplemented sheep

The performance of the supplemented sheep is given in Tables 1 and 2. Final body weight and average daily gain of supplemented sheep were significantly different ($P < 0.01$) from the un-supplemented ones. Lambs supplemented with oat grain/noug cake mixtureand oats/vetch hay mixture gained significantly ($P < 0.01$) more weight than the control. These results confirm the findings of Abebe *et al*., (2006 a & b) and Sisay (1994) who reported the importance of lamb supplementation in the dry period to lessen morbidity of animals.Theresult indicates the advantage of dry season supplementation when the available pasture is not sufficient to support productivity to the desired level. No significant weight difference was noted in average daily gain, total weight and final weight gain between oats/vetch hay and oat grain/nougcake mixture supplemented groups. To make sheep enterprises more profitable and sustainable at MehalMeda where farmers keep large number of flocks, a balance should be made between available pasture and animals that graze a particular area.The average daily weight gain due to treatment III (oat grain + noug cake supplementation) is consistent with what Abebe *et al*. (2006b) obtained at Chacha but less than reported for MehalMeda area (Abebe*et al*., 2006a).

Dry season supplementation of sheep has a long-term financial benefit by increasing lamb survival rate and minimizing nutritional distress, and thus prevailing financial losses incurred by farmers who would otherwise be forced to sell their lambs when prices hit their bottom line. Lambs kept under supplementation can fetch better prices towards the end of the dry season when the demand is extremely high due to Easter Holiday market". The average daily weight gain due to treatment III (oat grain + noug cake supplementation) is consistent with what Abebe*et al*. (2006) obtained at Chacha but less than reported for MehalMeda area (Abebe*et al*., 2006).

Table 1. The pattern of weight gain in yearling Menz lambs exposed to different feed supplementation during the dry season.

Supplementation	No	Initial weight (kg)	Total gain /loss (g)	Average daily gain (g)	Final body weight (kg)
Only grazing	10	20.30±0.6156	-2.02 ± 0.3133^{b}	-22.44 ± 3.481^{b}	18.27 ± 0.313^{b}
Oats/vetch hay	10	20.60±0.6156	$+3.23\pm0.3432^{a}$	$+38.03\pm3.723^{a}$	23.81 ± 0.443^{a}
Oat grain + noug cake	10	19.96±0.6156	$+3.33\pm0.3149^{a}$	$+37.01\pm3.499^{a}$	23.62 ± 0.315^{a}
Mean		20.29			20.47

Dry season supplementation is one of the ways by which smallholder farmers can intensify the traditional system to increase their household incomes. In the traditional markets of North Shoa, prices for lambs are set based mainly on body condition and skin color rather than actual live weight.Oat/vetch hay mixture can be used as a substitute of concentrates to supplement yearling Menz sheep at MehalMeda. The use of oat vetch hay and cultivated pasture as a dry season supplementary feed could help farmers to produce heavier and good conditioned lambs that attract higher prices without incurring much cost as family labor is involved in undertaking the enterprise. The price estimations confirmed that sheep on oats/vetch hay fetch more money (47 birr) followed byoat grain/noug cake (17 birr) while the un-supplemented group lost on the average -7.00 birr per lambs.

Table 2. Average farm gate price estimates at the end and actual price of lambs at the start of the experiment (Birr/lamb).

Treatment	Initial price	Estimated price	Gross margin
Only grazing	131.00	124.00	-7.00
Oat grain + noug cake	136.00	154.00	+17.00
Oats/vetch hay	133.00	180.00	+47.00

Conclusion

There was an improvement in final body weight, average daily gain and total body weight gain through supplementation during the critical dry periods. Supplementation increased farmers' incomes from the sale of fattened lambs as they fetch good prices due to good body conditions.Oat/vetch hay mixture can be used as a substitute for concentrates to supplement yearling Menz sheep. The result of the current experiment implies that the technology can be adopted by smallhoders and could be applicable to other similar oat/vetch growing areas

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On Farm Dry Season Supplementation of Sweet Blue Lupin Grain for Farta Sheep Fed on Hay as Basal Diet in Dera District of South Gondar Zone, Ethiopia

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Abstract

The study was conducted under on-farm condition at Dera district from end of February to mid of May 2013 to evaluate dry season supplementation of sweet blue lupin grain for Farta sheep, the potential of sweet blue lupin grain as substitute for commercial concentrate and to assess economic feasibility of the experiment. Twenty four yearling Farta ram lambs were used for the study. The design was an independent t-test. Experimental animals were grouped into two feeding treatments: T_1 (hay+ 300g/d/head Noug seed cake) and T_2 (Hay+400g/d/h lupin grain). The difference in average daily weight gain and final body weight in the two treatment groups is not statistically significant ($p>0.05$). There was no problem observed and reported on sweet blue lupin grain utilization during the experimental period. Economic analysis result showed that T_2 was more economical with a net return of ETB 264.42. Thus sweet blue lupin grain can be used as an alternative home grown supplement feed (protein source) in sheep fattening. Therefore, the result obtained should be demonstrated and scaled up to other sweet blue lupin grain producing areas.

Key words: Farta sheep, Noug cake, Sweet blue lupin grain and Dera District.

Introduction

In Ethiopia sheep production is an integral component of the mixed crop-livestock production system. It is an important source of cash income, food, manure and fiber for smallholder farmers (ECSA, 2011). Local sheep in Ethiopia are commonly marketed at body weights of around 20kg, although they can grow to body weights of at least 30kg if they are fed with supplement feeds specially during the long dry season. The great majority of sheep sent to market is unfinished milk teeth lambs of less than 20 kg though several findings (Solomon *et al*, 2004a) demonstrated the possibility of attaining 30 kg with supplementation.. Sheep fattening plays an important role in improving food security and alleviating poverty. However, the contribution of the sector to the country's economy is low compared to its potential due to breed related factors and feed shortage in terms of quality and quantity. On the other hand, the demand for livestock products is increasing from time to time due to urbanization, population growth and an improving economic situation. One of the major constraints is shortage of feed in terms of both quality and quantity which is especially severe during the long dry season (Mulat, 2006). Hay making is practiced in the study area and is produced from a plot of privately or communally owned land preserved for hay production (BoARD, 2010). In the high and mid-altitude areas of Ethiopia, the typical farming system is a mixed crop – livestock farming system. In this type of farming system, multipurpose crops like lupin can be easily integrated and adopted by smallholder farmers. The major reasons for low adoption rate of introduced forage crops in Ethiopia are the lower multi-functionality and complicated agronomic practices associated with growing introduced forages (Melese et al., 2005). Lupins (*Lupinus* spp.) are grain legumes, the seeds of which contain relatively high protein contents (300 to 400 g kg-1 dry matter) (Gladstones, 1983).Other research finding confirmed that lupins have the potential to replace some of the imported protein feeds (Guillaume et al, 2006). The use of lupins for feeding sheep has shown that lupins can increase body weight in young and mature animals and it has considerable potential as a source of protein for ruminant livestock (Buckingham, 1999). Growth is directly related to the quality and level of feed supplied. In the locality especially in holidays well conditioned sheep attract good prices as opposed to the poor ones. In the dry season where the natural pasture is not sufficient to evade weight loss; research findings reveled the advantage of supplementation in the dry season. Therefore, this experiment was conducted to evaluate dry season supplementation of sweet blue lupin grain for Farta sheep, the potential of sweet blue lupin grain as substitute for commercial concentrate and to assess economic feasibility of the experiment

Materials and Methods

Description of the study area

The study was conducted at Enkulal watershed in Dera district of South-Gondar zone, ANRS, Ethiopia. The district is situated at 11°40′ N latitude and 38° E longitude and located at about 55 km north-east of Bahir Dar, Ethiopia. It lies within an altitude range of 1900-4000 m above sea level. The district receives an average annual rain fall of 900-1099 mm and a mean-range temperature of 9-25°C. The rainy season ranges from May to September (WOARD, 2012).

Lupin seed production

Sweet blue lupin seed production was done at Dera district on six selected Volunteer farmers' farmland. The production was done under rain fed condition. Nougcake was purchased from local market and distributed to the participants

Animal feeding and management

A total of twenty four yearling Farta sheep with initial body weight of 21.1±0.62 kg were used for the experiment. Twelve Volunteer farmers were selected and participated in the feeding trial. Each farmer provides two sheep. All the experimental animals were vaccinated against some common diseases and dewormed against internal parasites. They were allocated randomly in to two feed treatment groups.

The treatment groups were:-
T1: Hay+Nougcake (300g/d/head)
T2: Hay+Sweet lupin grain (400g/d/h)

Orientation was given for the participant farmers how to feed and manage the experimental animals. Hay was used as basal diet and was provided *ad libtum*. Whole seed form of lupin seed was used. Sheep in each treatment group received their supplementary feed twice a day half in the morning and the rest in the afternoon. Water and salt was provided *ad libtum.* The feeding trial was conducted for 105 days including 15 days of acclimatization period

Data collection

Body weight parameters of animals such as initial body weight, fortnight body weight and final body weight were taken with a Salter balance (50 kg capacity of 200 g precision). In addition to this data on selling and purchasing price of sheep, production costs and farmers perception about the feeding practice was collected during the course of the experimental period. All data was collected by trained and recruited enumerator.

Statistical analysis and Data management

The collected data was analyzed using the general linear model procedure of Statistical Analysis Soft ware (SAS, 9.2; 2003).Partial budget analysis was employed to evaluate Profitability of the experiment. Sensitivity analysis was employed to quantify the effects of fluctuating input and output price on the profitability of the activity

Results and Discussion

Body weight change

The difference in average daily weight gain and final body weight in the two treatment groups is not statistically significant ($p>0.05$). But relatively higher body weight gain and final body weight was obtained from T1 (Table 2). The variation could be associated with noug cake is a rich protein supplement. Despite the relatively higher crude protein intake sheep supplemented with sweet blue lupin grain, the lower average daily weight gain could be associated with the higher proportion of rumen digestible protein in lupin seed which limits the amount of by pass protein in to the small intestine as mentioned in other similar works. The daily weight gain obtained from T2 was similar to the same breed (58g/day) (Nega and Melaku, 2009) and on Sidama sheep breed (51g/day) (Dessie et al., 2010) supplanted with similar amount of nougcake. The similar daily weight gain obtained with literature results from lupin seed supplementation compared to nougcake supplementation indicated that lupin has a potential to be used as concentrate supplement feed in the diets of growing Farta sheep fed on hay as basal diet. But the daily weight gain obtained from T2 (48g/day) was lower than the reports of Yeheyis et al., 2010 for washera sheep supplemented with lupin seed (76g/day). The variation could be associated with due to variation in breed type, basal feed type and amount of lupin seed given. The average daily weight gain obtained from T1 was lower than Washera sheep supplemented with similar type and amount of concentrate supplement feed (68g/d vs 76g/d). The variation could be associated with the variation in breed and basal feed type.

Table 1: Body weight change parameters of farta sheep exposed to different feed supplementation

Treatment groups	N	Initial weight (kg)	Average daily gain (g)	Final body weight (kg)
T1	12	20.8 ± 0.62^{a}	68.8 ± 3.48^{a}	26.8 ± 0.31^{a}
T2	12	20.1 ± 0.62^{a}	52.8 ± 2.50^{a}	25.9 ± 0.31^{a}
Mean		20.4 ± 0.62	58.8 ± 3.13	26.4 ± 0.31
CV (%)		12.3	13.6	14.2

T1: Hay + 300 g /d/h Nougcake; T2: Hay + 400g/d/h Sweet blue lupin grain; N: Number of animals

Economic analysis

The economic analysis result indicated that (Table 3) supplementing Farta sheep with 400g/d/head Sweet lupin grain was more economical than feeding with 300g/d/head nougcake with a net return of ETB 264.42. It also indicated that substituting nougcake with sweet lupin grain was more profitable than the use of nougcake as protein source.

Table 2: The partial budget and sensitivity analysis

Variables	Partial budget (ETH birr)		Sensitivity analysis			
			10%		15%	
	T1	T2	T 1	T 2	T1	T2
1. Benefit from fattening						
Fattened sheep price (ETB)	1027.5	1054.17	924.75	948.75	873.36	896.04
A. Total Benefit (ETB)	**1027.5**	**1054.17**	**924.75**	**948.75**	**873.38**	**896.04**
2. Cost of fattening						
cost for sheep purchase (ETB)	682.92	647.75	751.21	712.53	785.36	744.91
Concentrate or lupin	180	135	198	148.5	207	155.25
Medicament	7	7	7.7	7.7	8.05	8.05
Labor						
B. Total Cost (ETB)	**869.92**	**789.75**	**956.91**	**868.73**	**1000.41**	**908.21**
Net benefit (A-B)	**157.58**	**264.42**	-32.16	80.03	-127.03	-12.17
Benefit /Cost Ratio (A/B)	**1.18**	**1.33**	0.97	1.09	0.87	0.99

T1: Treatment 1; T2: Treatment 2

Conclusion and recommendation

Sweet Lupine grain has a potential to be used as concentrate supplement feed in the diets of growing Farta sheep fed on hay as basal feed. Thus, in the mixed crop livestock production system of the study area and similar areas where commercial protein supplement is either inaccessible or expensive sweet blue lupin grain can be used as an alternative home grown supplement feed (protein source) in sheep fattening. Therefore, the result obtained in this experiment should be demonstrated and scaled up to other sweet blue lupin grain producing areas.

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Analysis of Feed Value Chain in Diga District, Western Oromia, Ethiopia

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Abstract

This report provides an overview of the findings of the assessments on livestock production, feed availability, feeding systems and an appraisal of feed value chain in two selected kebeles (Bikila and Arjo Konan Bula) in Diga district and the "Anan Robsan" dairy cooperative members in Nekemte town, western Oromia, Ethiopia. The field survey was conducted during the fourth week of December 2013 and information was gathered from feed producers, feed traders and feed consumers through focus group discussions, structured questionnaire, key informant interviews and own observations. The major types of feeds available in the areas, livestock feeding systems, constraints and opportunities of the prevailing feed utilization systems and illustration of the feed value chain with descriptions of the major actors are given in the report.

Introduction

Ethiopia has numerically the largest livestock resource in Africa. However, both the per capita consumption of animal products and contribution of the livestock sector to the national economy of the country are far below the anticipated potential. The major factor contributing to low performance of the livestock sector is feed shortage in terms of both quantity and quality. The problem of feed shortage is more intense in the mid altitude and highland parts of the country where more than 80% of both the human and livestock population are concentrated. It is thus imperative to tackle feed shortage to ensure economically viable and environmental friendly livestock production. The feed resource base for smallholder livestock producers in integrated crop-livestock farming systems includes feed produced on-farm and feed obtained from other off-farm sources. While roughage feeds are mainly produced on-farm by the farmers, the concentrate feed ingredients are produced as by-products of agro-industries located in different parts of the country and being channeled to the smallholder farmers through various chains. Understanding of the existing situations of feed production, distribution and utilization is essential in order to identify and design proper interventions to improve feed supply, and hence livestock productivity. This requires applications of appropriate system analysis tools including value chain analysis approaches.

In a broader sense, a value chain can be defined as the full range of activities required to bring a given product to final consumers passing through the different phases of production, processing and delivery (IDRC, 2000). It can also be defined as a market-focused collaboration among different stakeholders who produce and market value-added products. The above definition can also apply to the feed value chain and analysis of the feed value chain is essential for an understanding of the core processes, activities and the major actors involved in the chain. It also helps to identify the critical constraints limiting the production, delivery and proper utilization of feeds for improved livestock production. The use of feed value chain analysis is a relatively recent phenomenon especially under Ethiopian conditions. The works of Getu et al (2012) in the dairy-feed value chain and that of Beneberu et al (2012) in the sheep-feed value chain are some of the few efforts which need to be mentioned, but information regarding feed value chain per se is lacking. This study was therefore conducted in two selected rural kebeles of the Diga district and also on "Anan Robsan/~meaning Milk Flood" cooperative members in Nekemte town, east Wollega Zone of Oromia region in western Ethiopia with the following specific objectives to assess the overall aspects of livestock production, feed availability/production and feeding systems in the study sites and to understand, describe the core functions, major actors, activities and constraints associated with the feed value chains in the areas

Methodology

Site description

The study was conducted in two rural kebeles (Arjo Konan Bula and Bikila) of Diga district and the "Anan Robsan" Dairy Cooperative located in and around Nekemte town of East Wollega Zone of Oromia Regional State, western Ethiopia. Diga is one of the 17 woredas (districts) of East Wollega Zone located at a distance of 343km west of Addis Ababa and 15km west of Nekemte, zonal capital of East Wollega. Diga district consists of 21 rural kebeles and 2 special town kebeles. In general, there are 23 kebele administrations and 12 farmers' services cooperatives. The district is categorized into two agro-ecologies the mid-altitude (Woynadega) zone covers 28,939 ha (48.6%) and the lowland zone (Kola) covers 30,606 ha (51.4%) with a mean annual rainfall ranging from 1200 – 2000 mm and temperature range of 18 °C – 32 °C and altitude from 1100 to 2300 masl (District Office of Agriculture and Livestock Agency).

Data collection procedures

A field survey was conducted during the 4th week of December 2013 in order to assess the feed value chain in the district. Two kebeles, namely Bikila and Arjo Konan Bula both characterized by crop-livestock integrated farming systems were selected as focal study sites with the help of district livestock production expert and village level development agents. The selected kebeles, Bikila and Arjo Konana Bula, are located at a distance of about 18 and 34 km, respectively, from Nekemte town. Moreover, members of the "Anan Robsan" cooperative located in and around Nekemte town were also considered as potential target groups in the study. About 17 farmers from Bikila Kebele and 18 farmers from Arjo Konan Bula Kebele who were strategically identified to compose different age groups, land size, farming experience and gender were selected and contacted to collect information from the small-scale feed consumers' perspective. Similarly, 14 members of the "Anan Robsan" cooperative most of which were urban dairy producers in Nekemte town were contacted as sources of information. Gender composition of the sample farmers in the three study sites is was considered. Equal proportions of males and females from the "Anan Robsan" cooperative were involved in the study indicating that the cooperative is composed of a significant proportion of women farmers. Some concentrate feed ingredient producers (oil processors, grain millers) and feed traders operating in Nekemte town were also contacted. A checklist based focus group discussion (FGD), a structured questionnaire based individual interview, key informant interview and personal observations were used for data collection. The collected qualitative and quantitative data were coded and analyzed using the statistical package for social sciences (SPSS version 16).

Results and discussion

Available feed resources and systems of feeding livestock in the areas

Table 6 indicates the major feed resources available for livestock feeding in the study sites as described by the sample households. About 7 categories of different feed resources were available in the areas. In both Bikila and Arjo Konan Bula kebeles, natural pasture, crop residues and roadside grazing in that order of importance constitute the dominant feed resources used for feeding livestock. A considerable proportion of the sample households in Arjo Konan Bula kebele also reported to use planted fodders (mainly of Napier grass and Rhodes grass), conserved feed (crop residues, hay), collected fodder (such as sugar cane tops) and purchased feed for feeding their animals, while small proportions of the respondents in Bikila kebele reported use of these feed resources. On the other hand for “Anan Robsan” cooperative members in Nekemte town, purchased feed and conserved forage (grass hay purchased from the surrounding government compounds like public schools, private holdings, and also baled hay purchased from Sululta area, etc) were the dominant feed resources reported. Moreover, a considerable proportion of the cooperative members also reported that they fed their animals with crop residues, natural pasture (grazing) and planted fodder. In contrast to the case in many other parts of Ethiopia (e.g. the central highlands), the use of “Atela” (a by-product of the local alcoholic beverage) as livestock feed was observed to be less common in the present study areas. This may be attributed to the Protestant Christian religious affiliation of the community who do not consume alcohol, infrequent brewing of local alcoholic beverages, and therefore low supply of the by-product (“Atela”) to use as feed. Generally, in terms of overall availability and contribution to livestock feed supply, natural pasture was reported to rank first followed by crop residue in both Bikila and Arjo Konan Bula kebeles. The 3rd dominantly used feed resource was roadside grazing in Bikila kebele and conserved forage in Arjo Konan Bula kebele. In the case of “Anan Robsan” cooperative members, conserved forage, purchased feed and planted fodders respectively, ranked 1st, 2nd and 3rd in availability and contribution to livestock feeding.

As shown in Figure 4, 100% of the sample households in Bikila kebele reported that sole grazing constitutes the main system of feeding livestock. Similarly, the majority (72.2%) of the sample households in Arjo Konan Bula kebele keep their animals via grazing alone, while the rest (27.8%) use some stall feeding on top of grazing. On the other hand, the main system of keeping livestock by the “Anan Robsan” cooperative members (64.3%) is stall feeding, while the rest 35.7% of the cooperative members use grazing on top of stall feeding. Generally, stall feeding was less developed in the rural setting (Bikila and Arjo Konan Bula kebeles) indicating the low input-low output extensive system of livestock production in the areas as compared to the more market oriented and intensive system of dairy production practiced by the “Anan Robsan” cooperative members in Nekemte town.

Table 1. Major feed resources available/used for livestock feeding in the study areas according to the sample respondents

Feed resource	Proportion of respondents (%)		
	Bikila Kebele (n=17)	Arjo Konan Bula Kebele (n=18)	Anan Robsan Cooperative (n=14)
Natural pasture	100	100	42.8
Crop residues	100	100	50
Road side grazing	100	100	7.1
Collected fodder	11.8	38.9	-
Planted fodder	17.6	61.1	35.7
Conserved forage	29.4	61.1	100
Purchased feed	17.6	33.3	100

On-farm feed production

The types, area harvested and quantities of different feeds produced on-farm by the surveyed households during the last three months prior to the time of this study are shown in Table 7. In Bikila kebele, 17.6, 5.9 and 23.5% of the sample households reported to produce planted fodder, green stover and crop residues, respectively during the specified period. The average area harvested and estimated quantities of feed produced from the different feed types per household in Bikila kebele were: planted fodder (0.09 ha, 0.42 t), green stover (0.01 ha, 0.20 t) and crop residues (0.69 ha, 0.79 t). In total, about 1.41 t feed was estimated to be produced from a total area of 0.79 ha per household in Bikila kebele during the period. Unlike the case in Bikila kebele, comparatively better on-farm feed production was reported in Arjo Konan Bula kebele. About 66.7, 27.8, 22.2 and 50% of the sample respondents in the Arjo Konan Bula kebele reported to produce planted fodder, cut grass/hay, green stover and crop residues, respectively in the last three months prior to this study. The corresponding area harvested and estimated quantities of feed produced from the different feed types per household in Arjo Konan Bula were: planted fodder (0.41 ha, 1.16 t), cut grass (0.32 ha, 0.79 t), green stover (0.71 ha, 2.86 t) and crop residues (0.61 ha, 0.68 t). About 5.49 t total feed was estimated to be produced per household from a total area of 2.05 ha during the specified period. In both the kebeles, the quantity of feed estimated to be produced on-farm per household was very low indicating that livestock in the areas obtain the majority of their feed supply from communal grazing lands.

Some "Anan Robsan" cooperative members also produce different feeds, while the majority were not producing feed due lack of access to farm land. About 28.6, 35.7 and 7.1% of the cooperative members produce planted fodder, cut grass/hay and green stover, respectively. The total area of land devoted to the production of the different feeds per household was 1.44 ha (0.34 ha for planted fodder, 1.00 ha for cut grass and 0.10 ha for green stover). The total feed produced on-farm per household during the last three months prior to this survey was 7.34 t (1.14 t of planted fodder, 5.21 t cut grass and 0.99 t green stover). In addition to the on-farm feed production, about 78.6% of the Anan Robsan Cooperative members in Nekemte town also reported to purchase baled hay from Sululta area via their cooperative. The average quantity of hay purchased by the members was estimated to be about 215 bales (ranging from 15 to 1000 bales) and the average price per bale was about 40 Ethiopian Birr (ranging from 25 Birr during the peak harvesting times to 70 Birr during the dry season and rainy seasons) depending on the season and time of purchase. As one bale on average weighs about 16 kg, it implies that price per kg of grass hay could range from 1.56 to 4.44 Birr indicating that hay can cost as high as or even more than commercial feed ingredients such as wheat bran and noug cake during the dry and rainy seasons. Some respondents of the "Anan Robsan" cooperative also make hay by purchasing the pasture grown in the protected government compounds such as public schools, seed enterprises and also from individual farmers in the surrounding. In this regard, prices were negotiated based on land area and visually assessed stand performance of the pasture.

Table 2. The types, area harvested and estimated quantities of different feeds produced on-farm by the sample households during the last three months prior to this study

Kebele	Feed type	% of respondents	Area (ha)	Quantity produced	
				Donkey cart	Ton*
Bikila (n=17)	Planted fodder	17.6	0.09	6.33	0.42
	Green Stover	5.9	0.01	3.00	0.20
	Dry cereal crop/crop residue	23.5	0.69	18.75	0.79
	Total		*0.79*	*28.08*	*1.41*
Arjo Konan Bula (n=18)	Planted fodder	66.7	0.41	17.50	1.16
	Cut grass/hay	27.8	0.32	12.00	0.79
	Green Stover	22.2	0.71	43.33	2.86
	Dry cereal crop/crop residue	50.0	0.61	16.11	0.68
	Total		*2.05*	*88.94*	*5.49*
Anan Robsan Cooperative (n=14)	Planted fodder	28.6	0.34	17.25	1.14
	Cut grass/hay	35.7	1.00	79.00	5.21
	Green Stover	7.1	0.10	15.00	0.99
	Total		*1.44*	*111.25*	*7.34*

* Estimation in ton was based on the average values of 66 kg (range: 50-85 kg) for 1 donkey cart of green feeds (planted fodder, cut grass, stovers), and 42 kg (range: 30-55 kg) for 1 donkey cart of crop residues as estimated by the farmers

Commercial/purchased feeds utilization

The types, prices and quantities of commercial feeds purchased by the sample respondents during the last three months prior to this study are shown in Table 8. The commercial feed ingredients used by farmers in the area were by-products of different agro-processing industries including noug cake, sunflower cake and wheat bran to some extent. Moreover, grains such as maize and soya bean and grain by-products like pulse hulls were also used for feeding dairy cattle mainly by the "Anan Robsan" cooperative members. The study showed that only small proportion of the sample households in the rural setting (17.6% in Bikila kebele and 33.3% in Arjo Konan Bula kebele) purchase and use noug cake for feeding livestock during the specified period. On average, only 0.27 quintals (Q) of noug cake was purchased per household at the mean rate of 366.7 Birr/Q in Bikila kebele. Including the indicated transport cost, about 106.7 Birr was estimated to be spent on noug cake per household during the specified period in the kebele. The average quantity of noug cake purchased per household in Arjo Konan Bula kebele was found to be 1.04 Q at the rate of 426.7 Birr/Q. The total expense incurred per household for noug cake including the transport and labour costs was estimated to be 461.6 Birr during the specified period in the kebele. The observed differences in prices of noug cake reported by the sample households in the two kebeles may be attributed to the differences in transport cost due to their relative distance from Nekemte town and differences in feed purchase channels used and social relations between the farmers and the feed traders. Generally, the use of commercial feeds has been less developed by the sample households in both Bikila and Arjo Konan Bula kebeles which could be associated with the extensive livestock production and less market-orientation which do not encourage the farmers to spend on the highly expensive commercial feeds.

In contrast to the case at Bikila and Arjo Konan Bula kebeles, the "Anan Robsan" cooperative members in Nekemte town, not only use diverse types of commercial feed ingredients, but also purchase reasonably large quantities of the ingredients. About 6 types of purchased feed ingredients including noug cake (64.3% of the respondents), wheat bran (14.3% of the respondents), sunflower cake (50% of the respondents), maize (50% of the respondents), soya bean (14.3% of the respondents) and pulse hulls from mill houses (71.4% of the respondents) were used by the cooperative members. The average quantities of the different feed ingredients purchased per household during the three months prior to this survey ranged from about 8 Q of pulse hulls to 107.5 Q of soya bean with the corresponding total expense ranging from 2178.4 Birr for soya bean to about 86,225.0 Birr for soya bean. There were some cooperative members who keep as many as 30 head of dairy cattle using a stall feeding system necessitating the use of such large amounts of the commercial feed ingredients. As shown in Figure 5, food processing plants (oil processors, grain millers) and retail shops were the major sources of commercial feed ingredients for the farmers in the study sites. The "Anan Robsan" cooperative members also purchase maize and soya bean from large scale grain retailers in Nekemte town and also from private grain farm owners in the area.

Table 3. The types, quantities and prices of different commercial feed ingredients purchased by the surveyed households during the last three months prior to the time of this study

Kebele	Type of feed purchased	% of respon.	Quantity (Q)	Price (Br/Q)	Transport (Br/Q)	Labour (Br/Q)	Total cost (Br)
Bikila (n=17)	Noug cake	17.6	0.27	366.7	30.0	-	106.7
Arjo Konan Bula (n=18)	Noug cake	33.3	1.04	426.7	24.0	11.2	461.6
Anan Robsan Cooperative (n=14)	Noug cake	64.3	39.67	372.2	28.9	10.6	16,151.0
	Wheat bran	14.3	16.50	300.0	25.0	10.0	5527.5
	Sun flower cake	50.0	44.17	325.0	19.2	9.3	16,165.5
	Maize grain	50.0	91.14	410.0	25.7	9.3	43,331.1
	Soya bean	14.3	107.50	600.0	25.0	10.0	86,225.0
	Pulse hulls	71.4	8.00	261.5	25.0	9.6	2178.4

Home mixing of feeds

The sample households in the three study sites practice home mixing of different locally available and/or purchased feed ingredients into a compound feed prior to feeding their animals. As depicted in Figure 6, 64.7, 61.1 and 71.4% of the sample respondents in Bikila kebele, Arjo Konan Bula kebele and the "Anan Robsan" cooperative members, respectively practice home mixing of feeds. The purpose of mixing the different feed ingredients according to the respondents was to form a compound feed which can supply useful nutrients that help to improve condition of the animal, milk production and power output in the case of draught oxen. Mixing different feed ingredients also helps to improve the quality and intake of the low quality feed resources and by-products, and improves the overall efficiency of feed utilization. The various types/categories of feed ingredients used for home mixing and compound feed preparation according to the sample respondents in the study sites are presented in Table 9. About 11 categories of home mixed feeds prepared by mixing the different feed ingredients and by-products were identified according to the surveyed farmers in the study areas. According to the sample respondents in both Bikila and Arjo Konan Bula kebeles, most of the ingredients used for compound feed preparation were the different grains produced on the farm and their by-products. Maize, sorghum, finger millet and barley grains were the main ingredients used for home mixed feed preparation, while salt was also commonly included in the mixture. It was not possible for the farmers to provide information on the exact proportions of the different ingredients used for preparation of a given compound feed. However, they indicated that the proportions used vary depending on availabilities of the different ingredients, and the more available ingredients account for the higher proportions than the less available ones in the mixture.

The grains are mostly ground, salted, diluted in water and fed to the animal in liquid form mainly to lactating dairy cows. The use of salted and diluted grain flour, mainly barley, for feeding to lactating cows is commonly practiced in Wollega in general and in the study areas in particular. Such liquid feed made from diluted grain flours is locally called “Samadara” in Afan Oromo and mainly used to condition cows following the calving stress and also to stimulate higher milk production. Some of the sample respondents also feed boiled grain mixtures (maize + sorghum) to lactating cows, while some others also feed pancakes of finger millet to fattening and/or working oxen for conditioning/finishing and/or improving the power output. Hence, home-mixed feeds are fed in diluted, boiled and/or solid (cooked or without cooking) forms in the study areas. Generally, farmers in Bikila and Arjo Konan Bula kebeles seem to have a well-established practice of preparing and using home mixed compound feeds using the farm produced and locally available feed ingredients mainly of grains and their by-products. It was reported that 71.4, 64.7 and 61.1% of the farmers in Anan Robsan Copp, Bikila and Arjo Konan Bula respectively, practice home mixing of feeds. This could be considered as a good alternative for the observed low utilization of commercial feed ingredients in the areas. In the case of the “Anan Robsan” cooperative members, purchased concentrate feed ingredients (mainly noug and sun flower cakes and wheat bran), grains like maize and soya bean and grain by-products (mill house scraps and pulse hulls) and salt were the main ingredients used for making home mixed compound feeds. As in the case of Bikila and Arjo Konan Bula kebeles, proportions of the different feed ingredients used for home mixing varies depending on availabilities and costs of the various ingredients. Similarly, the ingredients are mixed and fed in diluted, solid and/or boiled forms.

Table 4. Types of the different feed ingredients used for home mixing according to the respondents in the three study sites

Types of feed ingredients	Bikila Kebele	Arjo Konan Bula Kebele	Anan Robsan Cooperative
1. Ground (maize + sorghum + millet) + salt for lactating cows	□	□	-
2. Ground (maize + sorghum + millet) + Vernonia leaf + salt for lactating cows	□	□	-
3. Salted pan cake of millet for working and/or fattening oxen	□	□	-
4. (Barley + maize) flour salted and diluted in water for lactating cows	□	□	□
5. Barley flour + sugar diluted in water for fattening oxen	□	-	-
6. Boiled (maize + sorghum) + salt for lactating cows	□	□	
7. Ground maize + Noug cake + salt for lactating cows	□	□	□
8. Noug cake + mill house scraps + salt	-	-	□
9. Sunflower cake + pulse hulls + ground maize + salt soaked with water and fed to milking cows	-	-	□
10. Noug cake + wheat bran + pulse hulls + ground maize + salt for milking cows	-	-	□
11. Sole soya bean grain (boiled) for milking cows	-	-	□

Major feed purchase channels and influencing factors

Table 10 indicates the feed purchase practices and the channels used for feed purchase by the sample households in the study areas. On average, about 17.65, 44.44 and 100% of the sample respondents in Bikila kebele, Arjo Konan Bula kebele and the “Anan Robsan” cooperative members in Nekemte town, respectively have experience of purchasing different feed ingredients for feeding their livestock, mainly cattle. The major feed purchase channels used by the sample households include farm level producers (for roughage feeds and grains), oil processing plants, grain millers, small retailers, large retailers and to some extent feed processing plants. This indicates that only a few feed purchase channels are used by households in the rural settings (Bikila and Arjo Konan Bula kebeles) and that oil processing plants are the most important followed by small and large retailers. In the case of “Anan Robsan” cooperative, all the channels described above were used for feed purchase, but with varying extents. The most dominantly used feed purchase channels by the cooperative members in order of importance include oil processing plants (100% of the respondents), grain millers (78.57% of the respondents), farm level producers (78.57% of the respondents) and small retailers (14.29% of the respondents). Overall, oil processing plants followed by grain millers and farm level producers were the important channels used for feed purchase by the sample households in the study areas.

Table 5. Feed purchasing practices and major channels used for feed purchase by the sample households in the study sites (% of respondents)

Question	Response	Bikila Kebele (n=17)	Arjo Konan Bula Kebele (n=18)	Anan Robsan Cooperative (n=14)	Mean
Do you have experience of purchasing feed for your livestock?	Yes	17.65	44.44	100.00	54.03
	No	82.35	55.56	-	45.97
Channels used for purchasing feed					
Farm level producers		-	-	78.57	26.19
Oil processing plants		17.65	44.44	100.00	54.03
Grain millers		-	16.67	78.57	31.75
Feed processing plants		-	-	7.14	2.38
Small retailers		5.88	16.67	14.29	12.28
Large retailers		-	-	7.14	2.38

Some of the major factors influencing the choice of feed purchase channel according to the sample respondents in the study sites are presented in Table 11. The factors influencing choice of the feed purchase channel were more or less similar in the three study sites, but their order of importance varied by site. In Bikila kebele, trust of the system followed by expected price level, price variability and transport costs were the most important factors influencing choice of the feed purchase channel. Similarly, trust of system followed by expected price level, simplicity of system, price variability and social influences were the most important factors influencing choice of the feed purchase by the sample households in Arjo Konan Bula kebele. According to the "Anan Robsan" cooperative members, choice of the feed purchase channel was made primarily based on the expected price level followed by simplicity of system, trust of system, transport costs and price variability. The sample respondents have generally underlined that choice of the feed purchase channel is made by considering combinations of the different factors and that there is no hard and fast rule for choice of supplier.

Table 6. Factors influencing the choice of feed purchase channels according to the surveyed households in the study sites (% of respondents)

Factors	Bikila Kebele			
	1st	2nd	3rd	Overall mean
Expected price level	11.76	5.88	-	5.88
Variability of price	-	5.88	5.88	3.92
Transport costs	5.88	-	5.88	3.92
Simplicity of system	-	-	5.88	1.96
Trust of system	17.65	5.88	-	7.84
Social influence	-	5.88	-	1.96
	Arjo Konan Bula Kebele			
	1st	2nd	3rd	Overall mean
Expected price level	11.11	5.56	11.11	9.26
Variability of price	-	11.11	-	3.71
Security	-	-	5.56	1.85
Simplicity of system	5.56	11.11	5.56	7.41
Trust of system	16.67	11.11	5.56	11.11
Social influence	5.56	-	5.56	3.71
	Anan Robsan Cooperative Members			
	1st	2nd	3rd	Overall mean
Expected price level	50.00	14.28	21.43	28.57
Variability of price	7.14	7.14	7.14	7.14
Transport costs	7.14	7.14	14.28	9.52
Payment arrangements	-	7.14	-	2.38
Simplicity of system	21.43	14.28	28.57	21.43
Trust of system	14.28	21.43	28.57	21.43
Social influence	-	7.14	-	2.38

The major constraints limiting the use of concentrate feeds/ingredients for feeding livestock in the study sites as perceived by the sample households are shown in Table 12. The constraints identified in all the study sites were more or less similar and mainly related to prices, transportations, market access and supply of the ingredients, farmers' knowledge regarding the feeds and financial limitations. In Bikila kebele, some of the top ranking constraints limiting the use of concentrate feed ingredients included high cost of the feeds, poor access to markets, poor knowledge of feeds and high transportation costs. According to the sample respondents in Arjo Konan Bula kebele, poor knowledge of feeds, high feed costs, poor access to markets and high variability in feed prices were the important factors limiting the use of concentrate feeds. Moreover, the present assessment indicated that the livestock production system in both Bikila and Arjo Konan Bula kebeles was extensive mainly based on free communal grazing and the cattle raised by the surveyed farmers were local Zebu breeds. Hence, this could be another important factor limiting the use of concentrates in areas.

In the case of the "Anan Robsan" cooperative members, about 9 factors were reported to limit the use of concentrate feeds. Some of the high ranking constraints emphasized by the cooperative members include high variability in feed prices, high feed costs, high transportation costs, poor access to market and poor knowledge of feeds in that order of importance. Some other constraints mentioned by the cooperative members, but not by respondents in Bikila and Arjo Konan Bula kebeles include poor distribution arrangements, lack of feed quality control and seasonality in milk production. Despite all these limitations, it was noted that all the responding "Anan Robsan" cooperative members were using one or more of the concentrate feed ingredients for feeding dairy cattle. This could be attributed to the fact that they have been engaged in market-oriented dairying and also their better access to markets and information regarding improved practices as compared to the farmers in the rural setting (Bikila and Arjo Konan Bula kebeles).

Table 7. Major constraints in using concentrates as perceived by the surveyed households in the study sites (% of respondents)

Constraints	Bikila Kebele			
	1st	2nd	3rd	Overall mean
High cost of feeds	52.94	35.29	-	29.41
High variability in prices	-	5.88	5.88	3.92
High transport cost	5.88	23.53	23.53	17.65
Poor access to markets	23.53	23.53	17.65	21.57
Poor knowledge of feeds	17.65	5.88	41.18	21.57
Lack of literacy & numeracy of farmers	-	5.88	-	1.96
Lack of finance	-	-	11.76	3.92
	Arjo Konan Bula Kebele			
	1st	2nd	3rd	Overall mean
High cost of feeds	44.44	22.22	-	22.22
High variability in prices	5.56	16.67	11.11	11.11
Poor access to markets	27.78	22.22	5.56	18.52
Poor knowledge of feeds	5.56	27.78	55.56	29.63
Poor distribution arrangements	-	11.11	5.56	5.56
Lack of literacy & numeracy of farmers	16.67	-	-	5.56
Seasonality in milk production	-	-	11.11	3.70
Lack of finance	-	5.56	11.11	5.56
	Anan Robsan Cooperative Members			
	1st	2nd	3rd	Overall mean
High cost of feeds	64.29	7.14	-	23.81
High variability in prices	21.43	42.86	14.28	26.19
High transport cost	7.14	14.28	14.28	11.90
Poor access to markets	-	21.43	7.14	9.52
Poor knowledge of feeds	-	7.14	21.43	9.52
Poor distribution arrangements	-	7.14	7.14	4.76
Seasonality in milk production	-	-	7.14	2.38
Lack of quality control	-	-	14.28	4.76
Lack of finance	7.14	-	14.28	7.14

Table 7 shows some of the potential opportunities perceived to enhance utilization of concentrate feeds in the view of the sample respondents in the study sites. According to the sample households in both Bikila and Arjo Konan Bula kebeles, changing production practices, expanding livestock enterprise and increase in milk production were some of the major opportunities available to enhance the use of concentrates. Moreover, improvement in efficiency of the producers' enterprise and increased current returns to justify future expansion were the other opportunities which will necessitate using concentrates for feeding selected productive animals. In the case of the "Anan Robsan" cooperative members, improved efficiency of the producers' enterprise, expanding livestock enterprise, increase in milk production and changing production practices in that order of importance were the major opportunities available to enhance the use of concentrates. These groups of dairy producers also have comparatively better access to markets (both to purchase concentrate feed ingredients and also to sell milk and other dairy products at a reasonably premium price as compared to farmers in the rural setting). As a result, the use of concentrates for feeding dairy cattle was observed to be a well-established practice among the cooperative members.

Table 8. Available opportunities for enhancing use of concentrates as perceived by the surveyed households in the study sites (% of respondents)

Constraints	**Bikila Kebele**			
	1st	2nd	3rd	Overall mean
Expanding livestock enterprise	70.59	17.65	11.76	33.33
Improved feed access to livestock farmers	-	11.76	-	3.92
Changing production practices	29.41	58.82	35.29	41.17
Own enterprise becoming more efficient	-	-	5.88	1.96
Increase in milk production	29.41	11.76	47.06	29.41
	Arjo Konan Bula Kebele			
	1st	2nd	3rd	Overall mean
Expanding livestock enterprise	55.56	11.11	5.56	24.08
Improved feed access to livestock farmers	-	5.56	-	1.85
Changing production practices	16.67	44.44	16.67	25.93
Own enterprise becoming more efficient	11.11	11.11	27.78	16.67
Increase in milk production	5.56	5.56	44.44	18.52
Increasing current returns to justify expansion	11.11	22.22	-	11.11
	Anan Robsan Cooperative Members			
	1st	2nd	3rd	Overall mean
Expanding livestock enterprise	42.86	14.28	28.57	28.57
Improved feed access to livestock farmers	7.14	-	7.14	4.76
Changing production practices	7.14	42.86	-	16.67
Own enterprise becoming more efficient	14.28	28.57	21.43	64.28
Increase in milk production	21.43	14.28	35.71	23.81
Increasing current returns to justify expansion	7.14	-	7.14	4.76

Information regarding advisory services and the nature of the advice, and major sources of information to the farmers on feed related issues were also assessed in the study. As shown in Table 14, all the sample respondents (100%) in Bikila and Arjo Konan Bula kebeles, and 28.57% of the interviewed "Anan Robsan" cooperative members obtain some advisory services related to feeds. The average frequency of advisory services offered to the farmers was between 1 to 2 times per month in the three sites. However, the sample households have underlined that advisory service interactions are not specifically organized for feed per se, but are general encompassing the overall agriculture and social aspects among which feed related issues are also addressed. The nature of advice provided to the farmers was noted to be relatively general focusing on proper management of available feed resources and proper feeding systems of livestock. The major sources of information to the farmers were mainly government extension staff, and to some extent research institutions (such as Bako Research Center) and the currently on-going projects in the areas by ILRI.

Table 9. Reactions of the surveyed households regarding sources of information and advisory services related to feeds

Issue	Bikila Kebele	Arjo Konan Bula Kebele	Anan Robsan Cooperative
Get advice related to feeds (% of respondents)	100	100	28.57
Frequency of advice obtained per month	1.82	1.12	1.25
Visit other farmers` fields (% of respondents)	35.29	77.78	35.71
Number of visits made per HH in the last 12 months	3.33	4.00	3.80
Nature of advice obtained from service providers	Proper management of available feeds Proper feeding systems		
Major sources of information	Government extension staff (DAs, woreda experts) Research institutions (such as Bako) On-going projects by ILRI		

Visiting other farmers' fields and sharing best available experiences were also used as other important sources of information by surveyed farmers in the study sites. Accordingly, 35.29% of the respondents Bikila kebele, 77.78% of the respondents in Arjo Konan Bula kebele and 35.71% of the interviewed "Anan Robsan" cooperative members visit other farmers' fields in their surroundings. The average number of other farmers' fields visited per household during the last 12 months prior to the time of this study was 3.33 in Bikila kebele, 4.00 in Arjo Konan Bula kebele and 3.80 in the case of the "Anan Robsan" cooperative members. Particularly the sample respondents in Bikila and Arjo Konan Bula kebeles emphasized that they have been sharing best experiences and different ways of doing things from those farmers displaced from Hararghe (eastern Oromia) and settled in the areas. The well-developed cattle fattening practice by the Hararghe farmers could be cited as one exemplary experience to be adopted by the local farmers in the present study areas.

Core functions, actors and activities in the feed value chain

In Diga area, livestock feeds were observed to be sourced in two ways: through on-farm production (for crop residues, native grass hays and improved forages, the latter being practiced rarely) and through purchases for feeds such as oil seed cakes, pulse grain hulls, mill house scraps, locally obtainable native grass hays and baled hay from Sululta area. Purchase of baled hay from Sululta area is practiced by the few relatively big dairy farms in and around Nekemte. The appraisal generally indicated that there is no formal and well organized input supply, production, distribution, marketing and consumption of feeds in the study areas. The informal chain was observed to be composed of five main segments: input supply, production, transport and marketing, feed storage and processing, and finally consumption. A concise account of the important features of each segment in the value chain is described in the following sections. A generic schematic diagram depicting the peri-urban dairy feed value chain in the study sites is given in Figure 7.

Input supply

Major inputs used for on-farm feed production include forage seed, labour for on-farm activities and fencing materials for native hay production plots, the latter often sold to peri-urban dairy farmers. A range of cereals, oil and pulse crops produced in the area also serve as important inputs used by small scale oil and flour processing mills, contributing to the supply of byproducts like hulls, cakes and mill house scraps. Feed grains like maize and soybeans were also observed to be sourced from large scale commercial farms and grain traders operating in the area. Similarly, cereal grains such as finger millet, sorghum, maize and teff are used as input in the preparation of traditional alcohols from which a range of dregs or lees, generally named '*atela*', are obtained. Use of chemical fertilizers as input for improved forage and native grass hay production was not a common practice.

Feed production

The actors involved in feed production consist of crop farmers (supplying mainly teff and finger millet straws), opportunistic hay producers (farmers who set aside some land for native hay production targeting mainly peri-urban dairy farmers, and grass hay inadvertently produced on school and church compounds, and oil and flour processors supplying hulls, cakes and mill house scraps as by-products. Smallholder peri-urban dairy farmers were observed to apportion a piece of land for improved forage crops and production of native grass hays. Concentrate feed processing plants and concentrate feed retailing businesses are not available in the area. Some dairy farmers buy baled hay and wheat bran from other areas, the former mainly from areas around Addis Ababa. '*Atela*', a byproduct obtained from processing of traditional alcohols is an important ingredient fed to dairy animals alone or mixed with noug seed cake or brans. Maize and soybean grain are also used by a few peri-urban dairy farmers in Nekemte area and these ingredients are sourced mainly from grain traders at both sites; and mainly from investors owning large scale commercial farms. Generally, it was widely agreed that available feed does not match with the prevailing demand, be it for roughage or concentrate feeds. Shortage of land, low technical know-how on improved forage production and financial constraints mainly for purchase of ingredients were indicated to be important problems. Rural farmers in the study area use mainly native pasture grazing for their animals and they indicated that termite and weed infestation and urban encroachment to be critical problems affecting productivity of the native grasslands.

Transport

At farm level, on-farm produced feeds are collected and carried by family labour, mainly by boys and household heads. Donkeys and humans are predominantly used for transporting cereal straws from nearby rural sites for sale to peri-urban dairy farmers. It is also common for women to transport teff and finger millet straw on their backs for sale to peri-urban dairy farmers. Trucks are used to transport loose hay produced at relatively distant sites on privately owned or rented-in land or on fenced compounds of different organizations. In situations where the hay production site is close by, carts pulled by mules are commonly used. A small number of dairy farmers who are members of Anan Robsan Dairy Cooperative use trucks to transport purchased feeds like baled hay and concentrates from Addis Ababa.

Marketing

A range of roughage and concentrate feeds are purchased for peri-urban dairy cattle feeding. Noug cake is a protein supplement used on a large proportion of the dairy farms as reported by the dairy farmers. The price of this concentrate ingredient is increasing steadily, and this rise in price is one of the factors troubling the peri-urban dairy business in Nekemte. Other concentrate feed ingredients like hulls and mill house scraps are also commonly used feeds and are purchased almost throughout the year. Among the crop residues, the cost of teff straw was perceived to be high compared to finger millet and the price of cereal straws was observed to generally exhibit variation across seasons of the year. In general, price falls just after crop harvest and reaches its peak during the rainy months. The majority of Anan Robsan Dairy Cooperative members reported that feed prices have significantly increased over recent years, with a significant proportion of the income obtained from milk sales going to feed purchase.

Storage

Under mixed crop-livestock conditions, cereal straws meant for sale to peri-urban dairy farmers or for home consumption are collected and conserved in stacks in the open or under trees on raised wooden beds. After purchase, the residues are commonly stored by peri-urban dairy producers under roof in loose form to avoid risks of spoilage by rain water and other farm wastes. Some farms were also observed to store teff and finger millet straws indoors, packed in plastic or sisal bags on concrete floor or on raised wooden beds.Grass hays are stored under the roof where space is available; but they are commonly stored in the open with the heap covered using plastic sheets to avoid moisture induced damage and shattering losses. Concentrate feeds are generally stored in sisal or polyethylene sacks under shade. At a number of farms, some risks of spoilage were noticed as feeds are normally stored in proximity to the dairy barn. Feed contamination with urine and other farm wastes was also observed to be common. This could be a serious herd health threat mainly when concentrate ingredients like hulls, grains, beans and brans are contaminated by urine and wet manure.

Processing and utilization

Processing and utilization of feeds purchased from various sources were observed to vary slightly with the type of farms visited. Chopping of grass hays and mixing of different feed ingredients before feeding are widespread across the sites. Cereal straws are commonly fed as acquired but since grass hays commonly used at both locations are dominated by late harvested native stands, typically *Hyparrhenia* species, presenting to the animals in their harvested form is not appropriate. As a result, farmers indicated that they chop grass hays into shorter lengths using sharp edged tools before feeding.

A few farmers also practice sprinkling water, salt solution or liquefied '*atela*' on chopped hays, and crop residues before feeding. Moreover, noug cake is usually mixed with '*atela*' before it is fed to animals. Hulls of various pulse crops, brans and scraps bought from mill houses are, however, fed in the form they are acquired. A few farms use feed troughs made of concrete materials while the majority of smallholder peri-urban farms use feeding troughs made of wooden poles and nails, disposed plastic materials, barrels and tree trunks prepared in various shapes.

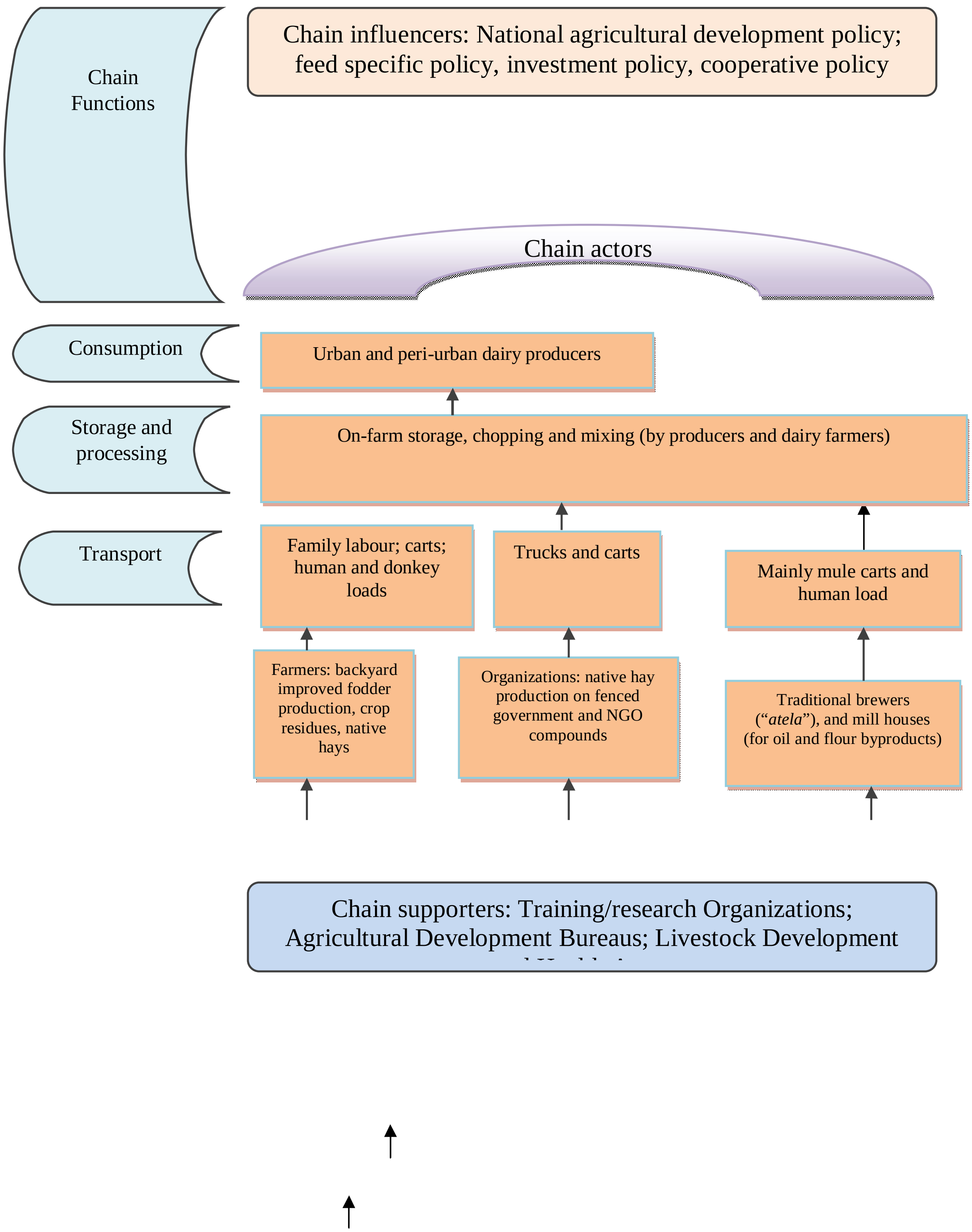

Figure 1. Schematic diagram depicting the feed supply chains in Diga and Nekemte areas

Conclusions

Cattle are the dominant livestock species reared and natural pasture and crop residues constitute the major feed resources available in the study areas.Livestock feeding is mainly based on sole grazing in Bikila and Arjo Konan Bula kebeles, while some farmers also feed selected groups of cattle such as lactating cows and working oxen indoors using feeds produced on the farm (crop residues, native pasture hay and improved fodders). On the other hand, stall feeding using purchased feeds (both roughages and concentrates) is the main feeding system of dairy cattle by the "Anan Robsan" cooperative members in Nekemte town.

Livestock production in general and dairy production in particular is extensive in nature with minimal market orientation in Bikila and Arjo Konan Bula kebeles. Consequently there is low utilization of bought-in concentrate feed ingredients for supplementation compred to the case of the "Anan Robsan" cooperative members. However, there is a well-established practice and use of home mixed compound feeds using farm produced grains and/or grain by-products in the areas. The major constraints identified by the feed value chain actors in the study sites include: seasonal shortages in supply of required inputs, shortage of food processing plants and/or performance of the existing ones below their capacity, unreliable electric power supply, limited supply and high cost of the feed ingredients (by-products), lack of awareness on input quality and associated risks, lack of feed quality standards, poor knowledge of feeds and feed markets, and the overall lack of capacity to initiate feed related interventions.

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Analysis Feed Value Chain in Lemo District of Hadiya Zone, SNNP Region, Ethiopia

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Abstract

This report highlights results of assessment of feed production, marketing and utilization and an analysis of the feed value chain in three villages (Jawe, Upper Gana and Hayse) of Lemo district of Hadiya zone, SNNPR, south central Ethiopia. Information used in this report was collected through focus group discussions and individual interviews with feed producers, traders and consumers and visual observations. A focus group discussion was carried out with a group of 17 representative farmers in Jawe, 19 farmers in Gana and 3 dairy producers in Hayse villages. Selection of farmers for group discussion took into account wealth status (land holding), gender, age, farming experience, knowledge of the participant about the farming system in the area and the level of education. Results showed that grazing plus some stall feeding was the dominant system of livestock keeping in Jawe and Gana, followed by mainly stall feeding and some grazing in Jawe (25%) and mainly grazing (33%) in Gana. Overall, crop residues (24%), natural pasture (23%) and collected fodder (18%) were the main sources of livestock feed pooled over the two sites. The number of animals owned by each family was observed to be low. Farmers in Jawe and Gana, rural kebeles or villages that are far away from Hosaina town, indicated that they occasionally purchase feed, while those in Hayse indicated that they purchase regularly. Farmers purchase feeds in varying amounts from feed retailers in Hosaina town and from Licha Hadiya Farmers Cooperative Union, which owns a flour mill and a small feed processing plant. However, a private flour factory in Hosaina indicated that it disfavors retailing in small quantities, and thus delivers its feed products to retailers. The respondents indicated difficulty of access to credit for feed purchase. Though Omo and Wisdom Micro-finance Institutions were reported to operate in the area, the borrowing process seems unfavorable. For the feed processed at Licha Coop Union, 75% of the ingredients are wheat bran produced at its own flour mill, while oil seed cakes and other ingredients are obtained from Addis Ababa area. Buyers of feed products from the firms include: dairy farmers in Hosaina town and its environs, some rural farmers, research centers, and some individuals engaged in occasional fattening activities. The feed processing plant of Licha Coop Union complains of low demand for feed and frequent power interruption as problems whereas the smallholder farmers in Jawe and Gana and the dairy farmers in Hayise reported difficulty of access to feed (not available in their vicinity, transport problem and high price of feed when available) as the main constraints to purchased feed use.

Introduction

In Ethiopia, the economic contribution of the livestock sector is low owing to a number of constraints (Chanyalew *et al*., 2009). Among these, feed shortage is considered to be very important (EEA, 2006). Thus it is vital to address this constraint if improvements in livestock productivity are to be achieved. To design feed interventions, appropriate entry points need to be identified at the outset before strategies are put in place. This requires appraisal of the existing production systems through appropriate system analysis tools such as value chain approaches. A commodity value chain encompasses a full range of activities and services required to bring a product from its production to sale in its final markets (Anandajayasekeram and Gebremedhin, 2009; Ayele *et al*., 2012). It includes input supply, production, retailing and consumption. At one end are the producers who raise the animals and at the other end are the consumers who consume the livestock products, and in the middle stages are other actors undertaking activities in the middle of the value chain. Value chains may also include a range of services needed to maintain function including technical support (extension), business enabling and financial services, innovation and communication and information brokering. Value chains can be simple when producers directly sell to the consumers but long and complex when other actors play roles in buying, processing, transporting and selling to the end user.

The approach value chain approach facilitates mapping and characterization of feed production activities, and identification of the actors involved and their roles and the nature of the interaction between them (Anandajayasekeram and Gebremedhin, 2009; Rich *et al*. 2011). Value chain analysis focuses on issues of value creation and market opportunities and linkages. The use of this framework for analyzing feed value chains is a recent experience in Ethiopia. Based on the existing realities, feed value chains may consist of various functions such as input supply, production, processing, marketing and consumption. They may also consist of a range of enablers and supporters interacting within the borders of a given locality or beyond borders in different ways to sustain the operation of the entire value chain. This suggests the need to visualize the input supply, production, marketing and utilization of feed through a value chain lens to better understand the constraints and to be able to put in place appropriate value chain improvement strategies. The present study was undertaken to understand livestock feed value chains in Lemo district of Hadiya zone based on case studies at three villages in the district. The study had the following specific objectives of appraising important features of livestock production activities and characterize the crop-livestock production systems of the area, to map the feed value chain functions and identify actors involved along the chain.

Materials and methods

Description of the study site

The current appraisal was undertaken at Jawe, Upper Gana and Hayse kebeles of Lemo district of Hadiya zone, Southern Nations, Nationalities and Peoples Regional State (SNNPR), south central Ethiopia. Hadiya Zone in general and Lemo district in particular are among the most intensively cultivated and densely populated areas of Ethiopia. Enset based mixed crop-livestock production is the main agricultural production system. The major crops produced in the area include enset, wheat, barley, tef, faba bean and potato. The farmers also keep different types of livestock including cattle, sheep, goats, equines and poultry.

Research methodology

Information used in this report was collected through focus group discussions and individual interviews with feed producers, traders and consumers as well as visual observations in the area. A focus group discussion was carried out with 17 representative farmers in Jawe village and a group of 19 farmers in Upper Gana (to be referred to hereafter as Gana) and 3 dairy producers in Hayse village. Selection of farmers for group discussion took into account wealth status (land holding), gender, age, farming experience and level of education of the farmers. During the group discussion, the farmers were allowed to debate and the final note was taken when the group reached consensus concerning the issue under discussion.

In addition to the smallholder farmers in Jawe and Gana and the dairy farmers in Hayse kebeles, producers of feed ingredients such as oilseed cake (one oil processing plant) and wheat bran (Sifona Flour Mill and flour mill of Licha Hadiya Cooperative Union) and compound feed (Licha Coop Union Feed Processing Plant) and two feed traders were also interviewed about production and marketing of feeds and associated issues. The data gathered through focus group discussions were categorized into thematic areas and logically structured, described and discussed. The quantitative information collected from individual interviews was analyzed and summarized using descriptive statistics.

Results

Feeds and feeding systems

Information on livestock feeding system in the area is presented in Figure 1. Grazing plus some stall feeding was the dominant livestock feeding system practiced by 50% of the respondents in both Jawe and Gana villages. This was followed by 'mainly stall feeding and some grazing' in Jawe (25%) and by 'mainly grazing' (33%) in Gana. The ranking of the major feed resources in the study villages as captured from the perception of the interviewed farmers are presented in Table 2. About 75% of the farmers in both Jawe and Gana reported that natural pasture is the main feed resource in their area. On the other hand, 25% of farmers in Jawe and 17% farmers in Gana reported crop residues as the main feed whereas 63% of the farmers in Jawe and 67% in Gana indicated that crop residues are the second most important feed resources in the area. Livestock feeds in the two sites are sourced mainly from crop residues and natural pastures. This concurs with other reports from mixed-crop livestock production systems where the contribution of crop residues was considerable in feeding livestock (Assefa, 1999; Mengistu, 2004; Tolera, 2007). Similarly, the potential use of crop residues as livestock feed was greatest in mixed crop-livestock farming systems of the highlands (Eshete, 2002). Roadside grazing and collected fodder are the next most important feed resources for both Jawe and Gana kebeles. Overall, crop residues (24.22%), natural posture (23.44%) and collected fodder (17.97%) were the main sources of livestock feed pooled over the two sites.

Table 1. Major feed resources for livestock as perceived by the respondent farmers (% of respondents)

Feed type	Jawe					Gana			
	1st	2nd	3rd	4th	Overall	1st	2nd	3rd	4th
Natural pasture	75.0	12.50	0.00	0.00	75.0	25.0	0.0	0.0	23.44
Crop residues	25.0	62.50	6.25	0.00	16.7	66.7	16.7	0.0	24.22
Collected fodder	0.0	6.25	25.00	37.50	8.3	0.0	8.3	58.3	17.97
Roadside grazing	0.0	6.25	31.25	18.75	0.0	8.3	58.3	0.0	15.36
Purchased feed	0.0	6.25	6.25	25.00	0.0	0.0	0.0	16.7	6.77
Planted forage	0.0	6.25	25.00	6.25	0.0	0.0	0.0	16.7	6.77
Enset by products	0.0	0.00	6.25	6.25	0.0	0.0	0.0	0.0	1.56
Conserved forage	0.0	0.00	0.00	6.25	0.0	0.0	16.7	8.3	3.91

The number of animals owned by each family was observed to be low . The average number of livestock holding per household was higher in Jawe than in Gana. In both villages the herd structure is dominated by oxen because of their importance as sources of draught power for farm operations (land preparation and threshing) in the smallholder mixed farming system. It was also reported that most farmers own chickens with a mean of 4.71 birds at Jawe and 4.75 birds in Gana.

The mean area of land (in ha) from which livestock feed resources were collected during the three months preceding the time of this study is presented in Table 3. Land under improved forage species was observed to be generally low (0.04 ha at Jawe and none at Gana). Native grass hay was collected from 0.09 and 0.08 ha at Jawe and Gana, respectively. Green maize stover after green cob harvest is collected from an area of land of 0.08 in Jawe and 0.09 ha in Gana. The study also showed that farmers allocate more land to small cereals (wheat, barley and tef) from which straws used for livestock feed are collected. Accordingly, it was indicated that straws were collected from an area 0.59 and 0.58 ha of land at Jawe and Gana, respectively. Regarding concentrate ingredients, over the three months preceding this study, farmers purchased an average of 65.5 kg and 21.83 kg of wheat bran at Jawe and Gana villages, respectively. In the same way, limited number of farmers practice home mixing of feeds, the frequency being 31.25% and 16.67% for Jawe and Gana, respectively (Table 2).

Table 2. Area of land (in ha) from which various types of feed were collected (in the three months preceding this study date) and quantity (in kg) of concentrate ingredient purchased (3 months estimate)

Category feed	Villages	
	Jawe	Gana
Planted forage (ha)	0.04	0.00
Cut native grass (ha)	0.09	0.14
Green stover, mainly maize (ha)	0.08	0.09
Dry straws small cereals like wheat, barley and tef (ha)	0.59	0.58
Bran (kg)	65.5	21.83
Farmers reported practicing home mixing of feeds (%)	31.25	16.67

Table 3 shows the purchase channels for livestock feed in the study sites. Accordingly, 33% of the farmers buy feeds from farmer (producers) in their surroundings. Purchase of concentrate ingredients from small retailers, large retailers and large scale flour producers were reported by 24%, 9.4% and 3.1% of the respondents. None of the farmers from either kebele reported purchase of feed from grain millers, oil processors, feed processors and wholesalers.

Table 3. Purchase channels (% of respondents reporting on the specific purchase channel used)

Channel	Village		Overall mean
	Jawe	Gana	
Producers (farms)	25.00	41.67	33.3
Small retailers	31.25	16.67	24.00
Large retailers	18.75	0.00	9.40
Flour processors	6.25	0.00	3.10

At Jawe, selection of feed purchase channel mainly depended on transport cost (22.92%), trust (20.83%) and simplicity (12.5%) of the system (Table 5). The study showed that 12.5% of the farmers have no insight regarding the factors influencing the selection of purchase channel which could imply that these farmers are not using any purchased feed on their farm. In the same way, at Gana, farmers indicated that simplicity of the channel (13.9%) followed by transport cost (11.1%) influence the choice of feed purchase channel. Around 25% of the farmers interviewed at this site did not have a clear understanding of the factors affecting purchase channel. In both sites, problems associated with finance and price volatility were indicated to prevail widely.

Table 4. Factors influencing choice of feed purchase channel as conceived by the respondents in the study villages

Factors	Jawe			Mean
	1st	2nd	3rd	
Availability	6.25	0.00	0.0	2.08
Expected price level	6.25	18.75	6.3	10.42
Lack of money	12.50	0.00	0.0	4.17
I have no insight	12.50	12.5	12.5	12.50
Security	6.25	0.00	0.0	2.08
Transport cost	25.00	12.50	31.3	22.92
Trust of the system	12.50	18.75	31.3	20.83
Variability of price	6.25	0.00	0.0	2.08
Simplicity of the system	0.00	25.00	12.5	12.50
Quality	0.00	6.25	0.0	2.08
Social influence	0.00	0.00	6.3	2.08
	Gana			Mean
	1st	2nd	3rd	
Expected price level	25.0	0.0	0.0	8.3
I have no insight	25.0	25.0	25.0	25.0
Transport cost	8.3	8.3	16.7	11.1
Trust of the system	0.0	0.0	41.7	13.9
Variability of price	8.3	25.0	0.0	11.1
Simplicity of the system	0.0	33.3	8.3	13.9
Not available	33.3	0.0	0.0	11.1
Increase throughput	0.0	8.3	0.0	2.8
Timing of purchase	0.0	0.0	8.3	2.8

Constraints associated with concentrate feeding as ranked by the farmers interviewed are presented in Table 4. At Jawe, 27.1% indicated that high cost of concentrate is a critical challenge. Lack of financial resources (25%), high transport cost (18.8%) and poor access to concentrate feed (16.7%) were also very critical. A similar situation was also observed in Gana, with high feed cost (27.8%) and lack of knowledge about the benefits of concentrates (19.4%) and poor access to market (22.2%) being important factors. The rising price of concentrate feeds and their increasing transaction costs as viewed by farmers in the present study sites was also in agreement with observations documented earlier (Geleti *et al*., 2012).

Table 5. Constraints in feeding concentrates as ranked by respondents (% of respondents ranking the indicated constraints)

Jawe	1st	2nd	3rd	Mean
High cost of feeds	18.75	43.75	18.75	27.1
High variability in prices	6.25	0.00	6.25	4.2
Lack of finance	56.25	18.75	0.00	25.0
Poor knowledge of feeds	12.5	12.5	0.00	8.3
Poor access to market	6.25	0.00	43.75	16.7
High transport cost	0.00	25.00	31.25	18.8
Gana				
High cost of feeds	33.33	8.3	41.67	27.8
High variability in prices	0.00	33.3	0.00	11.1
Lack of finance	8.33	8.3	16.67	11.1
Poor knowledge of feeds	25.00	25.0	8.33	19.4
Poor access to market	33.33	16.7	16.67	22.2
High transport cost	0.00	8.3	8.33	5.6
Supply problem	0.00	0.00	8.33	2.8

Table 6. Perceptions of farmers regarding the opportunities for enhancing the use of concentrates

Jawe	1st	2nd	3rd	Mean
Changing production practices	12.5	6.25	43.75	20.83
Expanding livestock enterprises	18.75	18.75	0.00	12.50
Improved feed access to livestock farmers	43.75	12.5	0.00	18.75
Improving quality	6.25	0.00	12.5	6.25
Increase in milk production	18.75	37.5	12.5	22.92
Own enterprise becoming efficient	0.00	25	6.25	10.42
Lack of natural pasture as trigger	0.00	0.00	25.00	8.33
Gana				
Changing production practices	25.00	16.67	8.33	16.67
Expanding livestock enterprises	8.33	0.00	33.33	13.89
Improved feed access to livestock farmers	8.33	16.67	8.33	11.11
Improving quality	0.00	16.67	0.00	5.56
Increase in milk production	16.67	16.67	16.67	16.67
Own enterprise becoming efficient	8.33	8.33	16.67	11.11
High demand for feed	16.67	0.00	0.00	5.56
Increasing current returns to justify expansion	16.67	25.00	16.67	19.44

Farmers also reflected their views on the potential opportunities that could trigger the use of concentrate feeds in the area (Table 8). At Jawe, increase in milk production (22.92%), changing production practices (20.83%) and improved feed access to livestock farmers (18.75%) were some of the opportunities they think would enable use of concentrate feeds. At Gana, increasing current returns to justify expansion (19.44%), changing production practices (16.67%) and increase in milk production were suggested to be potential opportunities that would enhance integration of concentrate feed ingredients in livestock feeding system. The present appraisal also indicated that concentrate feed ingredient and improved forage production and utilization is triggered more when integrated with market-oriented activities (example dairy production in Hayse site) where use of concentrate and improved forage production and utilization was widespread. This also concurs with the claims of Ayele *et al*. (2012) and Ergano *et al*. (2010) who stressed that feed interventions would be better enabled when integrated with market oriented livestock commodities but was at variance with what was observed for introduced forages by others (Geleti *et al*., 2014).

Essential features of the feed value chain

The important features of feed value chain based on information gathered during the group discussion are presented in Table 7.

Table 7. Essential features of feed value chain activities at selected rural sites in Hadiya zone based on discussion with consumers at three sites

Issue	Sites		
	Jawe	Layignaw Gana	Hayse
Feed purchasing practices	Occasionally	occasionally	Regularly
Commonly purchased concentrate ingredients	Dominantly oil seed cakes and wheat bran	Dominantly oil seed cakes and wheat bran	Cakes and wheat bran, and compound dairy feeds are purchased
Feed price setting	No price negotiation; price fixed by the retailers	No price negotiation; price fixed by the retailers	No price negotiation; price fixed by the retailers
Feed price variability	Low price in the dry seasons; high price during wet seasons	Low price in the dry seasons; high price during wet seasons	Low price in the dry seasons; high price during wet seasons
Quality assessment	Sensory (smelling, touching, observing); physical form of the ingredients (brans vs. short, for example); inspection for mould development and dampness	Sensory (smelling, touching, observing); physical form of the ingredients (brans vs. short, for example); inspection for mould and dampness	Sensory (smelling, touching, observing); physical form of the ingredients (brans vs. short, for example); inspection for mould development and dampness
Extent of use of concentrate ingredients	low; triggered largely by targeted fattening activities and dairy production;	low; triggered largely by targeted fattening activities and dairy production;	High, due to the widespread use of improved dairy cattle in the area
Common types of	Straws; enset and its	Straws; enset and its	Straws; enset and its

Issue	Sites		
	Jawe	Layignaw Gana	Hayse
feed purchased from local sources	residues; *atela*; for enset byproducts price of *corm* > *pseudostem* > leaves	residues; *atela*; for enset byproducts price of *stem* > *pseudostem* > leaves	residues; *atela*; for enset byproducts price of *corm* > *pseudostem* > leaves
Feed packaging	Flour mills and oil processing plants normally package brans and oilseed cakes in 50 kg sacks. But retail shops can sell in smaller quantities if the buyers come with their own containers.	Flour mills and oil processing plants normally package brans and oilseed cakes in 50 kg sacks. But retail shops can sell in smaller quantities if the buyers come with their own containers.	Flour mills and oil processing plants normally package brans and oilseed cakes in 50 kg sacks. But retail shops can sell in smaller quantities if the buyers come with their own containers.
Finance for feed purchase	No access to credit for feed purchase; Omo and Wisdom micro-finance institutions operate in the area, but the process was inauspicious	No access to credit source for feed purchase; Omo and Wisdom micro-finance institutions operate in the area, but the process was inauspicious	Have access to credit source; they reported to get credit from the milk processing cooperative owned by the dairy farmers in this site
Issues considered in selection of feed supplier	ease of access; quality of the product supplied; favorable price; willingness to offer credit	ease of access; quality product; favorable price; willingness to offer credit	ease of access; quality product; favorable price; willingness to offer credit

Livestock producers (feed consumers) in Jawe and Gana indicated that they occasionally purchase feed, while those at Hayse reported that they purchase regularly (Table 7). All farmers interviewed in the latter location own dairy cattle and were well integrated with milk markets leading to high demand for commercial compounded feeds and ingredients. Regarding feed price setting, it was indicated that there is no negotiation and that prices are fixed by the suppliers/retailers themselves. Wheat bran and oil seed cakes are the commonly purchased concentrate ingredients in both Jawe and Gana villages, while compound dairy feeds (obtained from Licha Flour and Feed Factory) and wheat bran (from flour mills and retailers) are commonly purchased by those farmers at Hayse. Price variability is an important aspect, with feed prices falling during dry seasons (associated with increasing volume of wheat and oil seeds supplied) and rising during the wetter months of the year, due to the opposite trend in ingredient supply to feed and flour processors.

The respondents indicated that purchased feeds are transported by donkey carts and head loads from point of sale to the respective farms. Remoteness from source is one of the constraints faced in feed transport. The farmers reported that they use methods such as smelling, touching and inspection of dampness, mould development and presence of inert materials for assessment of feed quality when they buy feeds. Regarding the price issue, farmers are enthusiastic to pay for better quality. The use of concentrate ingredients also varies to some degree across the study villages. At Jawe and Gana, concentrate feed utilization was observed to be low, while at Hayse, due to the presence of improved dairy cattle, farmers regularly buy such feeds for their animals. There was also a tradition of marketing feeds obtainable from local sources, such as straws, enset by-products, native grass hays and *atela*.

Farmers can purchase ingredients or formulated feeds in variable quantities based on their capacity from feed retailers in Hosaina town and from Licha flour and feed factory. On the contrary, private flour factories such as Sifona indicated that they disfavor retailing in small quantities. Regarding credit services, there is lack of access to credit sources for feed purchase. Though Omo and Wisdom Micro-finance Institutions operate in the area, the conditions for accessing credit (be it for feed purchase or other purposes) seem unfavorable. In deciding the supplier from whom to buy feed, ease of access, quality of the feed ingredient supplied, favorable price and willingness of the supplier to offer feeds on credit were some of the issues considered. On the subject of the institutional constraints affecting the feed value chain in the area, no clear insight of farmers was captured as to the institutional factors hindering feed value chain development in the area.

Table 8. Aspects of feed value chain activities captured during the discussions made with feed producers in Hosaina town

Issue	Producers		
	Licha Hadiya flour and feed factory	Sifona Flour factory	Ingida Kassa Oil Factory
Input price setting	No input price negotiation	No input price negotiation	No room for price negotiation; producers set the price based on cost of production and buyers take the price
Source of inputs	Wheat for flour production is sourced from member farmers; wheat bran for feed mixing sourced from own flour factory (75%); cakes and other ingredients from Addis Ababa area; molasses from Wonji Sugar factory	Wheat sourced from farmers and also allocated by government	Noug and linseed sources from as far as Wollega, Arsi and Bale (linseed only)
Buyers of feed products	Mainly dairy farmers in the town; some rural farmers; other coops from other zones; research centers; farmers engaged in occasional fattening operations	Urban dairy farmers; feed retailers mainly those who transport and retail feed at other towns; farmers engaged in occasional fattening operations	Retailers, livestock producers (farmers engaged in fattening and dairy production)
Technical efficiency	Operates below capacity due to low demand; power shortage; water shortage	Operates below capacity due to power shortage; water shortage	Produces at 10% of the capacity; was not in operation at the time of the study
Processing risks	Instable electric power and input supply; poor quality of wheat grain purchased from farmers	Instable electric power and input supply; poor quality wheat purchased from farmers	Unstable power and input supply; raw materials sourced from distant places with high transport cost
Problems in finding people who buy feed products	Yes, mainly during seasons of high feed availability	Yes, mainly during seasons of high feed availability	No. There is high demand for oilseed cakes but the problem is to find market for the oil
Type of feed packaging material	Sacks of 50 kg capacity	Sacks of 50 kg capacity	Sacks of 50 kg capacity. But can sell in 25 or 10 kg if the buyers bring own container
Institutional constraints	No excessive institutional constraint was indicated to prevail	No excessive institutional constraint was indicated to prevail	No excessive institutional constraint was indicated to prevail
Feed export?	No	No	No
Quality standard based production of feeds	No	No	No

Features of feed value chain activities captured during the discussions made with feed processors are presented in Table 10. As was the case for the actors in the consumer domain, no negotiation was reported to exist in input and feed price setting. Regarding the source of inputs, Licha flour factory source wheat from farmers who are members of the primary cooperatives of the union as well as from the market and wheat sold by the government. For commercial concentrate feed compounding, 75% of the wheat bran used is sourced from their own factory while oil seed cakes and other ingredients are obtained from the Addis Ababa area. Molasses is purchased from Wonji Sugar Factory. Sifona Flour factory sources wheat from both farmers and the government. Ingida Kassa Oil factory gets its oilseed supplies from distant places like Wollega, Arsi and Bale. Buyers of feed products from these commercial enterprises are dairy farmers in Hosaina town and its environs, some rural farmers, cooperatives outside of the zone, research centers, and some opportunistic fatteners who fatten cattle and small ruminants targeting major public holidays. Sifona Flour factory also indicated urban dairy farmers, feed retailers and opportunistic fatteners to be its important clients.

All the three factories indicated that they operate below the existing capacity due to low demand for the products and frequent interruption of power supply. Unstable power and input supply, poor quality of the wheat and oilseeds supplied by farmers seem to be the major constraints hindering their production efficiency. The factories also indicated that during seasons of sufficient feed availability, demand for feed ingredients falls. All the three firms indicated willingness to pack their products in fertilizer bags of 50 kg capacity and to borrow money for sustaining their factory operations. They also indicated that they do not have licenses for selling feed as it is understood that it is part of their license for operation of their respective mills. Licha Flour and Feed Factory do not offer credit for buyers, while Sifona Flour Mill and Ingida Kassa Oil Processing Plant indicated that they offer wheat bran and oilseed cakes, respectively, on credit, mainly to clients who regularly buy from them and whom they consider trustworthy. As was the case with consumers, no clear institutional problems affecting the operation of the firms were pinpointed. Additionally, the factories indicated that they are not involved in feed export and there is no standard quality based feed manufacturing processes in all firms.

Functions, activities and actors in feed value chain

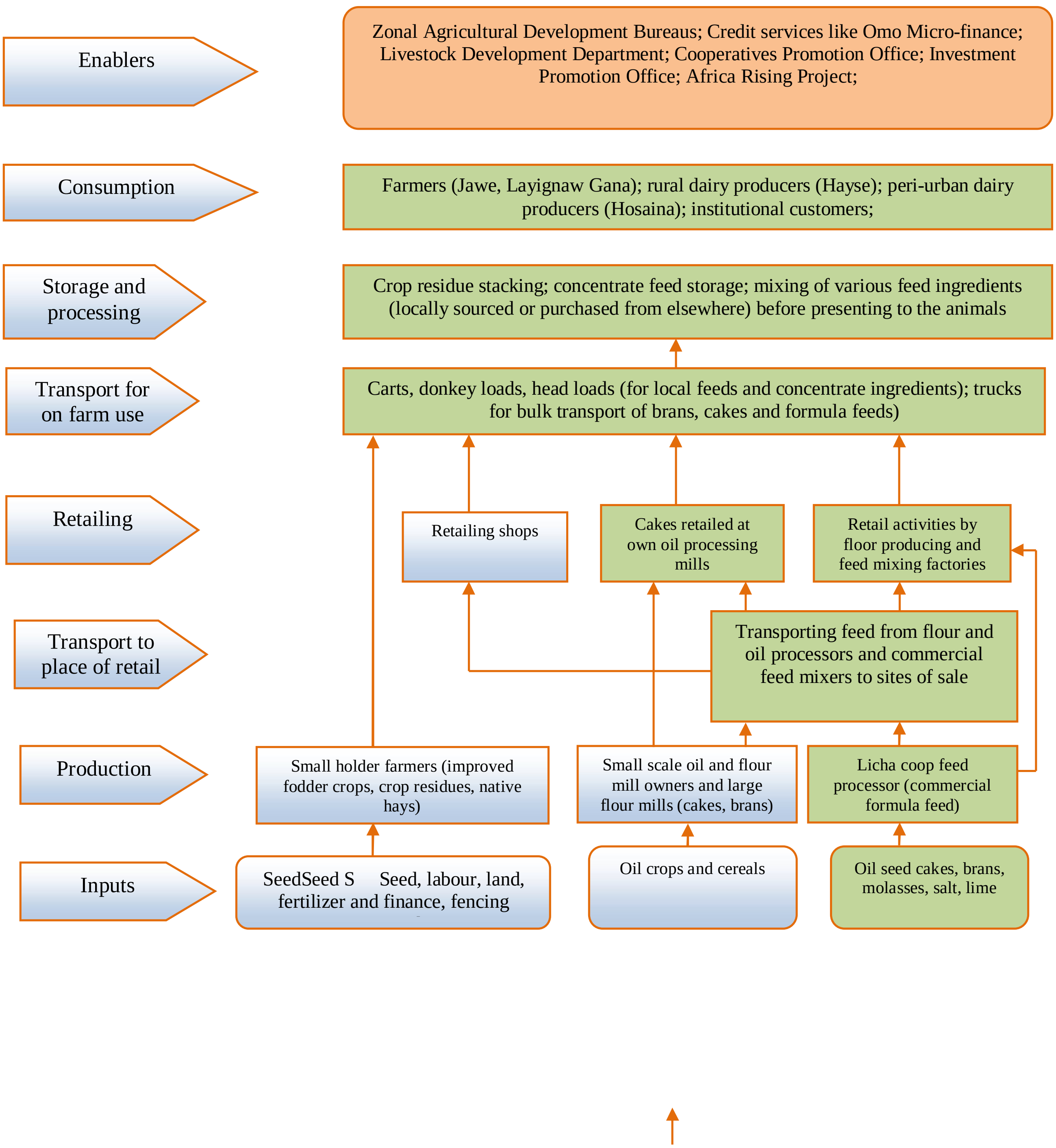
Based on the information gathered, the feed value chain was observed to have the following key stages (Figure 1). Input supply, feed production, feed transport to place of sale by retailers, feed retailing, feed transport to farm from points of retail, storage and processing and consumption.

Input supply

For feeds produced on farm by farmers, inputs required include land, forage planting material, financial resources for purchase of inputs and feeds, and labour for various farm operations. During the group discussion, land was an important constraint affecting feed availability in the study areas. Further, other inputs such as forage seed, and other forage planting materials are not readily available. Credit is not readily available for feed related expenses. Although Omo Micro-finance operates in the area, the service delivery processes were indicated by the group members to be unfavorable. For commercial feed compounders (Licha Hadiya Flour Factory) and flour processing factories, inputs like oil crop seeds, wheat, noug and linseed cakes and brans (from own source in case of Licha) are the key inputs used in the feed production process.

Feed production

Generally, farmers reported that they use crop residues (enset by-products, wheat and tef straws) and native pasture hays as feed for their animals. Farmers also plant some improved forage species like elephant grass, fodder beet and *Dasho* grass. Concentrate ingredients and compounded feeds are produced by flour factories and oil extracting entrepreneurs in Hosaina town.



Feed marketing
The interviewed farmers showed that they buy feeds from neighboring farmers (crop residues, native grass hays). They also purchase concentrate feeds and other concentrate ingredients from flour factories or retailers in Hosaina town. Generally, feed supply and price fluctuates depending on season. Typical small farmers in the present sites face challenges in terms of their access to concentrates feeds and ingredients while milk producers' cooperative members (for example in Hayse site) have better access to credit and other inputs required for sustainable milk production. Where credit constraints affect the use of potential technological interventions, it is thus vital that government supports technology dissemination activities through facilitating the provision of such services.

Feed transport
Feed transporting activities take place at two stages; first retailers buy and transport ingredients from source to place of retail; then farmers on the other hand buy feed from retailers, oil and flour processors and transport the feed to their farms. A key challenge in feed transport mainly for rural farmers is the distance from source. Farmers use head loads or donkey carts to transport feed from source to farm. At farm level, feed was produced and transported by family labour to the place of use or site of stacking.

Retailing
Feed retailing activities are undertaken by feed retailers who buy ingredients from the source and retail the feed in Hadiya town. The compound feed processor (Licha Hadiya) and another flour factory visited during the study (Sifona Flour Factory) undertake feed retailing activities at their factory site. Indeed, the former retails commercially compounded feed and wheat bran, and the latter retails only wheat bran.

Storage and processing
Crop residues and native grass hays are conserved for livestock feeding during lean periods. The most commonly stored feeds for periods of feed shortage are crop residue (wheat and barley, mainly as observed in Hayse area). Some farmers practice native hay and crop residue stacking, concentrate feed storage and mixing of various feed ingredients at feeding.

Consumption
Smallholder farmers (Jawe, Gana); rural dairy producers (Hayse); peri-urban dairy producers (Hosaina town), and institutional customers (like research centers) were the main consumers of livestock feed in the area. Generally, feed formulation was observed not to be species or physiological status specific. Licha Hadidya, the only factory that commercially produces mixed feeds was observed to produce feed for dairy animals but the factory reported that it also sells the same type of feed for other classes of livestock. It is planning to start compounding of calf and poultry feeds based on the emerging demand for this type of feed in the future.

Conclusion

This appraisal focused on assessment of feed production and feeding systems and on-farm dairy cattle performance assessment in Lemo district. It also diagnosed feed value chain activities and value chain functions. Important attributes of the feed value chain based on the perceptions of the farmers and feed manufacturers were discussed and the outcomes were tabulated and described. The study indicates that crop residues dominate the on-farm livestock feed resource base. The reproductive and productive traits of dairy cows managed on-farm are generally poor. Formal and informal feed value chains co-exist in the sites with the latter being more important in feed sourcing mainly for typical small holder farmers. The feed value chain in the area was observed to have the following key functions: Input supply, feed production, feed transport to place of sale by retailers, feed retailing, feed transport to farm from points of retail, storage and processing and consumption.

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Reproduction and Breeding

Genetic Conservation and Performances of Fogera Cattle Breed

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Abstract

This paper was initiated to review the production and reproduction performance of Fogera cattle and to pin out the conservation measures done at ALRC for sustainable utilization of the breed in the region as well as the nation. Among the 27 indigenous cattle breeds in Ethiopia, seven of them are well adapted in Amhara region and from which Fogera cattle is the most popular and productive breed that distributed in those woredas around Lake Tana. Fogera cattle are one of the renowned cattle breed with remarkable genetic qualities compared to other indigenous cattle resources of the country. Prominently the breed is known for its high milk yield per cow, good body conformation and growth rate, better draught power, resistance to internal parasites infestation and sound adaptability to water logged area/ plain attributed to its long legs. The existing dairying in Fogera district is dominantly smallholder production with 98.7% of cattle milk and meat is produced from indigenous cattle breeds on which Fogera breed contributes 98.1% of the farmers herd dynamics. The first priority production objective of Fogera cattle producers in Fogera area is milk production, followed by draught power and meat. The Fogera breed has also served as dam line in dairy production sector of the region in which the Fogera heifers are bred to Friesian sires by artificial insemination throughout the year. The F1 heifers produced are then bred to a Friesian bull (by AI) and handed over to the community in order to improved milk production output. The maximum and minimum partial daily milk yield of Fogera breed at ALRC was reported to be 2.14 kg and 0.45 kg, respectively while at on-farm level (Fogera districts) 2.79 litter and 0.3 litter was the recorded respective maximum and minimum milk yield. The recent works indicate the respective reproductive performance values of 298.40, 581.19, 52.43, 21.01 and 88.64 for DO, CI, AFC, BW, WW. This value compared to the previous works indicates a slight decrement in the performance of Fogera cattle, which needs a conservation and improvement measures. Conservation of Fogera cattle had done at Andassa and Metekel ranches for the past 52 and 28 years, respectively. These centers are mandated on conserving and improving the performance of the breed for its contribution to the gene pool.

Key words: Amhara region, Fogera breed, Reproductive performance, Genetic conservation

Introduction

Ethiopia has served as a gateway to domestic animals from Asia to Africa (Rege and Lipner, 1992) and its diverse ecology favored diversification of these resources (ibc, 2012). Ethiopia has the largest cattle population in Africa (CSA, 2013); of which the vast majority of the national herd is of indigenous zebu cattle maintained in rural areas under extensive husbandry systems (Firdessa et al., 2012). Amhara region has very vast livestock resources. However, the regional average consumption is lower than that of national level. Per capita milk and meat consumption are estimated to be 9.1

and 6.4 kg/annum respectively in the region (Belete, 2006). But in the region, there are highly productive livestock breeds to contribute to food security and protein requirements, such as the Fogera cattle. Among the 27 indigenous cattle breeds in Ethiopia (Rege and Tawah, 1999), seven of them are well adapted in Amhara region and from which Fogera cattle is the most popular and productive (Addisu bitew et al., 2010a) breed that distributed in those Woredas around lake tana (north and south gondar and west Gojjam). Fogera cattle are one of the renowned cattle breed with remarkable genetic qualities compared to other indigenous cattle resources of the country. Prominently the breed is known for its high milk yield per cow, good body conformation and growth rate, better draught power, better resistance to internal parasites infestation and sound adaptability to water logged Fogera plain attributed to its long legs (Alberro and Haile-mariam, 1982; Bodo, 1989; Addisu et al., 2010a). The existing dairying in Fogera district is dominantly smallholder dairy production largely based on indigenous cattle, where 98.7% of cattle milk and meat is produced from indigenous cattle breeds (Belete, 2006). The first priority production objective of Fogera cattle producers in Fogera area is milk production (Zewdu, 2004), followed by draught power and meat.

Fogera cattle breed is now interbreed with other cattle breeds and consequently the pure line is declining (IBC, 2012); as the report of Alberro and Haile-Mariam (1982) and Gebeyehu *et al.* (2004) indicated the population of Fogera breed had declined in alarming rate between the reporting years of the authors. The main threatening problems, as reported by different authors and observations, are genetic admixture with highland zebu breeds, shift of production system in the native areas of the breed, shrinkage of grazing land, and poor management practices (feed scarcity and disease prevalence). These problems coupled with the changing climate leads the breed to lose its characteristics and lowering of its productivity. Now, Andassa Livestock Research Center (ALRC) works conservation and improvement strategies of Fogera cattle for the past 5 decade's years at on-station and community based conservation and improvement strategies at its native Fogera district. Therefore, this paper had initiated with the objectives of reviewing the reproductively and production performance of Fogera cattle and indicate future directions for the breed improvement and conservation strategies.

Material and Method

Description of the production area

Conservation of Fogera cattle had done at Andassa and Metekel ranches for the past 52 and 28 years, respectively. The two centers had originally established for conserving the pure fogera cattle and additionally to cross the breed with Holstein Friesian for increasing the milk supply of the region by distributing the in-calf crosses breeds to their surrounding farmers. Additionally, the breed had kept at its native area, Fogera district, and other districts surround Lake Tana. ALRC had a total area of about 360 hectares while Metekel ranch had formerly 6200 and now 1367 ha, on which many of the areas had given to Ethiopian Seed Enterprise for improved seed multiplication. The breed had also adapted in wide areas of Amhara region mainly in the surrounding districts of Lake Tana like Bahir Dar zuria, Libokemkem, Dembia, Alefa and Takussa, and South Achifer districts. Even if its native home areas are vast, the pure breeds of Fogera cattle are not well kept at the farmer level because of admixture with Highland zebu cattle's those are distributed because of their resistance ability for shortage of food and small body size, which is a threatening problem for these areas.

Descriptions of Fogera breed

Fogera cattle are one of the distinct main cattle breeds/types identified in Ethiopia. Fogera cattle originated in Lake Tana area in Amhara region. The breed belongs to the intermediate Zebu-Sanga type. Most of its characteristics (small horns, very large dewlap, pendulous naval flap and preputial sheath) indicate Zebu cattle characteristics. However, the rather small hump and its cervical or Cervico-thoracic position represent the Sanga influence. Therefore, Alberro and Haile-Mariam (1982) classified Fogera cattle as an intermediate Zebu-Sanga type. Fogera cattle are generally large, being tall with long legs. A massive body with solid strong bones is one of the breed's main features. The hair coat color varies, but white with black spots and pure white are the common types (DAGRIS, 2007). Fogera breed has a number of unique genetic characteristics. The breed is one of the best milk breeds in the country. It is highly tolerant or resistant to heat stress and solar radiation which could be due to its light color and short hair. The breed is known for its tolerance to high altitudes, parasite and disease infestation, fly burden, wet soils or swampy areas.

Figure 5. Fogera breed: breeding females (www.youtube.com/watch?v=14ml4TZ3Oo0) and breeding cow at Andassa Livestock Research Center (left)

Population status of the breed

The actual population size of the breed at the native areas of the breed had not yet reported since 2004, works done by Gebeyehu and its colleague. The population status of the breed at the two conservation and improvement ranches viz. ALRC and Metekel had summarized and presented in the following two figures.

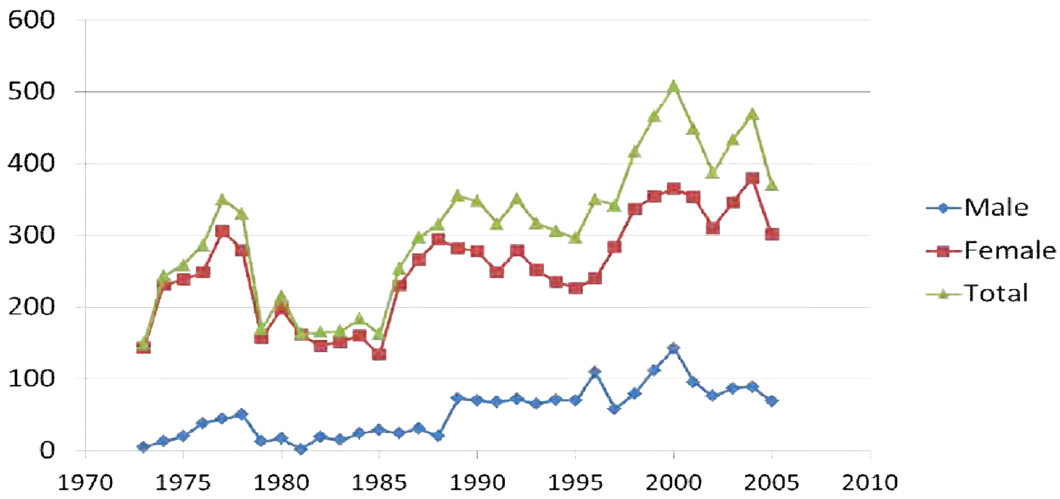

Figure 6. Population trend of Fogera cattle at ALRC

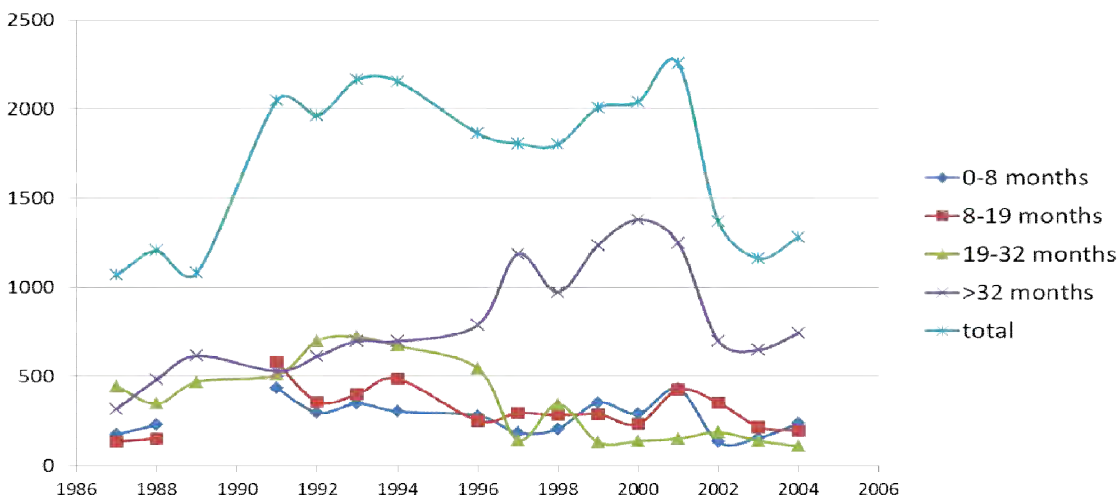

Figure 7. Population trend of Fogera cattle at Metekel ranch

Breeding program

The ranch runs two breeding schemes: the pure Fogera Breeding Unit (FBU) and the Cross Breeding Unit (CBU). In the FBU, the practice is to run the Fogera bull among 40-50 breeding cows for three months during the breeding season (September to December). Females produced in this unit are retained as replacement heifers on the basis of their growth performance and health status. In the CBU, Fogera heifers are bred to Friesian sires by artificial insemination throughout the year. The F_1 heifers produced are then bred to a Friesian bull (by AI), and handed over to the community after pregnancy has been confirmed.

Herd management

Animals were allowed to graze the natural pasture for eight hours and during dry season they were provided with hay harvested from the natural grazing pasture. The animals were watered from Andassa river and spring water during wet season for young and sick animals which stayed at barn. In the breeding program both natural mating with Fogera bulls and artificial insemination with Friesian semen were used to produce Fogera and F1 calves. Cattle were managed in a loose housing system. Health management practice had prevention and control scheme. The prevention scheme focused on vaccination against anthrax, blackleg and pasteurellosis once in every six to eight months and once per year for CBPP. Control measures were taken against internal and external parasites. Mass treatment against internal parasites was conducted twice a year, at the start and end of the rainy season. Animals were treated for ecto-parasites fortnightly in peak season and monthly when the infestation level was low.

Calves had free access to suckle their dams for the first four days to ensure that they consume enough colostrum (Fig. 4a). They were then separated from their dams and allowed to partially suckle (two teats) at milking times until weaning (Fig. 4b). Calves stayed around the barn until three months of age and allowed for grazing thereafter. While they were at barn they were provided with hay and water (Fig. 4c). Calves are allowed to run with their dams till they reach the weaning age (usually 8 months), and later on are selected for further breeding program based on their weaning weight, body conformation and health status. Grazing constitutes the basal ration, but hay, made of natural pasture, is additionally supplemented during the dry season. Concentrate feed composed of wheat bran and nougcake (oil cake of *Guizotia abyssinica*) is also supplemented to lactating and pregnant cows.

Figure 4. (a) Fogera cow: calf relationship;

(b) Fogera cow partially milked;

(c) Calves feeding hay at their barn

Performance of Fogera cattle breed

Milk Yield

Twenty-two years back, the milk production potential of elite Fogera cows was estimated to be 1500 liters of milk per lactation (Alberro and Haile-Mariam, 1982). This productivity level has now declined to 1102 liters of milk per lactation even under research center management at Andassa Livestock Research Center (Addisu *et al.,* 2010). The maximum and minimum partial daily milk yield of Fogera breed at ALRC was reported to be 2.14 kg and 0.45 kg, respectively (Addisu *et al.,* 2010) and 2.79 litter and 0.3 litter of respective maximum and minimum milk yield at on-farm (Fogera district) level (Addisu *et al.,* 2007) (Table 1). This decline, next to deterioration in the production environment (feed shortage and disease), is an indication of genetic deterioration of the breed due to admixture and/or inbreeding between relatives. Additionally, as meeting reports and field observations indicate, the possible causes for the decrease in the productivity of Fogera breed could be genetic admixture with poor milking local breeds, negative selection by farmers for other traits antagonistic to milk yield, and absence of maintenance and improvement of the breed's characteristics (Addisu *et al.,* 2010).

Table 1. Summary for milk production of Fogera cattle

Traits	Mean value	Study site	Source
Total milk yield (litter)	1500.0		Alberro & Haile-Mariam, 1982
	1102	ALRC	Addisu *et al.,* 2010
	613	ALRC	(Prabhakar and Addisu (2004)
	780	Metekel ranch	MFBCMR, 2013
Lactation length (day)	353	ALRC	Prabhakar and Addisu (2004)
	305.1	On-farm (Fogera woreda)	Addisu *et al.,* 2007

Reproductive Performance

Table 2 summarizes the reproductive performance of Fogera cattle at Andassa Livestock Research Center and Metekel ranches as reported by different researchers and MSc thesis works at different years.

Table 2. Summary of reproductive performances of Fogera cattle

Traits	Mean value	Study sites	Source
AFS	44.8	ALRC*	Giday, 2001
Age at first calving (months)	53.75	ALRC	Asheber, 1992
	49.32	On-farm (Fogera woreda)	Addisu *et al.*, 2007
	52.43AFC	Metekel ranch	Almaz Bekele, 2012
	39	Metekel ranch	MFBCMR, 2013
	54.60	ALRC	Giday, 2001
	47.61	Metekel ranch	Addisu, 1999
Gestation Length (day)	279.99	ALRC	Asheber, 1992
	281.30	ALRC	Giday, 2001
	284.10	Metekel ranch	Addisu, 1999
Calving Interval (day)	559.00	Metekel ranch	Addisu, 1999
	601.2	on-farm (Fogera woreda)	Addisu *et al.*, 2007
	581.19CI	Metekel ranch	Almaz Bekele, 2012
	477	Metekel ranch	MFBCMR, 2013
	560.60	ALRC	Giday, 2001
Days open (Days)	284.60	ALRC	Asheber, 1992
	298.40DO	Metekel ranch	Almaz Bekele, 2012
	280.50	ALRC	Giday, 2001
	303	ALRC	Goshu *et al*., 2005
NSC	1.54	ALRC	Giday, 2001
	1.62	ALRC	Goshu *et al*., 2005

*ALRC – Andassa Livestock Research Center

Growth performance

Table 3 summarizes the growth performances viz. birth and weaning weight of Fogera cattles at Andassa Livestock Research Center and Metekel ranches.

Table 3. Birth weight and Weaning weight of Fogera breed

Traits	Mean value	Study site	Source
Birth weight (kg)	23.1	ALRC	Asheber, 1992
	21.01BW	Metekel ranch	Almaz Bekele, 2012
	21.5	Metekel ranch	MFBCMR, 2013
	22.45	Metekel ranch	Addisu, 1999
	21.9	ALRC	Giday, 2003
Weaning weight (kg)	114.2	Metekel ranch	Addisu, 1999
	88.64 WW(adjusted)	Metekel ranch	Almaz Bekele, 2012
	100.9	ALRC	Giday, 2003
	122.8	Metekel ranch	MFBCMR, 2013

Genetic Improvement and Genetic Parameter estimation

The variation between mean partial daily milk yield of the herd (1.926 kg) and best 10 percent (3.2 kg) and 25 percent (2.8 kg) cows was high, indicating the potential for improvements in productivity through long term genetic selection (Table4)

Table 4. Milk yield and lactation length of Fogera cows at ALRC (2004/2005)

Parameters	Lactation length	milk yield/cow/day, kg
Overall mean	259.81	1.926
Best 10% mean	459.78	3.2
Best 25% mean	396.95	2.8
Maximum	539	4.44
Minimum	103	0.86

Source (Addisu *et al.,* 2010)

The mean partial lactation milk yield of first parity cows was significantly lower than other higher parities. This might be because of the immature udder size and nutrient requirement for growth of some of the milking cows which had not attained mature weight, thus reducing the lactation milk yield. Cows milked from 2002 to 2004 had significantly higher mean partial lactation milk yield than those milked from 2005 to 2008. This was largely because cows milked in the earlier years were milked for longer lactation periods (334-398 days) compared to those cows milked on later years (210-254 days). The variation between mean lactation milk yield of the herd (291 kg) and best 10 percent (551 kg) and 25 percent (447 kg) cows was high indicating the potential for improvements in productivity through long term genetic selection (Table 4).
In addition before the improvement operation starts the birth weight of calves were about 19-20 Kg which upgraded later to 24-25 Kg and then 30 Kg birth weight.

Table 5. Genetic parameter estimate for Fogera cattle

Traits	Heritability value	Expected genetic gain per year (kg)	Study site	Source
Birth weight	0.38 ± 0.32	0.15	ALRC	Asheber Sewalem (1991)
Weaning weight	0.22 ± 0.25	0.77	ALRC	Asheber Sewalem (1991)
CI	0.02		Metekel ranch	Almaz Bekele, 2012
AFC	0.07		Metekel ranch	Almaz Bekele, 2012

Efforts done by the research center for improvements of the breed

Maintaining pure Fogera nucleus herd

The current state of the Fogera population may warrant maintenance of a pure nucleus population in a research or other government farms (i.e. *Ex situ in vivo* conservation). The nucleus herd at Andassa Livestock Research Center had strengthened and well established to be a source for nucleus herd. Currently ALRC farm had 307 breeding females' and 96 breeding males with a total

403 breeding populations; those are grouped in to eight herds based on their age and sex. The nucleus herd had five pure breed herds that had 38 to 45 individual cows with one breeding bull in each herd; one bull; two growers and one cross breed (HF X Fogera) herd (ALRC, 2013).

Figure 5. (a) Breeding Fogera Heifer and (b) Breeding pure Fogera calves at ALRC

The research center had develop a multistackholder analysis workshop at the research center those incorporating researchers and experts from ILRI, EIAR, ESAP, IBC, Addis Abeba University, Bahir Dar University, Debre Tabor University, EAAPP, Livestock Agency (regional, Zonal and woreda level), farmers from the native areas of the breed. The workshop had collect different ideas from these officials participating in the meeting; and the main ideas those will benefit and share by other centers are summarized as follow:

- In the coordination and leading role of Andassa livestock research center all concerned stakeholders which include Amhara region Livestock Development Agency, Bahir Dar University, Debre Tabor University, Chagni Cattle breeding and multiplication center and woreda agricultural offices should plan the way forward in the conservation and improvement program of the breed.
- There should be a strong stakeholder linkage to avoid duplication of efforts and resources
- The regional government should allocate enough resource for conservation and improvement of Fogera breed like Oromia region made for Boran breed.
- The issue of Fogera cattle should be the concern of Ethiopian Institute of Agricultural Research and Ethiopian Institute of biodiversity; and these institutes should work together with the research centers and the farmers at grass root level

Community-based conservation

In general, there is consensus that conservation should ideally be with the communities where the breed is kept (*In situ* conservation). Such conservation is sustainable only to the extent that the animal genetic resources being conserved also provide an appropriate livelihood strategy to the livestock keepers in the present and the future. With this fact Andassa Livestock Research Center had engaged at Wogetera Peasant Association (PA) of Fogera district for improving and conserving the breed at its native area. A detailed discussion with community of the PA had done on the couple effort viz. the community and the research center, to conserve the breed for their livelihood improvement via genetic improvement of the breed and the production area with various feed, health and breeding interventions. The research center had distributed four selected and improved pure Fogera bulls at two villages of the selected PAs. The research center had developed a 10 year strategic plan for the activities accomplished by the center and working document and separated strategic plan for Fogera breed for looking of budget sponsorship. But, yet the center had done by recurrent budgets and by ENIDP project. For the coming years the center had targeted to widen its target to neighboring PA's and districts with breeding and related integrated livestock technology approaches.

Figure 6. Discussion with the farmers on distribution of the selected Fogera bull for the community conservation strategy (Wagetera Kebele)

Figure 7. Distributed improved pure Fogera bulls

Threats of Fogera cattle

At the native areas of the breed the major threatening problems are the reduction of grazing lands because of crop intensification and over flooding of Lake Tana during the rainy seasons; genetic admixture with highland zebu breeds because of seasonal movement of Fogera breed to the highland areas to escape the over flooding of Lake Tana; shift of production system; and poor management practices (feed scarcity and disease prevalence). Livestock diseases of most economic importance in Fogera district include Foot and Mouth Disease, Blackleg, Anthrax, Lumpy skin disease, Contagious Bovine Pleuropnuemonia, Trypanosomiasis, Mastitis and Dermatophilosis

(Zewdu, 2004). These problems coupled with the changing climate leads the breed to lose its characteristics and lowering of its productivity.

Fogera Cattle Breed as dam line for milk production

To take the advantage of processing of purebred Fogera cattle with exotic cattle, the centre has started crossbreeding operation in 1981. Despite existed daunting problems in the previous era the centre has distributed crossbred heifers to the different cooperatives, organizations and private bodies in Gojjam and Gondar. For instance, from 1985 to 1991 ninety nine and from 1992 to 1994, eighty three crossbred heifers were distributed to the different administrative zones and for one defined NGO. Particularly, in 1986, 41 crossbred heifers were distributed though the plan was 30 heifers. Currently, many crossbreed were produced through Artificial Insemination by using Fogera cow as a dam line and Holstein Friesian as a sire.

Conclusion

The breed had conserved at ALRC and Metekel ranches; though through selection of the best performing once from the nucleus herd further improvement should better done. Additionally, improved management practice to the breeds should get attention to shy the potential of the breed.

Community based conservation and improvement of Fogera cattle

As described above the research center follow this strategy before 10 years; but yet because of interrelated problems the implementation was not well addressed and progressed. But know, the implementation had done with budget support of ENIDP. To make effective application of the strategy, with a willing participation of the local farmers, needs a designed incentive mechanisms and frequent and strong follow up of the progress.

Improving the production environment of the targeted area

The center had developed multidisciplinary proposals to improve the production environment of the production area to support the breeding strategy. From these activities designed to be implemented, evaluation of rice straw by-products for their nutritional content and feeding values; introduction and evaluation of water loving grass cultivars as a livestock feed; designing strategic deworming after identifying the major internal and external parasites, and analysis of local markets value chains for Fogera cattle and its products in Fogera District are the major once those allow to improve the livelihood of the farmers.

Budget for the improvement and conservation strategy

In years, the main problem that tackles the activity was shortage of budget. The recurrent budget that the center receives was always used for purchasing of concentrate feeds for the on-station activity. And works done at on-farm level had negligible. Therefore, budget from different source in addition to the government recurrent budget should be set for the work. With budget setup, regional bureaus and livestock agency should give attention for the conservation and improvement of Fogera cattle.

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Artificial Insemination Service Efficiency and its Constraints in North Shewa Zone, Oromia Regional State, *Ethiopia*

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Abstract

The study was carried out to evaluate efficiency of artificial insemination (AI) service and reproductive performance of crossbred dairy cows under smallholder farmers' conditions in North Shewa zone, Oromia National Regional State, Ethiopia. Forty straws of frozen semen was sampled from both districts, thawed and evaluated at the district level for its quality (motility, viability and morphology) following standard procedures. Besides, the study involved retrospective evaluation of the efficiency of AI using 9 years recorded data of 576 cows from the District AI centers, and structured and semi-structured questionnaires to generate data on household characteristics, dairy cattle management and reproductive performance of dairy cows. The mean number of crossbreed cows per household was 2.7 and 2.3 for AI service beneficiary and non-beneficiary households, respectively. The overall mean (±) percentage of frozen semen motility at district level was 44.5±0.64, and varied (p<0.01) between the district Artificial Insemination centers (AIC). While semen production period (batch) had significant (P<0.05) effect on frozen semen motility, the effect of breed was not apparent (P>0.05). The mean (±) percentage of viable (live) spermatozoa was 57.6±0.95. Sperm viability was influenced by Batch (P<0.001), where as breed had no effect (P>0.05) on frozen sperm viability. The overall mean percentages of major and minor sperm morphological defects were 4.8% and 20.9%, respectively, and it was affected (p<0.05) by district AIC, where as the effect was not significant (P>0.05) for breed and semen production period. The mean number of insemination per conception (NIC) at AI service centers was 1.3±0.023, where it was higher (P<0.001) for Berek than Kimbibit district AIC. However, there was no difference in NIC between the different dam breeds (crossbred and indigenous). There was also no variation in NIC among the different seasons of insemination. Year of insemination had significant (P<0.001) effect on NIC. Non-return rate value in Berek and Kimbibit districts were 79.2% and 70.8%, respectively. Constraints of AI service delivery system in the study area were poor heat detection, distance of households from AIC, insufficient perception about AI technology, and service charge for AI service.

Key words: semen quality, AI service, constraint, conception, efficiency

Introduction

Ethiopia possesses the largest livestock population compared to any country in Africa. Livestock, especially, cattle in Ethiopia are one of the important and promising sources of wealth. It has been reported that cattle population of the country is about 49.3 million (CSA, 2010). In Ethiopia, genetic improvement through crossbreeding has been introduced through development and research projects during the last four decades. The distribution of crossbred heifers, the provision of artificial insemination service and setting up of bull service stations were major components of the development projects. As indicated by Ahmed *et al.* (2003) through the effort of these projects, Ethiopia has built up a herd of more than 120 thousand cattle with exotic inheritance. However, since cattle breeding is mostly uncontrolled in Ethiopia, an appropriate bull selection criteria have not been established, applied and controlled which makes genetic improvement difficult (Desalegn, 2008). On the other hand, artificial insemination (AI), the most commonly used and valuable biotechnology (Webb, 2003) has been in operation in Ethiopia for over 30 years. Nevertheless, the efficiency and impact of the AI operation has not been well-documented (Himanen and Tegegn, 1998). Reproductive problems related to crossbreed dairy cows under farmers' conditions are immense (Bekele, 2005). Today AI was recognized as the primary tool for genetic improvement in cattle breeding. Therefore, a series of studies are needed to determine the coverage and performance of AI at national, provincial and district levels (NAIC, 1995). In Ethiopia almost all data used to evaluate breeding works so far are from government ranches or research stations. Nevertheless, they are not representative of the farming condition in the country (Mekonnen, 1994). There were few field studies made to evaluate the reproductive performance of cows and efficiency of Artificial insemination (Haileyesus, 2008). Thus, since information collected from ranches and on stations are from controlled environment, it is difficult to figure out problems and enhance possible solutions on AI service efficiency and reproductive performance at farmers level. On the other hand, reproductive performance and artificial insemination services are highly influenced by environmental factors, which call for studies under farmer management. Hence, the current research was initiated with the objective of evaluating efficiency of artificial insemination service, and its limitations in North Shewa zone, Oromia National regional State, Ethiopia.

Materials and methods

Study Areas

The study was conducted in two districts of North Shewa Zone; Berek and Kimbibit. The districts are among the seventeen districts of North Shewa administrative zones of Oromiya National Regional State. Berek district is located at a distance of 40 km north of Addis Ababa. The area has an altitude ranging from 2280 to 3228 meters above sea level (BDAO, 2010). Based on the meteorological data obtained from the District, the annual rainfall ranges 700-1250 mm and the minimum and maximum average temperatures were 7 ^{o}C and 25 ^{o}C, respectively. Kimbibit district is also located in the North direction to the capital city Addis Ababa at a distance of 78 km. The area is situated at an altitude of 2620-3020 meters above sea level. The district has an annual rainfall of 913 mm and an average maximum and minimum temperature of 24^{o}c and 8.5^{o}c, respectively (KDAO, 2011).

Study animals and study procedures

Retrospective data recorded on reproductive indices of 576 dairy cows during the last nine years was collected from the case of book of the respective district AI centre. These includes year of insemination, season of insemination, dam breed, number of insemination per conception, and non-return rates. For assessment of semen quality, forty straws of frozen semen, 20 from each district, were randomly collected and examined in the laboratory of respective districts to estimate sperm motility, viability (live and dead cell count) and morphological defects. The semen was composed of two breeds (100% Holstein Friesian, and 75% Holstein Friesian and 25% Boran) and four production batches (B_1= batch code 12/100 and production date 9/4/2012; B_2= batch code 12/101 and production date 10/4/2012; B_3= batch code 12/163 and production date 11/6/2012; B_4= batch code 12/178 and production date 26/6/2012). Data on frozen sperm quality (motility, viability [live and dead cell count] and morphology) at district level was carried out by sampling from District AI centre and microscopic examinations. Data on sperm quality at the site of production and processing was collected from record book at National AI centre. Thus, loss of sperm quality was estimated as the difference between the two measurements. Besides information regarding semen collection, processing and packing procedures was obtained from national artificial insemination center (NAIC) at Kaliti.

Data Analysis

Data collected through the survey were analyzed using descriptive statistics. Data collected from the records (retrospective) and direct measurements were analyzed using the General Linear Model procedure in SAS (SAS, 2008). Mean differences were examined using tukey adjustment.

Result and Discussion

Individual progressive Motility of frozen and fresh semen

Fresh semen individual progressive motility for all samples at the time of collection and processing at NAIC was 80% (Table 1). However motility of the same semen after freezing at the same center was 57.5%, on average 22.5% loss due to freezing. After transportation and further storage at the respective district the average motility of frozen semen was further reduced to 44.5% (13% loss), where the loss was slightly higher for Kimbibit (14.8%) than Berek (11.3%) district. This is in general agreement with Tadasse (2010). The effect between districts might be due to differences in chilling and freezing environment including the volume and temperature of liquid nitrogen (storage) and transportation of semen from NAIC to district AI service center. The report of IAEA and FAO (2005) indicated that frozen semen bellow minimum recommended motility of 40% should be discarded, because it affects the efficiency of semen fertility. However, even though, the losses due to various factors explained above was substantial, sperm progressive motility in the current study was slightly higher than the minimum recommended threshold 40%, below which conception rate was negatively influenced.

Table 1. Individual progressive motility of fresh and frozen sperm

District	Breed	Batch	N	Fresh semen (%) at NAIC	Frozen semen (%) at NAIC	Frozen semen (%) at district	Motility loss (%)
Berek	Pure HF	B_1	10	80	60	47.0±1.10	13
	Cross	B_2	10	80	55	45.5±1.16	9.5
Kimbibit	Pure HF	B_3	10	80	55	43.0±1.10	12
	Cross	B_4	10	80	60	42.5±1.34	17.5
Mean				80	57.5	44.5±1.17	13

N= number of observation; Pure HF= 100% Holstein Frisian; Cross= 75% Holstein Frisian crossbreed with 25% Boran; B_1= batch code 12/100 and production date 9/4/2012; B_2= batch code 12/101 and production date 10/4/2012; B_3= batch code 12/163 and production date 11/6/2012; B_4= batch code 12/178 and production date 26/6/2012

Frozen semen individual motility and Viability

The overall mean percent frozen semen progressive individual motility in the current study at district level was 44.5 % (Table 2). The result is lower than 51.7% reported by Desalegn (2008) and 51.5% reported by Tadesse (2010). The post frozen semen examination assesses both the ability of the semen to withstand freezing, thawing and the efficiency of the processing itself. A study by IAEA and FAO (2005) indicated that if there are 40% or more of semen moving actively forward after freezing and thawing the quality is acceptable for artificial insemination, which is consistent with the current study. The current study revealed a significant ($P<0.01$) effect of district on frozen semen individual progressive motility. Similarly frozen semen motility was significantly ($P<0.05$) affected by batch of semen production. However, breed had no effect ($P>0.05$) on frozen semen motility. The higher percentage of individual progressive motility observed in Berek district (46.3%) compared to Kimbibit district (42.8±0.84) might be due to differences in frozen semen handling practices, transportation, storage facilities and proximity of the former district to National Artificial Insemination Center (NAIC), Frozen semen motility obtained for 100% Holstein Friesian in this study was smaller than 54.5% reported by Desalegn (2008) and 52.5% reported by Tadesse (2010) for pure Holstein Friesian cattle. Frozen emen produced in batch (production period) B_1 had higher motility than the rest batches. The significant effect of batch on frozen semen motility in the current study might be due to differences in original material and freezing process at NAIC, and/or due to differences in transportation, storage and handling practices at district level AI centre.

Table 2. Least squares mean (±SE) percent frozen semen individual progressive motility

Variables	N	motility (LSM ±SE)	Semen viability (LSM ±SE)
Overall mean	40	44.5±0.64	57.6±0.95
District		**	***
Kimbibit	20	42.8±0.84a	54.1±1.02a
Berek	20	46.3±0.80^{b}	61.3±1.12^{b}
Sire breed		ns	ns
100% HF	20	45.8±0.88	58.2±1.38
75% HF	20	44.0±0.93	57.3±1.33
Batch(production period)		*	***
B_1	10	47.0±1.10^{a}	61.7±1.53^{a}
B_2	10	43.0±1.10^{c}	61.0±1.73^{a}
B_3	10	45.5±1.16^{b}	54.7±1.72^{b}
B_4	10	42.5±1.34^{c}	53.5±1.18^{b}

N = number of observation; B_1= batch code 12/100 and production date 9/4/2012; B_2= batch code 12/101 and production date 10/4/2012; B_3= batch code 12/163 and production date 11/6/2012; B_4= batch code 12/178 and production date 26/6/2012; **= $P<0.01$; *$P<0.05$; ns= $P>0.05$, means with the different superscript for the same effect in the same column are significantly different ($P < 0.05$) from each other.

The overall mean frozen semen viability at district level was 57.6% (Table 2). The percentage of live spermatozoa observed in the current study was lower than (67.0%) reported by Tadesse (2010). According to IAEA and FAO (2005), for normal reproduction function, at least 50% of the frozen spermatozoa should be live, because each straw was initially packed with 30 million spermatozoa and at least half of this figure (15 million) is expected to be alive. The result of the current study indicated that frozen semen viability was significantly ($P<0.001$) affected by district and batch, whereas breed had no effect ($P>0.05$) on frozen semen viability. The effect might be attributed to differences in handling, freezing and storage practices at different district AI service centers and to differences in transportation of semen from NAIC to districts. Frozen semen with inferior viability has its own impact on number of insemination per conception and conception rate. However, sperm viability recorded in this study, irrespective of the different effects, was higher than the minimum threshold of 50%, below which conception was negatively influenced.

Frozen spermatozoa morphological defects

The result of the current study indicated that the overall mean morphological defects of frozen semen at district level were 25.4% (Table 3). District had significant (P<0.05) effect on spermatozoa morphological defects, while breed and batch had no effect (P>0.05) on morphological defects of spermatozoa. The differences in morphological defects between districts might be due to differences in semen handling, freezing and storage practices at different district AI service centers, and/or semen handling during transportation from NAIC to district AI service centers.

Table 3. Least squares means (±SE) percent frozen sperm morphological defects

Variables	N	Overall defect (LSM ±SE)	Major defect (LSM±SE)	Minor defect (LSM ±SE)
Overall mean	40	25.4±1.02	4.8±0.46	20.9±0.95
District		*	ns	*
Kimbibit	20	27.7±1.63a	4.1±0.65	23.2±1.33a
Berek	20	23.2±1.04^{b}	5.4±0.62	18.5±1.16^{b}
Breed		ns	ns	ns
100% HF	20	24.9±1.66	4.2±0.67	21.4±1.57
75% HF	20	26.0±1.20	5.3±0.62	20.3±1.09
Batch		ns	ns	ns
B_1	10	23.0±1.98	5.1±0.93	19.0±2.03
B_2	10	23.4±0.81	5.7±0.88	18.0±1.22
B_3	10	26.7±2.65	3.3±0.91	23.8±2.25
B_4	10	28.6±2.00	4.9±0.91	22.6±1.55
Mean normal spermatozoa		74.58		

N = number of observation; B_1= batch code 12/100 and production date 9/4/2012; B_2= batch code 12/101 and production date 10/4/2012; B_3= batch code 12/163 and production date 11/6/2012; B_4= batch code 12/178 and production date 26/6/2012; ***= P<0.01; * ns= P>0.05, means non- significant; means with the same superscript are not significantly different (P > 0.05)

The overall mean of major and minor morphological defect of frozen spermatozoa in the current study was 4.8 and 20.9%, respectively (Table 3). The result obtained in the current study for major morphological defects were less than 6.5% reported by Desalegn (2008) and greater than 4.3% reported by Tadesse (2010). The overall defects obtained in this study were slightly higher than the recommended overall major morphological defects, which is not more than 4% (IAEA and FAO 2005). The same report indicated that the major morphological defects affect the AI delivery system through decreasing fertilizing ability of the post-thawed semen and by increasing the numbers of service per conception. This study revealed that district, breed and batch had no effect (P>0.05) on frozen semen major morphological defects. However, slightly higher proportion of major morphological defects was observed in Berek district (5.4±0.62), which might be due to differences in semen handling practices, transportation and freezing facilities. The common major sperm morphological defects recorded in this study were pear shaped head, small abnormal head, detached abnormal head, acrosome defects, middle piece defects, tail stump, proximal droplet, strongly folded tail and narrow at the base.

The percent of minor morphological defects recorded in this study was lower than 46.1% reported by Tadesse (2010) and within the range of maximum minor morphological defect of 20% reported by IAEA and FAO (2005). Variation in district had a significant ($P<0.05$) effect on minor morphological defects of spermatozoa, which might be due to handling, freezing, transportation and storage facilities of frozen semen at different district AI service center. On the other hand, breed and batch had a non-significant ($P>0.05$) effect on minor morphological defects of spermatozoa. Simple bent tail, terminally coiled tail, abaxial implantation, detached normal head, giant broad head, and distal droplet were common minor morphological defects observed in the current study. The overall mean frozen semen head morphological defect in the current stud was 4.6% (Table 4). The most common head defects in this study were pear shaped head, narrow at the base, abnormal counter, abaxial implantation, detached normal and abnormal head, giant broad head and acrosome defects. There was no difference ($P>0.05$) between district, breed and batch on sperm head morphological defects.

Table 4. Least squares mean (±SE) percent sperm head, mid-piece, and tail morphological defects

Variables	N	Head-defects (LSM ±SE)	Mid-piece-defect (LSM ±SE)	Tail-defect (LSM ±SE)
Overall mean	40	4.6±0.56	7.8±0.74	13.2±0.98
District		Ns	*	ns
Kimbibit	20	4.6±0.88	9.4±1.13^{a}	13.6±1.52
Berek	20	4.7±0.72	6.2±0.83^{b}	12.8±1.27
Breed		Ns	ns	ns
100% HF	20	4.0±0.79	7.8±1.03	12.3±1.55
75% HF	20	5.3±0.80	7.8±1.08	14.1±1.20
Batch		Ns	ns	ns
B_1	10	4.2±1.08	6.4±1.43	12.1±2.37
B_2	10	5.2±0.98	5.9±0.93	13.4±1.05
B_3	10	3.8±1.20	9.1±1.44	12.4±2.13
B_4	10	5.3±1.32	9.7±1.83	14.8±2.22

N=number of straw per sample; HF= Holstein Friesian; B_1= batch code 12/100 and production date 9/4/2012; B_2= batch code 12/101 and production date 10/4/2012; B_3= batch code 12/163 and production date 11/6/2012; B_4= batch code 12/178 and production date 26/6/2012; ns= non-significant; means with the same superscript are not significantly different ($P > 0.05$)

The overall mean sperm mid-piece defect was 7.8% (Table 4). The result of the current study indicated that mid-piece morphological defects were significantly ($P<0.05$) affected by variation in district while, breed (blood level) and batch had no effect ($P>0.05$) on morphological defects of mid-piece. Frozen semen at Kimbibit district AI service center found to have higher percentage of mid-piece morphological defects (9.4±1.13) than what was observed in Berek district (6.2±0.83). Variation in morphological defect between districts AI service center might be due to handling, freezing, transportation, and storage facilities of frozen semen at different district AI service center. The mean sperm tail morphological defect of sperm in the current study was 13.2%. The study revealed that district, breed (blood level) and batch had no effect ($P>0.05$) on tail morphological defects. Bent tail, tail stump and terminally coiled tail were common morphological defects found in this study.

In general, the overall mean frozen sperm morphological defects (25.4%) are consistent with what has been recommended (25%) for better conception rate. However, in this study, the proportion of morphologically abnormal spermatozoa was slightly higher for Kimbibit district (27.6%) as compared to the maximum recommended level. The mean percent sperm morphological head defects recorded in the current study was less than the recommended maximum value of 10%, above which conception rate might be affected. Similarly, the proportion of major sperm defects was also small. However, unlike head and major sperm defects, the overall mean proportion of mid-piece and tail defects is higher, which together contributed to about 81.9% of the total sperm morphological defects, where the proportion is slightly higher for Kimbibit than Berek. This shows that maximum care should be taken to minimize minor sperm defects and/or sperm mid-piece and tail defects while transporting, handling and storing semen at district level, particularly for Kimbibit district. The fact that sperm minor defects such as simple bent tail are influenced by cold shock and laboratory semen evaluation techniques such as staining should also not be underemphasized.

Number of Insemination/Service per conception (NIC)

The overall mean number of services per conception was 1.3 (Table 5). The average number of insemination per conception was 1.3 for both local breed and Friesian crosses. The average number of services per conception in this study was less than (1.7) reported Yifat *et al.* (2009) for crossbred dairy cattle in smallholder farmers condition. Similarly, the present result was lower than (2.4-2.6) reported by Swensson *et al.* (1981) for Zebu cattle of Ethiopia, (1.74-1.8) reported by Azage (1981) for highland crosses of Ethiopia and Enyew (1992) for F_1 Jersey crosses in Ethiopia and (1.85) reported by Haileyesus (2006). The mean numbers of inseminations per conception (NIC) in Berek and Kimbibit districts were 1.2 and 1.4, respectively (Table 5). Numbers of inseminations per conception was significantly affected by district ($P<0.001$) for both local breed and crossbreed dams. The lower NIC in Berek district might be due to the continuous supply of liquid nitrogen for semen preservation since the district is found close to NAIC. Besides differences in heat detection efficiency by farmers and timely insemination, performance of inseminators, supplementation with concentrate feed and management of dairy cows might be the reason for the effect.

Table 5. Least square means (±SE) number of services per conception in Berek and Kimbibit districts

Variable	N	Proportion (%)	NIC LSM ±SE
Over all Mean	576		1.3±0.02
District			***
Berek	288	50	1.2±0.03 [a]
Kimbibit	288	50	1.4 ±0.04 [b]
Dam breed			ns
Local	288	50	1.3±0.03
Cross	288	50	1.3±0.03
Season of insemination			ns
Long rainy	192	33.3	1.4±0.04
Short rainy	192	33.3	1.3±0.04
Dry	192	33.3	1.3±0.03
Year of insemination			***
2002	48	8.3	1.3±0.08 [c]
2003	48	8.3	1.3±0.09 [c]
2004	96	16.7	1.4±0.07 [c]
2005	48	8.34	1.2±0.05 [b]
2006	48	8.34	1.3±0.08 [c]
2007	96	16.7	1.4±0.06 [c]
2008	96	16.7	1.1±0.04 [a]
2009	48	8.3	1.3±0.08 [c]
2010	48	8.3	1.4±0.08 [c]

No. = number of observations; NIC= number of insemination per conception; ***= P <0.001; **= P < 0.01; *= P < 0.05; ns=non-significant; means with the same superscript are not significantly different (P > 0.05)

The influence of dam breed on NIC was not significant (p>0.05) in this study, even though crossbred dams required slightly less NIC compared to local breed dams. Anderson (1994) reported that zebu cattle exhibited less intensive symptoms of heat and remained in estrus for shorter period than temperate breeds which may be the reason for low NIC in this study. Higher number of insemination per conception for local breeds observed in the current study was consistent with Mekonnnen and Goshu (1987), who reported that the number of services required per conception tends to decrease with increasing Friesian inheritance among dam breeds. This study showed that season of insemination had no effect (P>0.05) on number of inseminations per conception. However, Mekonen (1987) reported a significance effect of season on number of insemination per conception. Seasonal difference might be related to availability of feed.

Year of insemination had a significant (P<0.001) effect on number of inseminations per conception (Table 5). The result was in agreement with Mekonnen (1987) and Haileyesus (2006). Thus, less number of inseminations per conception was observed during 2008 followed by 2005 while higher NIC was observed in other years in this study. The difference in NIC across the years studied might be attributed to difference in AI technicians, availability of feed and climatic conditions in different years.

Non-return rate (NRR)

The overall mean non-return rate to first, second and third inseminations for both districts in this study were found to be 75, 20.4 and 4.9%, respectively (Table 7). The result of the current study revealed that there was no difference (P>0.05) in NRR among districts. However, NRR was slightly higher for Berek than Kimbibit district. This might be attributed to differences in semen quality used for insemination, AI technicians, and semen handling practices as explained earlier.

Table 6. Non-return rate of Dairy cows in Berek and Kimbibit districts

District	Overall N	1st Insemination N	%	2nd Insemination N	%	3rd Insemination N	%	NRR	P-value
Overall performance	576	432	75	116	20.4	28	4.9	75	
Berek	288	228	79.2	52	18.1	8	2.8	79.2	0.2482
Kimbibit	288	204	70.8	64	22.2	20	6.9	70.8	

N- Number of observation; NRR- non return rate

AI service delivery system and its constraint

There are two types of AI delivery systems in the study area: stationed and mobile service delivery systems. In stationery AI service delivery system, inseminators are stationed individually and farmers bring their cows to the insemination point. This is mostly practiced in the study area, and has been recommended as reported by NAIC (1999) under the following conditions: when there is high cattle density in a particular area, when there is large commercial farm to employ the technicians, when it is not possible to provide the technician with means of transport due to financial reason. The other AI delivery system is a system in which AI technicians use motorcycles or car in order to visit AI crushes built along the main road in rural and peri-urban areas and known sites of the area.

In this study, the distance of sampled households from AI service centers in Berek and Kimbibit district is presented in Table 7. Among the sampled farmers about 19.2% of the households were located closer (<1km) to AI service center. However, about 15.8%, 23.3%, 23.3%, 18.4% of the households were located 2-3km, 4-5km, 6-7km and >7km from the AI center, respectively. Longer distance from AI center might influence AI efficiency negatively. Most of the farmers in the study area detect cows in heat by observing the animals during morning and night regularly. From the sampled farmers, about 77.5 % of the households use regular follows up during morning and night to detect estrus. The rest 9.2% and 13.35% of the household used either herdsman information or both regular follow up and herdsman information as means of heat detection, respectively.

Table 7. Distance of sampled households from AI cervices centers and method of heat detection practices in Berek and Kimbibit districts

Variables	District						
	Kimbibit		Berek		Total		
	N	%	N	%	N	%	p-value
Distance from AIC							0.6298
<1km	8	13.31	15	25	23	19.2	
2-3km	14	23.3	5	8.3	19	15.8	
4-5km	8	13.3	20	33.3	28	23.3	
6-7km	8	13.3	20	33.3	28	23.3	
>7km	22	36.7	-	-	22	18.4	
System of Heat detection							<.0001
Herdsman information	7	11.7	4	6.7	11	9.2	
Regular follow up	47	73.3	46	76.7	93	77.5	
Both	6	10	10	16.7	16	13.3	

AI= artificial insemination; AIC= artificial insemination service center

The major constraints of AI service delivery system in the study area are presented in Table 9. The major constraints of AI service delivery system were poor heat detection systems, and distance from AI centres, perception about artificial insemination service and service charge for AI service in the order of their importance. Similarly, Damron (2000) and Barrett (1974) reported that heat detection, AI technicians' efficiency and fertility level of the herd was the most severe problems of AI delivery system. The other constraint of artificial insemination service was shortage of input for AI activity particularly semen and liquid nitrogen. These problems have a counter effect on semen quality and reproductive performance of dairy cows.

Table 8. Major constraint of AI service delivery in Berek and Kimbibit district

Constraint	N	Percentage*
Problem in heat detection	91	75.83
Distance from AI center	51	40.83
Insufficient perception about AI	34	28.33
Service charge for AI	16	13.33

N =number of observation; *=multiple responses were possible

In the current study, about 47.2% of AI beneficiary households (close to half) complained that they had a problem with regard to sex of the calves when they used artificial insemination. Thus, among these 47.2% households, about 92% reported that the tendency was higher for male sex than females. Since dairy farms are highly dependent on females for replacement and expansion purpose and thereby increase milk production, the current complaint of having more male calf than females deserves further research.

Conclusion

Generally, the overall observed efficiency of artificial insemination service and reproductive performance of smallholder crossbred dairy cows in the study area was fairly good. Hence, coverage of the AI service and the ongoing activities to improve and expand crossbred dairy cattle production at smallholder level in the area should be encouraged. However, inadequate heat detection practices, long distance from AI center, lack of perception about AI technology, and differences in efficiency of AI technician are identified as major constraints of AI services.

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On-Farm Reproductive Performance and Breeding Objective of Sheep in Tigray Region, Ethiopia

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Abstract

The study was carried out in Atsibi Wonberta, Wukro Kilteawlaeo, Ofla, Alamata, Enderta and Degua Temben districts of Tigray Regional State of Ethiopia to assess the reproductive Performance and to describe the breeding objective of Sheep in the study area. A total of 12 peasant associations 2 from each district were selected randomly. A total of 180 households 30 from each district were selected randomly for the interview. Data were gathered through semi-structured questionnaire, focus group discussions and field observations. Data collected through questionnaire were described by descriptive statistics using JMP 5, 2002. In this study reproduction performance of sheep is assessed by their age at sexual maturity, age at first lambing, lambing interval, weaning age and lambing pattern. The overall estimated mean age at first lambing of ewes in the districts of Astibi-wonberta, Wukro-kilteawlaelo, Ofla, Alamata, Enderta and Degua-Tembien sheep was 18.15, 16.77, 16.7, 16.83, 17.77 and 16.77 months, respectively. The estimated mean lambing interval of highland sheep in Atsibi-Wonberta (9.6±0.7), Wukro-Kilteawlaelo (8.3±0.8), Ofla (6.3±0.7), Enderta (10.4±0.6), Degua-tembien (8.4±0.5) and Afar (Elle) sheep in Alamata is 7.6±0.5 months respectively. The average weaning age of sheep in the study districts was three to six months. But, in Atsibi-wonberta (30%), Ofla (43.33%) and Enderta (36.67%) districts the average weaning age was greater than six months. Lambing of sheep was the highest during the months of December and November with an index value of 0.34 and 0.26, respectively. Generally the reproductive performance of sheep in this study area implies that the sheep breeds have acceptable age range for breeding though it is late compared to temperate breeds. In the study area for ram selection, farmers target was for breeding purpose and market value and fattening ability of the ram.

Key words: *Sheep reproduction, lambing, districts*

Introduction

Generally Tropical sheep are characterized by slow growth rate, able to breed throughout the year, adapted to live and produce under harsh environment, resistant/tolerant to disease, heat tolerant, ability to use poor quality feed, ability to survive on irregular supply of feed and water (Sahana *et al*., 2004; Yilmaz *et al*., 2004; Dixit *et al*., 2005). Ethiopia has diversified genotypes and largest sheep population estimated to be 26.1 million (IBC, 2007, CSA, 2009). These animals are distributed in all part of the nation with the highest population (75%) found in the highland area of the country (Yacob, 1999). Early maturing females are also known to have a relatively long and fruitful reproductive life (Mukasa-Mugerwa and Lahlou-Kassi, 1995). It is the single most important factor influencing flock productivity (ILCA, 1990). Age at sexual maturity (ASM), Age at first lambing (AFL) and lambing interval (LI) and weaning age are among the most important components of reproductive performance in sheep (Ibrahim, 1998, Mukasa- Mugerwa *et al.*, 2002, ILRI, 2007). In any small ruminant production system, high reproductive performance is a very important attribute and a major component of the overall production efficiency (Owen, 1976). Good reproductive performance is a prerequisite for any successful sheep production systems. Therefore this study was launched to assess the reproductive performance of sheep in the selected districts and to describe the breeding objective of sheep in the study area.

Materials and Methods

Description of the study area

The study was conducted in six districts namely, Atsbi-Wonberta, Wukro-Kilteawlaelo, Ofla, Alamata, Enderta and Degua-Temben. Atsbi-Wonberta and Wukro-Kilteawlaelo districts are found in Eastern zone of Tigray; while Ofla and Alamata are in Southern Zone of Tigray Regional State. The remaining two districts viz, Enderta and Degua-Temben are part of South Eastern of Tigray Region (figure 1). The mean annual temperature of the study areas varies from $14^{o}c$ to $22^{o}c$. The mean annual rainfall ranges from about 400 mm to around 969 mm. The altitudes of districts were situated at 1500- 3200 masl. The farming system in all of the surveyed districts is a crop livestock mixed farming system. The major crops grown in Southern; South Eastern and Eastern zones of Tigray Regional state are sorghum, Teff (Eragrostis tef), maize in Alamata, Enderta and Wukro-Kilteawlaelo districts. Whereas, wheat, bean, barley, pea, lentil, grass pea, chick pea, rarely linseed wheat and other highland crops in Ofla, Atsibi-Wonberta, Degua-Tembien districts. Cattle, goat, sheep, equines, poultry and honey bees also reared in these districts. Detail description of the above six districts was made as follows (Table 1).

Selection of the study site

Study sites were selected based on their suitability for sheep production, sheep distribution patterns, agro-ecology, and access to infrastructures like road and public transport. A rapid reconnaissance survey was done before the main survey to know the distribution and sampling framework from which sampling of district was taken. Two districts from each of three Zones (Eastern Tigray, South Eastern Tigray and Southern Tigray) were purposively selected. The selections of districts from the Zones were made to include one dominantly highland and one dominantly lowland district. The districts included in the study are (Atsbi-Wonberta, Wukro-Kilteawlaelo, Ofla, Alamata, Enderta and Degua-Tembien). A total of 12 peasant associations (Felege wein, Golgolnaele, Genfel, Aynalem, Menkere, Wonberet, Timuga, Limat, Debri, Maitsedo, Mahibere-silassie and Hagereselam), 2 from each district were selected randomly. A total of 180 households 30 from each district and 15 from each peasant associations were selected randomly for the interview.

Procedures and methods of data collection

Data from primary (observation, questionnaire and interview) and secondary sources (different offices) were collected. Data were generated through use of structured questionnaires, field observation and group discussions and from secondary sources. A modified questionnaire was prepared by adopting a questionnaire prepared by Oromiya Agricultural Development Bureau (OADB) for survey of livestock breeds in Oromiya (Workneh and Rowlands, 2004). The pre-tested questionnaires were administered to 180 households by the researcher and development agents.

Data management and analysis

Data collected through questionnaire were described by descriptive statistics using (*JMP5, 2002)*. Index was calculated to provide ranking of the breeding ram selection criteria and lambing pattern of sheep according to Musa *et al.* (2006).

Result and Discussion

Reproductive performance of sheep

In this study reproduction performance of sheep is assessed by their age at sexual maturity, age at first lambing, lambing interval, weaning age and lambing pattern.

Age at sexual maturity (ASM)

The age at sexual maturity of common highland ram in Atsibi-wonberta was 10.33±2.66 months. While the age at sexual maturity of *Elle* (Afar) ram was 6.87±0.86 and 8.03±1.09 months in Alamata and Enderta districts respectively (Table 2). Similarly, common highland rams (in Ofla, Wukro-kilteawlaelo and Degua-Tembien districts) attains sexual maturity at earlier age than Atsibi with average age of 6.7±0.84, 7.03±1.03 and 7.7±0.99 months respectively. The age at sexual maturity primarily depends on the nutrition supply during the growth period. Well fed ewe lambs may reach puberty at nine months, but when nutrition is poor, puberty may occur as late as twenty months (Gatenby and Humbert, 1991). But the result is not agreed with this range.

Age at first lambing (AFL)

The overall estimated mean age at first lambing of ewes in Astibi-wonberta, Wukro-kilteawlaelo, Ofla, Alamata, Enderta and Degua-Tembien sheep was 18.15, 16.77, 16.7, 16.83, 17.77 and 16.77 months, respectively (Table 2). This variation may be due to season of birth, litter size, maternal parity, nutrition and body condition score. This finding is comparable with previous works done on other breeds in different parts of Ethiopia. For instance, the age at first lambing for Gumuz sheep is 22.22 months (Beniam, 1992) and 13.67 months (Solomon, 2007). However, that of washera and menz sheep breed is 15.46 (Mengstie, 2008) and 18.5 (Abebe, 1999) months respectively. Similarly, the age at first lambing was 17.06 months reported by Niftalem (1990), for Menz breed at Debre Brehan. Generally, this result is in agreement with the report of Wilson and Murayi (1988) they indicated that age at first lambing for most of traditionally managed African ewes' ranges from 15 to 18 months. Similarly, the average ages of lambing for semi-arid and subhumid sub-Saharan countries were 16.9 and 16.2 months, respectively (Otte and Chilonda, 2002). This implies that the sheep breeds in the study area have acceptable age range for breeding though it is late compared to temperate breeds that reach puberty at the age range of 5-12 months (Susan, 2011).

Lambing interval (LI)

The estimated mean lambing interval of highland sheep in Atsibi-Wonberta (9.6±0.7), Wukro-Kilteawlaelo (8.3±0.8), Ofla (6.3±0.7), Enderta (10.4±0.6), Degua-tembien (8.4±0.5) and Afar (Elle) sheep in Alamata is 7.6±0.5 months respectively as presented in (Table 2). Lambing interval is affected by nutrition and management (Aseidu *et al*., 1983), season (Wilson and Murayi, 1988; Peacock, 1996; Abebe, 1999), sex and breed (Wilson and Durkin, 1983), and year of lambing (Niftalem, 1990). Previous study of Solomon (2007) reported that the average lambing interval of Gumuz breed was 6.64 ± 1.13 months. Aseidu *et al*. (1983) also reported that in western African sheep ewes lambed at even 6 months interval without provision of any supplementary feeding and these sheep breeds in this study area can be considered as one of such Eastern African sheep ewes. It has been reported that the lambing interval of black head Somali (BHS) sheep was 10.9 ± 2.33 months in Shinile and 10.01 ± 2.77 months in Erer district (Fekerte, 2008) and 10.53 months in Werer research station (Beniam, 1992). Peacock (1996) also reported the lambing interval of red Maasai sheep in Kenya pastoral areas 10.4 months. Similarly, the lambing interval for Menz breeds 13.17 months (Niftalem, 1990) and 8.37 months (Abebe, 1999) for the same breed. The lamping interval of Gumuz sheep also 6.64 months (Solomon, 2007).

Table 2. Reproductive performance (mean ± SD) of sheep in the study districts.

Name of Districts	ASM (mean)		AFL	LI
	Male(mean ±SD)	Female(mean ±SD)	mean± SD	mean± SD
Atsibi-Wonberta	10.33 ±2.66	11.37 ±2.22	18.15±2.15	9.6±0.7
Wukro Kilteawlaelo	7.03 ±1.03	8.43 ±0.89	16.77±1.22	8.3±0.8
Ofla	6.7 ±0.84	8.30 ±0.92	16.7±0.99	6.3±0.7
Alamata	6.87 ±0.86	7.97±0.81	16.83±1.02	7.6±0.5
Enderta	8.03 ±1.09	9.27±0.83	17.77±0.86	10.4±0.6
Degua-Tembien	7.7 ±0.99	8.9±1.03	16.77±1.19	8.4±0.5

* ASM= age at sexual maturity, AFL= age at first lambing and LI= lambing interval

Table 3. Summary of reported weaning age of sheep in the study area.

District		Average weaning age		
		3-4 months	5-6 months	>6 months
Atsibi-Wonberta	N	10	11	9
	%	33.33	36.67	30
Wukro-Kilteawlaelo	N	12	18	-
	%	40	60	-
Ofla	N	7	10	13
	%	23.33	33.33	43.33
Alamata	N	17	13	-
	%	56.67	43.33	-
Enderta	N	11	8	11
	%	36.67	26.67	36.67
Degua-Tembien	N	9	21	-
	%	30	70	-

* N= Number of Animals

Table 4. Lambing pattern of sheep in the study area

Months	Rank			Index
	R1	R2	R3	
January	20	40	4	0.14
March	-	-	4	0.004
May	1	-	21	0.02
August	-	-	3	0.003
September	21	3	26	0.09
October	27	26	64	0.19
November	31	65	40	0.26
December	80	46	18	0.34

*R1= rank 1, R2= rank 2and R3= rank 3

Table 5. Breeding rams selection criteria and ranking of the importance of these criteria

Criteria	R 1	R2	R 3	I
Size	127	21	33	0.42
Color	27	132	8	0.33
Horn	18	5	95	0.15
Ear	-	-	9	0.01
libido	8	14	19	0.07
Tail length	-	8	16	0.03

* R1, R2 and R3 = rank 1, 2 and 3 respectively. I= index

Weaning age of sheep

The average reported weaning age of sheep is summarized in Table 3. According to the respondents, the overall average weaning age was greater than three months in all of the study districts. In Atsibi-wonberta district about 33.3% (N=9) of the farmers allow the lamb to suckle their ewes for three to four months. However, the remaining weans their lambs five to six months (36.67 %) of age. Majority (60%) of the respondents in Wukro-kilteawlaelo reported that weaning takes place at five to six months of age. The rest wean three to four months. Generally the average weaning age of sheep in Wukro-kilteawlaelo, Alamata and Degua-Tembien districts was three to six months. But, in Atsibi-wonberta (30%), Ofla (43.33%) and Enderta (36.67%) districts the average weaning age was greater than six months. This increase in weaning age in the later districts might be due to the cold climatic condition and shortage of feed.

Lambing pattern

The distribution of lambing in the study districts ranged from September to January (Table 4). According to the index ranked by respondents, lambing of sheep was the highest during the months of December and November with an index value of 0.34 and 0.26, respectively, and the least during the months of August and March with an index value of 0.003 and 0.004, respectively. In general, most lambing pattern occurred during the dry season indicating that conception rates are highest during the long rain season. This result is partially in agreement to the reports of Agyemang *et al.* (1985), and Niftalem (1990) for the menz breed, both on-station and on-farm flocks around Debre Berhan area, where most lambing occurred during the small and big-rainy seasons, which might be attributed to the difference in the availability of feeds at conception in the study areas. Moreover, variation in the size of land holdings to have low grazing land, the amount of availability of fallow lands and shortage of communal grazing lands which are major sources of feed might have contributed for the difference in the season of lambing for the study areas.

Breeding objectives and adaptive traits

Clear definition of breeding objectives might be difficult under subsistence level of managements with a wide range of production objectives and marketing strategies (ILRI, 2006). In general, the results of this study suggested that farmers have multiple breeding objectives. These include large body size, coat color type (white, *Jimo,* red or brown and their combination), long and broad tails, early growth/meat production and reproduction, fertility and some adaptive traits in order of their importance. As the farmers said this is in order to get marketing value and then to get large amount of income. In this case an experience from the approaches used by Workneh *et al* (2004) was followed; the traits considered for improvement were production (meat), reproduction, Adaptation and conformation (aggregate of features including color, horns and size). This report was partially in agreement with the previous study of Zewdu (2008) in Adiyo Kaka and Horro districts. As mentioned by the respondents, in the study area the adaptive traits of sheep were drought tolerance, cold tolerance (Atsibi- wonberta, Ofla and Degua-Tembien distrcts) and heat tolerance walking ability and prolificacy and utilization of feed (Alamata district),. This present study is also agreed with (FAO, 1999, Solomon, 2008) reported that the ability of animals to survive natural calamities is necessarily more important than high productivity. In Alamata and Enderta districts Elle (Afar) sheep and goats were ranked next to camel in adaptability of water shortage. This might be due to sheep had low water requirement than bovine species and it might be because of their fat tailed. Similarly, (Rancourt *et al*., 2006) report that fat tailed sheep breeds can store energy for the dry seasons

Ewe and ram selection criteria

Sheep owners in the present study area also considered both morphological and production selection criteria with slightly more emphasis given for morphological characteristics for ram selection than for replacement ewe selection. It was because of this fact that farmers did not report on selection criteria of ewe. The current study showed that body size ranked first with an index of 0.42 for selection of breeding rams. Coat colour, horn, mating performance, tail and ear length was ranked second, third, fourth and fifth respectively for whole population (Table 5). Sheep breeders in Atsibi-wonberta,Wukro-kilteawlaelo, Ofla, Degua-Tembien and some part of Enderta districts prefer horned, long eared ram having a colour of white, red, red brown, grey (*Jimo*) with light red at the back, medium tail fat and ram having good body size. While, sheep breeders in Alamata and some part of Enderta districts that having Elle (Afar) breed prefers polled, short eared ram having a colour of white/creamy with light red at the back, medium tail fat and ram having good conformation. Similar results for Menz and Afar sheep breeds were also studied by Tesfaye (2008). In the study area for ram selection, farmers target was not only for breeding purpose but also they take into consideration the factors or traits that affected the market value and fattening ability of the ram after breeding. For instance, completely black ram in color, ram with abnormal legs, short ear and tail, ram with no horn and small size ram are not selected because such type of ram do not attract buyers and obtained low price. According to respondents, rams with any defects or visible injuries on testis, a ram with one testis descended or with unequal size of testes and having poor libido was not selected for breeding.

Conclusions

Generally the reproductive performance of sheep in this study area implies that the sheep breeds have acceptable age range for breeding though it is late compared to temperate breeds. In the study area for ram selection, farmers target was for breeding purpose and market value and fattening ability of the ram. Because of this, Sheep producers in the study area select breeding rams based on the physical appearance such as size, color, horn, tail, conformation and libido and hence to improve the productivity of sheep in the study area the farmers and livestock experts should give more emphasis on the economically important traits rather than qualitative traits.

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Breeding strategies to exploit trypanotolerance attributes of Sheko cattle breed in Ethiopia

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Abstract

Among Ethiopian cattle breeds, the taurine Sheko has long been considered trypanotolerant; however, its population has worryingly been dwindling rapidly in recent years. Alternative breeding schemes were simulated and compared for Sheko cattle conservation, genetic improvement and utilization both as pure breed and through introgression of its trypanotolerant genes into Gurage and Horro cattle breeds through crossbreeding. Twelve alternative schemes varying in terms of type of breeding population (entirely village herds or a combination of nucleus and village herds) and type of mating (natural mating or combinations of natural mating and artificial insemination) were simulated and evaluated for pure breeding. In the crossbreeding studies, first the relative importance of breed differences under mating of unselected parents was evaluated. Then, genetic gain per trait per year was estimated using deterministic modeling when crossbreeding programs are concurrently run with selection schemes for Sheko. The genetic gains for each trait were fairly comparable across the schemes under natural mating at a given number of cows assigned per bull. Artificial insemination tremendously improved the genetic gains relative to the natural mating particularly in schemes involving larger herd sizes. Considerable improvement can be achieved by crossing Sheko with Gurage not only for adaptive traits but also for production traits. Unlike in the SxG crosses, expected improvement in performance of SxH relative to Horro was very trivial. The different alternatives compared for conservation and genetic improvement of Sheko revealed the possibility to achieve substantial genetic gains within a breed. Crossbreeding Sheko with other trypano-susceptible breeds like Gurage may provide an opportunity to improve both trypanotolerance and production levels of cattle in areas affected by tsetse-trypanosomosis challenge and keeping other more productive breeds is not possible.

Keywords: Trypanotolerance, Sheko, Gurage, Horro, Conservation, Deterministic simulation

Introduction

In Ethiopia, where 96% of the total cultivated land is at present plowed with oxen power, trypanosomosis is one of the major impediments to livestock development and agricultural production. The affected area has been variously estimated to be in the range of 180,000-200,000 km^2 of agriculturally suitable land in the west and southwest of the country home to about 14 million cattle and small ruminants each, nearly 7 million equine and 1.8 million camels prone to contracting trypanosomosis at any time (Langridge, 1976 and MoARD, 2004, cited by Lemecha et al., 2006). Slingenbergh (1992) gives 220,000 km^2 as the highest estimate of tsetse infested land based on the maximum dispersal of the flies up to 2000 meters above sea level (m.a.s.l.) while

McDermott and Coleman (2001) estimate 9.6 million cattle inhabiting an area of 0.5 million km^2 of land to have been exposed to the risk of trypanosomosis.

The disease affects livestock productivity through mortality, abortion, decreased growth rates and stunting, loss of efficiency in animal traction and reduced fertility. Infections with *T. vivax* and *T. congolense* cause lesions in the male reproductive organs of cattle; the latter producing more severe effects (Leak, 1999). Synthesis of results from various comparative studies on herds under a combination of drug therapy and tsetse control routines (Swallow, 2000) indicated that incidence of the disease reduces calving rates by 1-12% and 11-20% and increases calf mortality by 0-10% and 10-20% in tolerant and susceptible breeds of cattle, respectively. It is clear that the condition under smallholder farmers or pastoralists that usually cannot afford the drug therapy can be worse. Calving rates of 80 and 60%, abortion rates of 2 and 10%, and crude mortality rates of 3 and 17% were recorded in low and high trypanosomosis risk areas of SW Ethiopia (Slingenbergh, 1992; Jemal and Hugh-Jones, 1992). One of the major consequences of infection with pathogenic trypanosomes is anemia. In acute infections, packed cell volume falls rapidly due to erythrophagocytosis. Moreover, hemorrhagic syndrome, particularly of the gastrointestinal tract, is seen in cattle with high parasitaemia due to infections with certain strains of *T. vivax* in Eastern Africa and is known to result in high mortality. Measurement of anemia gives reliable indication of disease status and performance (Naessens et al., 2002). Variations in tsetse density are believed to be the main factor responsible for the tsetse challenge and hence trypanosomosis prevalence in cattle (Leak et al., 1993) but presence of drug resistant trypanosomes also contributes to the observed prevalence rates (Rowlands et al., 1993). High average monthly prevalence rates of the disease have been reported from various parts of Ethiopia: 30% among adult cattle in Ghibe valley (Leak et al., 1993); 28.1% in villages of Asosa district, W Ethiopia (Mulaw et al., 2011); 20.9 and 25.7% in apparently tsetse-free and tsetse-infested areas, respectively, of Amhara region, NW Ethiopia (Cherenet et al., 2006); 17.2% among village cattle in Metekel area, W Ethiopia (Afewerk et al., 2000); and 14.2% in villages of Humbo district, S Ethiopia (Begna et al., 2011). For villages around Arba Minch, S Ethiopia (Teka et al., 2012) and Bench Maji, SW Ethiopia (Tadesse and Tsegaye, 2010), low prevalence rates of 4.43 and 4.4%, respectively, were recorded.

It has long been recognized that some breeds of cattle, as well as some species of wild *Bovidae* and *Suidae*, possess the ability to survive and be productive in tsetse-infested areas without the aid of treatment where other breeds rapidly succumb to the disease (Murray et al., 1990; Naessens et al., 2002). Trypanotolerance is the property of an animal that enables it to remain productive under tsetse-trypanosomiasis challenge through control of parasite proliferation, limitation of the pathological effects of the parasite, and acquired ability for better control of trypanosomiasis (Murray et al., 1982, 1990; d'Ieteren et al., 2000). The two most studied trypanotolerant breeds of cattle are the N'Dama and Baoule of west and central Africa. Most *B. indicus* cattle in tsetse infested areas require regular treatment or are found only on the fringes of fly belts whereas exotic breeds cannot be maintained even in areas of low tsetse risk without intensive drug therapy. Among Ethiopian cattle breeds, the taurine Sheko has long been considered trypanotolerant and recent empirical evidences strengthen such views (Lemecha et al., 2006; Taye, et al., 2007, 2012; Stein et al., 2009, 2011). Sheko cattle showed consistently superior performance for higher PCV, lower trypanosome prevalence rate, and lowest number of trypanocidal treatments compared to Abigar, Gurage and Horro in studies carried out at Ghibe valley (Lemecha et al., 2006; Stein, 2011) and in their breeding habitat (Stein et al., 2011). Scott and Pegram (1974) observed oxen remain in good working condition despite high tsetse challenge and incidence of infection during a herd monitoring work at Angar-Gutin, W Ethiopia. This is normally a Horro habitat and it might be that the oxen maintained good condition due to trypanotolerance. The objectives of this study were to design alternative breeding schemes for Sheko cattle breed, to trigger its conservation, genetic improvement and utilization with participation of communities, to study the potential benefits of introgression of trypanotolerant genes of Sheko into Gurage and Horro cattle breeds through crossbreeding.

Materials and Methods

Description of breeds and their habitats

Sheko cattle inhabit the humid agro-ecological zones of southwestern Ethiopia with the Sheko tribe in Bench-Maji zone (DAGRIS, 2007). The breed is the only surviving taurine in Ethiopia from ancient introductions of the taurine shorthorn types but is endangered in recent times due to replacement and/or interbreeding with zebu and Sanga types (DAGRIS, 2007). Altitude, mean annual temperature and mean annual rainfall of Sheko habitat range from 850 to 3000 m.a.s.l., 20°C to 40°C and 1200 to 2000mm, respectively (Taye et al., 2011). The area is characterized by warm and humid to per-humid climate with a tropical forest of high trees and savanna woodland. It is infested mainly with *G. pallidipes* followed by *G. fuscipes* (Lemecha et al., 2006). Recent empirical evidences (Lemecha et al., 2006; Stein, et al., 2011; Stein, 2011) corroborate the long held belief that Sheko cattle possess some degree of trypanotolerance similar to other West African taurine breeds such as N'Dama. Sheko keepers also recognize existence of trypanotolerance attribute among their herds (Stein, et al., 2011; Taye et al., 2012). Population of the breed is worryingly dwindling rapidly in recent years. According to Rege (1999), population estimate was 31,000 towards the end of the 1990s but few years later Taye et al (2007) reported only 4,040 animals (with 2,788 and 266 breeding female and male animals, respectively) based on a survey conducted in 2004/05. Very recently, complete inventory of the breed identified only 3,400 of these cattle (Asrat Tera, 2012, Pers. Comm.). In addition to disease tolerance, farmers reportedly recognize special characteristics and desirable qualities of the breed such as more milk yield and long lactation period, less selective feeding behavior and ability to maintain good body condition during times of feed scarcity; however, its reportedly voracious feeding habit and aggressive behavior were identified as main reasons for the breed to be replaced by zebu (Taye et al., 2009).

Horro cattle breed is widely distributed in western Ethiopia with main breeding tract in Horro Gudru zone (Rege and Tawah, 1999; DAGRIS, 2007). The breed is an intermediate type between zebu and Sanga and belongs to Zenga breed group. Its habitat has sub-humid to humid climate with moderately cool to high temperature. Vegetation cover is wooded savanna in the mid altitude areas ranging from 1300 to 1700 m.a.s.l. and crop-grassland vegetation in areas with altitude >1700 m.a.s.l. Trypanosome vector species are *G. m. submorsitans* and *G. tachinoides* and population of Horro cattle living with the disease challenge is increasing (Lemecha et al., 2006). The breed responded better to trypanocidal treatments than other breeds and also had significantly lower mortality at Ghibe station (Lemecha et al., 2006) and maintained high mean PCV levels and good reproductive performance in its home environment (Stein et al., 2011); both under trypanosomosis challenge suggesting that it may also possess some degree of trypanotolerance.

Gurage breed, also called Abysinian short-horned zebu, belongs to Small East African Zebu breed group and is found around the Guraghe and Hadiya areas in close proximity to the tsetse-infested valleys of the Ghibe tributaries (Rege and Tawah, 1999; DAGRIS, 2007). The area has sub-humid to humid climate with moderately hot temperature (maximum 35°C), mean annual rainfall ranging between 900 and 1500mm and an altitude that ranges from 1200 to 1800 m.a.s.l. (Lemecha et al., 2006). Vector fly species found here are *G. pallidipes*, *G. fuscipes* and *G. submorsitans*. Gurage cattle were found to be highly susceptible to trypanosomosis infection at Ghibe station (Lemecha et al., 2006; Stein, 2011) as well as in their home environment (Stein, et al., 2011) in all indicator traits, i.e., parasitaemia, PCV, survival, fertility and production performance.

Deterministic simulation studies

Alternative schemes for conservation and improvement of Sheko cattle

Twelve alternative schemes (Table 1) differing in population size and whether village herds alone or a combination of village and nucleus herds are used were simulated and compared using the PC program ZPLAN (Willam et al., 2008). For schemes 1, 2, and 3, only village-based options with herd sizes of 510, 750 and 1000 breeding cows, respectively were assumed whereas combinations of nucleus and village herds (nucleus cows representing 15, 20 or 25% of the total herd) were assumed for schemes 4 to 12. The smallest herd size was determined as the critical minimum required to perpetuate itself without undergoing population decline given the assumed productive life, reproductive, survival, and replacement rates. Defined selection groups and the gene transmission matrix are given in Table 2. Mode of dissemination of the genetic progress achieved in the nucleus to the village herds was assumed to be through male selection groups only. For the entirely village-based options, variation runs were tested with regard to number of cows per bull (CB20 and CB10 = 20 or 10 cows per bull) using natural mating (NM) alone. Variation runs for schemes 4 – 12 were based on the two levels of cows per bull and two types of mating, NM and AI. In total, 42 alternatives were evaluated (3*2 for entirely village-based and 9*2*2 for nucleus-village herds combinations). It was envisaged that nucleus bulls serve 75% of the village cows. The remaining 25% village cows were assumed to be naturally mated with bulls selected from village herds.

Table 1. Alternative schemes for Sheko breed conservation and improvement

Scheme	Village cows	Nucleus cows	Proportion of nucleus	Total cows
1	510	-	-	510
2	750	-	-	750
3	1000	-	-	1000
4	510	90	0.15	600
5	510	128	0.20	638
6	510	170	0.25	680
7	750	132	0.15	882
8	750	187	0.20	938
9	750	250	0.25	1000
10	1000	176	0.15	1176
11	1000	250	0.20	1250
12	1000	333	0.25	1333

Crossbreeding

The genetic gains expected from using Sheko sires over Gurage or Horro dams in a two-way crossbreeding program with the main objective of boosting trypanotolerance were compared under two scenarios. First, based on relative importance of breed differences under current scenario (mating of unselected parents), the mean performance of crossbred offspring were predicted and compared relative to the mean of the dam breed population with or without considering heterosis under two mating designs: backcrossing F1 females to Sheko sires or continuous *inter se* mating among F1 progeny to produce F2. Modest levels of individual and maternal heterosis (two last columns of Table 6) were used to predict the extra improvement above the mid-parent mean values using methods described by Olson (2011). In the second scenario, the genetic gain per trait per year was estimated using deterministic modeling when crossbreeding programs are concurrently run with selection schemes for Sheko and some degree of performance recording and relaxed selection of sires of dams among Gurage or Horro population is practiced. Selection groups and the gene transmission matrix are given in Table 3. Only the nucleus herd of Sheko with the largest size (333 cows) assumed in the pure breeding programs was chosen to estimate potential gains from crossbreeding. Sensitivity analyses were repeated at three levels of cows assigned per bull (CB55, CB20 and CB15). Furthermore, the genetic gains in the objective traits were tested with 2000, 5000, 10,000, and 15,000 dams of Gurage or Horro.

Table 2. Transmission matrix of the breeding plan: (a) four selection groups in the entirely village-based schemes and, (b) nine selection groups in the nucleus-village herds combinations.

	(a) Village herds only			(b) Nucleus-village herds			
	VB	VC		NB	NC	VB	VC
VB	1.VB > VB	2.VC > VB	NB	1.NB > NB	2.NC > NB	-	-
VC	3.VB > VC	4.VC > VC	NC	3.NB > NC	4.NC > NC	-	-
			VB	5.NB > VB	-	-	6.VC > VB
			VC	7.NB > VC	-	8.VB > VC	9.VC > VC

NB = nucleus bull; NC = nucleus cow; VB = village bull; VC = village cow

Essential input parameters for ZPLAN are presented in Table 4. Traits included in the breeding goal were growth (body weight at 2 yr. of age, WT24), lactation milk yield (LMY), age at first calving (AFC), calving interval (CINT), calf survival (SURV), packed red cell volume (PCV), and parasitaemia (INFR); the latter two as proxy for trypanotolerance. These traits were determined based on farmers' preferences reported earlier (Stein et al., 2009; Taye et al., 2011). Table 5 shows assumed genetic and phenotypic parameters derived from literature. Estimate of economic values for the various traits of livestock is not available in Ethiopia. Relative economic weights used in the present study were set after several sensitivity test runs starting with index weights calculated from data previously reported on preference of farmers for cattle traits (Taye et al., 2011). Index for a given trait was calculated as ((3*proportion of farmers that ranked a trait as first + 2*proportion of farmers that ranked a trait as second + 1*proportion of farmers that ranked a trait as third)/sum of (3*proportion of farmers that ranked a trait as first +2*proportion of farmers that ranked a trait as second + 1*proportion of farmers that ranked a trait as third for all traits in the list)).

Table 3. Selection groups and gene flow pathways for crossbreeding programs

	NB	ND	SVB	SVD	G/HB	G/HD
NB	1.NB > NB	2.ND > NB	-	-	-	-
ND	3.NB > ND	4.ND > ND	-	-	-	-
SVB	5.NB > SVB	-	-	6.SVD > SVB	-	-
SVD	7.NB > SVD	-	8.SVB > SVD	9.SVD > SVD	-	-
G/HB	-	-	-	-	10.G/HB > G/HB	11.G/HD > G/HB
G/HD	-	-	-	-	12.G/HB > G/HD	13.G/HD > G/HD
F1	14.NB > F1	-	-	-	-	15.G/HD > F1

NB = nucleus bull; ND = nucleus dam; SVB = Sheko village bull; SVD = Sheko Village dam; G/HB = Gurage or Horro bull; G/HD = Gurage or Horro dam

ZPLAN, written in FORTRAN and designed to optimize breeding strategies in livestock breeding by deterministic calculations, allows a flexible modification of existing subroutines to model desired breeding scenarios as realistically as possible. It is based on comprehensive evaluation of the genetic and economic efficiencies of the breeding strategies considering one cycle of selection. Important outcomes of ZPLAN include the annual monetary genetic gain (AMGG) for the aggregate genotype and the annual genetic gain for each trait but also the discounted return and discounted profit for the investment period. Selection index procedures and the gene flow method constitute core of the program. The selection index depends on the type and number of information sources available for evaluation of individual candidate. For the current study, selection index for male candidates was based on own and sire's performance records on WT24, PCV and INFR and dam's records for LMY, AFC, CINT, SURV, PCV and INFR. For female candidates, it was based on own and dam's records on LMY, AFC, CINT, SURV, PCV and INFR. This version of ZPLAN cannot consider inbreeding and reduction of the genetic variance due to selection. Approximate rates of inbreeding per generation (ΔF) and the effective population sizes (N_e) were estimated as:

$$\Delta F = (1/(8N_m))+(1/(8N_f)), \text{ and}$$

$N_e = 4(N_m*N_f)/(N_m+N_f)$, where N_m and N_f refer to male and female breeding animals, respectively (Falconer and MacKay, 1996).

Table 4. Population and biological parameters

Parameters	Sheko	Gurage	Horro
Population parameters (total number of breeding cows)			
S pure breeding			
Scheme 1	510	-	-
Scheme 2	750	-	-
Scheme 3	1000	-	-
Scheme 4	600	-	-
Scheme 5	638	-	-
Scheme 6	680	-	-
Scheme 7	882	-	-
Scheme 8	938	-	-
Scheme 9	1000	-	-
Scheme 10	1176	-	-
Scheme 11	1250	-	-
Scheme 12	1333	-	-
Crossbreeding (S[1] x G or S x H)			
2000 dams of F1	333	20,000	10,000
5000 dams of F1	333	50,000	25,000
10000 dams of F1	333	100,000	50,000
15000 dams of F1	333	150,000	75,000
Biological parameters			
Duration of use of breeding cows in time units (tu)[2]	5	6.5	5.5
Duration of use of dams of F_1 in tu	-	6.5	6
Duration of breeding bull use in tu	3	3	3
Mean age of cows at birth of first offspring (AFC), yr.	4.0	5.0	4.2
Mean age of bulls at birth of first offspring, yr.	3	3.5	3
Mean time between subsequent calving (CINT), yr.	1.3	1.33	1.3
Proportion of calves surviving	0.85	0.75	0.80
Mean calving rate	0.75	0.67	0.75
Survival among adult animals	0.90	0.85	0.88
Cost parameters			
Interest rate return	0.03	0.03	0.03
Interest rate costs	0.07	0.07	0.07
Investment period, years	25	25	25

[1]Only the nucleus herd of Sheko cattle with the largest size (333 cows) assumed in the pure breeding programs is chosen for the crossbreeding program. [2]In cattle, one time unit corresponds to one year.

Table 5. Estimates of heritability (diagonal elements), genetic correlations (above diagonal) and phenotypic correlations (below diagonal)

Selection traits	Unit	1.	2.	3.	4.	5.	6.	7.
1.WT24	Kg	**0.35**	0.20	-0.20	0.00	0.30	0.70	-0.10
2.LMY	Liters	0.10	**0.25**	0.02	0.20	0.20	0.50	0.00
3.AFC	Months	-0.20	0.10	**0.10**	0.02	0.00	-0.30	0.00
4.CINT	Months	0.00	0.07	0.07	**0.05**	0.00	-0.30	0.20
5.SURV	%	0.20	0.30	0.00	0.00	**0.05**	0.50	-0.30
6.PCV	%	0.30	0.30	-0.20	-0.20	0.50	**0.35**	-0.35
7.INFR	Freq.	0.00	0.00	0.00	0.20	-0.30	-0.20	**0.20**

Sources: Bosso et al. (2009); Trail et al. (1991); Lobo et al. (2000); Dahlin, 1998; Janssen-Tapken (2009).
WT24 = body weight at 2 yr. of age; LMY = lactation milk yield; AFC = age at first calving; CINT = calving interval; SURV = calf survival; PCV = packed red cell volume; INFR = infection rate or parasitaemia.

Table 6. Mean, phenotypic standard deviation (σ_p), relative economic weights (Econ. Wt), percent individual (H_I) and maternal (H_M) heterosis

Selection traits	S		G		H		Econ. Wt	H_I (%)	H_M (%)
	Mean	σ_p	Mean	σ_p	Mean	σ_p			
1.WT24	109.9	20.7	81.0	17.0	107.0	23.2	19.28	2.5	3.0
2.LMY	627.0	156.75	340.0	85.0	550.0	137.5	30.72	2.5	3.0
3.AFC	48.0	11.76	60.0	12.6	50.4	11.60	-9.96	-3.0	-3.5
4.CINT	15.6	2.18	16.0	2.18	15.6	2.18	-10.51	-3.0	-3.5
5.SURV	85.0	18.55	75.0	18.75	80.0	16.8	12.98	2.0	2.5
6.PCV	25.1	4.49	22.7	4.5	26.2	4.53	10.27	2.5	3.0
7.INFR	8.30	2.49	27.4	8.22	23.2	6.96	-6.28	-3.0	-3.5

WT24 = body weight at 2 yr. of age; LMY = lactation milk yield; AFC = age at first calving; CINT = calving interval; SURV = calf survival; PCV = packed red cell volume; INFR = infection rate or parasitaemia.

Results

Pure breeding

Average number of replacement animals required per year, estimates N_e and ΔF for the different schemes and scenarios are shown in Table 7. All the entirely village-based options resulted in acceptable levels of N_e and ΔF. Among these, scheme 1 had the highest ΔF of 0.51% and lowest N_e of 97.14, which are acceptable. On the other hand, all the AI-based scenarios and some scenarios of NM under schemes 4-12 resulted in high estimates of ΔF and very low N_e and hence, given the current status of Sheko cattle, estimates of genetic gains for these scenarios are not good enough and hence unrealistic. Selection intensities (figures not shown) for the sire selection groups in the breeding unit (1.VB > VB, 3.VB > VC, 1.NB > NB, and 3.NB > NC, see Table 2) were moderately high and differed little in all evaluated breeding programs under natural mating (e.g. selection intensities of 1.89 vs. 1.93 in schemes 12 and 3, respectively under CB20 and 1.58 vs. 1.60 in schemes 12 and 3, respectively under CB10). However, nucleus sires to be used in the village (5.NB > VB and 7.NB >

VC, Table 2) were less intensively selected under natural mating with intensities of 0.21and 0.83 at the CB10 and CB20, respectively, of scheme 4 variations. The corresponding intensities for the variations of scheme 12 were 0.58 and 1.08. On the other hand, village sires (8.VB > VC, Table 2) were more intensively (e.g. selection intensity of 2.28 and 2.32 under schemes 4 and 12, respectively at CB20) but less accurately selected. Selection accuracy for this group was very low at 0.15 compared to 0.69 and 0.67 for sire and dam selection groups in the nucleus. Dam selection lines were also less intensively selected (selection intensity ranging from 0.33 in scheme 1 to 0.31 in scheme 4). Generation intervals, as would be expected, were longer for the dam selection groups compared to sire selection pathways (7.16 vs. 4.13 yr.).

The genetic gains per year obtained for each objective trait under the different evaluated scenarios are shown in graphs consecutively numbered *a.* to *g.* (Figure 1). The genetic gains for each trait remained fairly comparable across the schemes under natural mating at a given number of cows assigned per bull both with the entirely village-based (schemes 1 – 3) and schemes that combine nucleus and village herds (schemes 4 – 12). With respect to number of cows per bull, genetic responses to selection obtained with CB20 were found to be consistently higher than those with CB10 both under NM and AI scenarios. As would be expected, AI tremendously improved the genetic gains relative to the natural mating particularly in schemes involving larger herd sizes. Thus, the lowest genetic gains per year for all the objective traits were with CB10 under natural mating whereas the highest gains were from AI-based scenarios beginning with CB20 in scheme 4. For instance, under schemes 1 and 12 of these two scenarios, respectively, the genetic gains ranged from 1.28 to 1.76 kg for WT24, 4.26 to 5.85 kg for LMY, -0.12 to -0.17 months for AFC, -0.012 to -0.016 months for CINT, 0.23 to 0.32 % for SURV, 0.31to 0.43 % for PCV, and -0.05 to -0.06 for INFR. The trend for AFC, CINT and INFR were all negative and favorable. Figure 1(*h*) shows the AMGG. Similar to the natural genetic gains for the objective traits, relatively the lowest AMGGs were obtained in schemes with CB10 under natural mating whereas the highest were from schemes that made use of AI (and CB20 for the 25% village cows). AMGG is a measure of the average monetary superiority per year of the progeny of the selected animals of one selection cycle (i.e. the improvement in breeding values). In the context of this study, AMGG is a function of the sum of genetic gain in individual breeding objective trait and their corresponding relative economic values and hence should be considered as the percent overall improvement in breeding values.

Crossbreeding

Table 8 presents the expected performance levels of crossbred progeny of Sheko and Gurage (SxG). The values for the crossbred progeny were estimated under two scenarios: 1) from mid-parent mean values disregarding heterosis, and 2) considering small amount of individual heterosis in F1 progeny and both individual and maternal heterosis in F2 progeny. As may be seen from Table 8, there appears to be considerable improvement to be made by crossing Sheko with Gurage not only for adaptive traits but also for production traits even in the absence of heterosis. For instance, LMY, WT24 and PCV increase by 143.5 kg (42.21%), 14.45 kg (17.84%) and 1.2 (5.29%), respectively and AFC and INFR each decrease by 6.0 months (10%) and 9.55 (34.85%) in F1 SxG compared to mean performance of Gurage. With small heterosis levels, LMY, INFR, WT24, AFC, and PCV improve by 45.76%, 36.80%, 20.78%, 12.70%, and 7.91%, respectively. In the F2 backcross progeny, the corresponding expected improvement levels were 63.31%, 52.28%, 26.76%, 15%, and 7.93%, respectively based only on mid-parent mean values and 70.31% (239.06 kg), 54.64% (14.97), 32.19% (26.8 kg), 19.20% (11.52 months), and 12.55% (2.85), respectively when further improvement potentials due to individual and maternal heterosis were taken into account.

Table 7. Herd sizes (average number of replacements per year), effective population size (*Ne*) and approximate rate of inbreeding (*ΔF*) for village and nucleus herds of Sheko when either NM or AI in combination with NM is used under the two levels of number of cows per bull

		NM						AI[1]			
		CB20			CB10			CB20		CB10	
Scheme	VC	VB	*Ne*	*ΔF*	VB	*Ne*	*ΔF*	*Ne*	*ΔF*	*Ne*	*ΔF*
1	510 (102)	25 (8.5)	97.14	0.0051	51 (17)	185.45	0.0027				
2	750 (150)	37 (12.5)	142.86	0.0035	75 (25)	272.73	0.0018				
3	1000 (200)	50 (16.67)	190.48	0.0026	100 (33.33)	363.64	0.0014				
	NC	NB			NB						
4	90 (18)	5 (1.5)	17.14	0.0292	9 (3.0)	32.73	0.0153	17.14	0.0292	32.73	0.0153
5	128 (25)	6 (2.0)	27.74	0.0202	13 (4.25)	46.55	0.0107	17.39	0.0288	33.64	0.0149
6	170 (34)	9 (3.0)	32.38	0.0154	17 (5.67)	61.82	0.0081	17.54	0.0285	34.19	0.0146
7	132 (26)	7 (2.2)	25.14	0.0199	13 (4.4)	47.34	0.0106	17.41	0.0287	33.70	0.0148
8	188 (38)	9 (3.0)	35.81	0.0140	19 (6.25)	68.63	0.0073	17.58	0.0284	34.36	0.0146
9	250 (50)	13 (4.0)	47.62	0.0105	25 (8.33)	90.91	0.0055	17.68	0.0283	34.75	0.0144
10	176 (35)	9 (3.0)	33.52	0.0149	18 (6.0)	64.00	0.0078	17.55	0.0285	34.25	0.0146
11	250 (50)	13 (4.0)	47.62	0.0105	25 (8.33)	90.91	0.0055	17.68	0.0283	34.75	0.0144
12	333 (67)	17 (5.5)	63.43	0.0079	33 (11)	120.10	0.0042	17.76	0.0282	35.05	0.0143

[1]Assumes same number of bulls across the schemes starting with that of scheme 4 under natural mating. It was further assumed that 75% of village cows are inseminated with semen from nucleus sires; the remaining village cows are naturally served. CB20 = 20 cows per bull; CB10 = 10 cows per bull; VC = village cows; VB = village bull; NC = nucleus cows; NB = bulls in the nucleus. Figures in parenthesis indicate number of animals replaced each year.

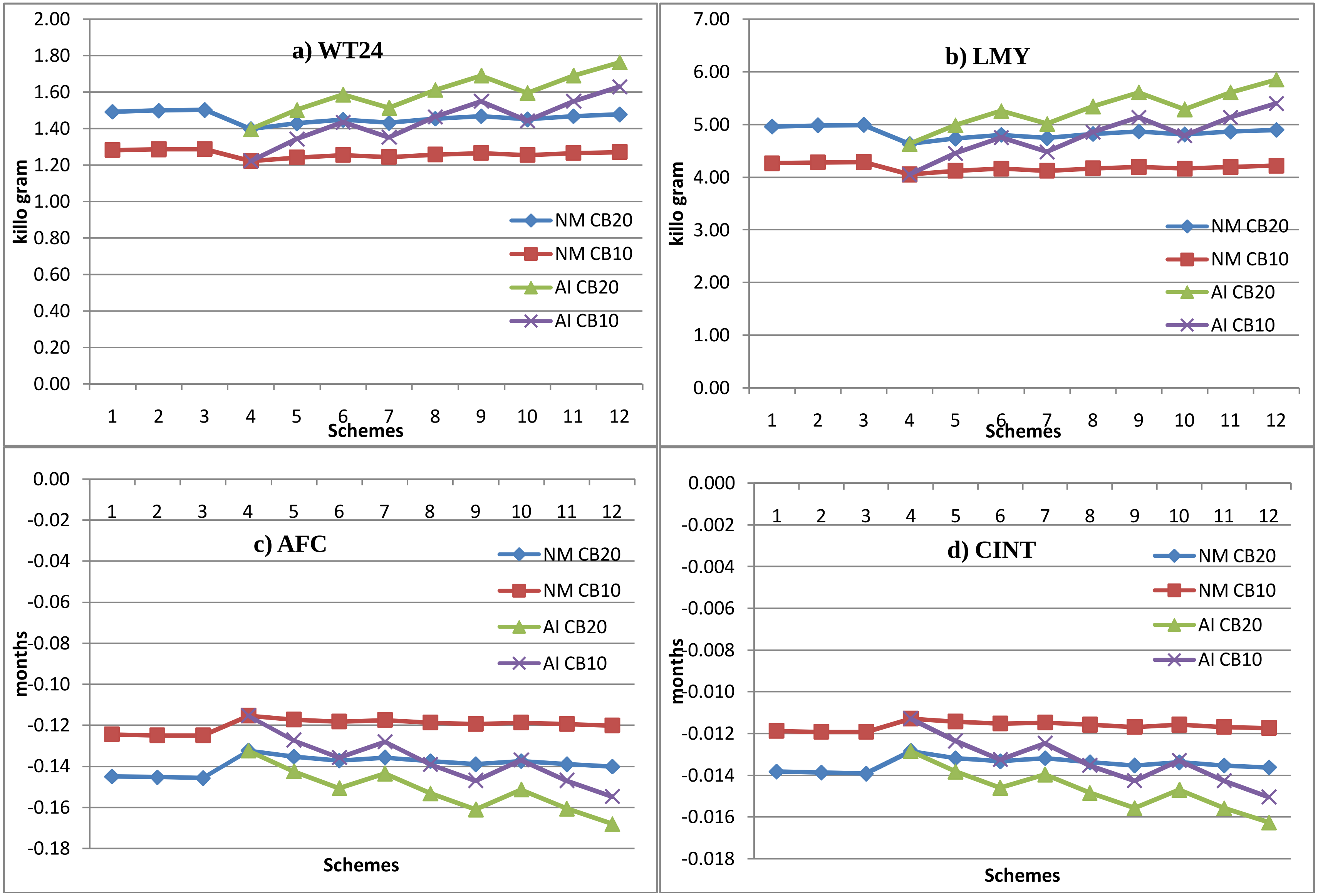

Figure 1. Predicted annual genetic gains: a) weight at two years of age, b) lactation milk yield, c) age at first calving and d) calving interval; NM = natural mating; AI = artificial insemination; CB20 = 20 cows per bull; CB10 = 10 cows per bull

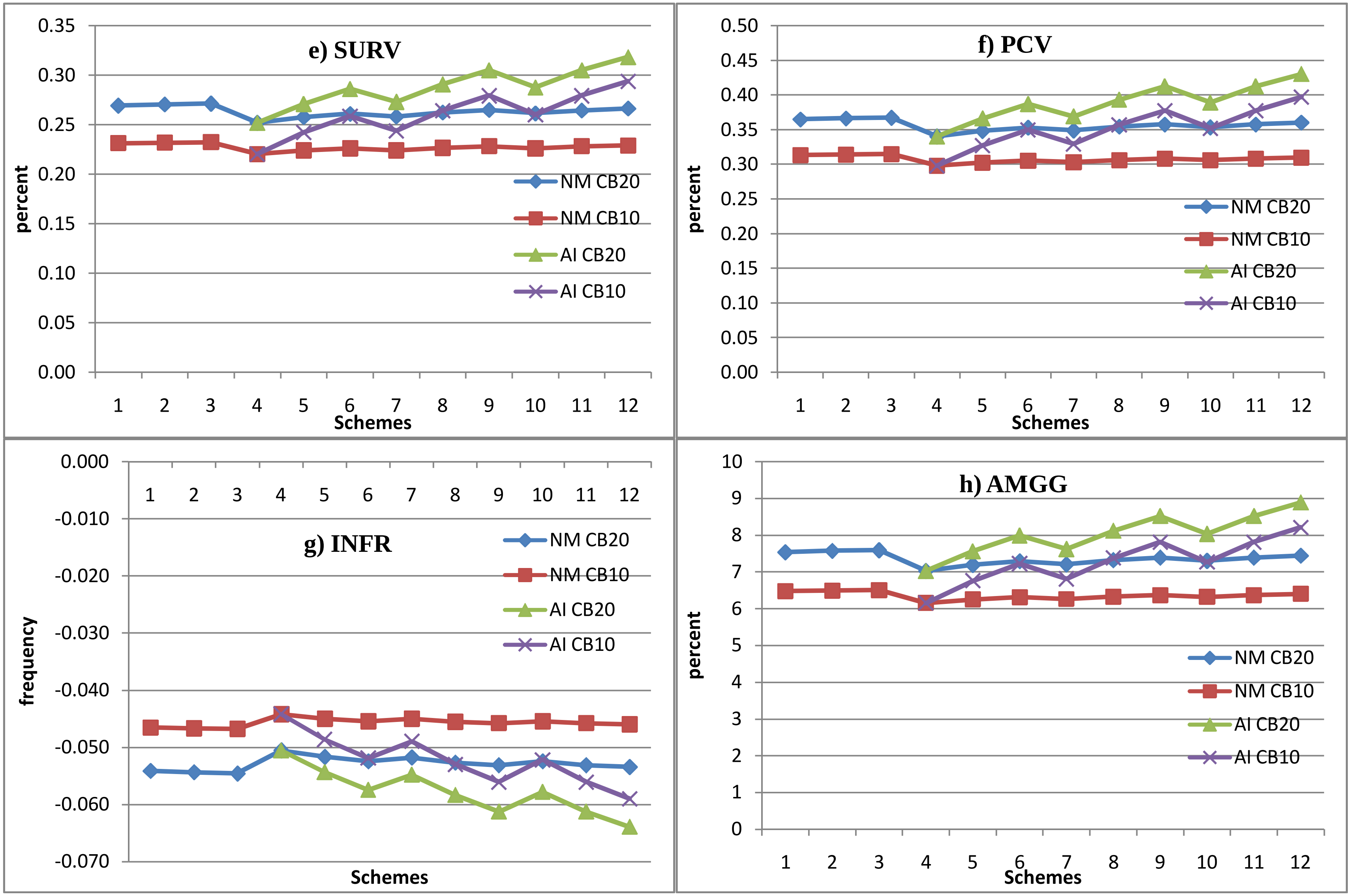

Figure 1 (Contd.). Predicted annual genetic gain: e) calf survival, f) packed red cell volume, g) parasitaemia, and h) annual monetary genetic gain; NM = natural mating; AI = artificial insemination; CB20 = 20 cows per bull; CB10 = 10 cows per bull

Table 8. Expected crossbred performance (ECP) from Sheko (S) and Gurage (G) crossing and percent improvements relative to the mean of dam breed

			F_1 (SxG)				F_2 (F_1 x F_1)[1]		Backcross (S x SG)			
	Purebred mean		H_I ignored		H_I considered		[2]H_I and [3]H_M considered		H_I and H_M ignored		H_I and H_M considered	
Traits	S	G	ECP	% change	ECP	% change	ECP	% change	ECP	% change	ECP	% change
1.WT24, kg	109.90	81.00	95.45	17.84	97.84	20.78	99.54	22.90	102.68	26.76	107.08	32.19
2.LMY, kg	627.00	340.00	483.50	42.21	495.59	45.76	504.23	48.30	555.25	63.31	579.06	70.31
3.AFC, mon.	48.00	60.00	54.00	-10.00	52.38	-12.70	51.33	-14.45	51.00	-15.00	48.48	-19.20
4.CINT, mon.	15.60	16.00	15.80	-1.25	15.33	-4.21	15.02	-6.14	15.70	-1.88	14.92	-6.73
5.SURV, %	85.00	75.00	80.00	6.67	81.60	8.80	82.82	10.42	82.50	10.00	85.41	13.88
6.PCV, %	25.10	22.70	23.90	5.29	24.50	7.91	24.92	9.80	24.50	7.93	25.55	12.56
7.INFR, freq.	8.30	27.40	17.85	-34.85	17.31	-36.80	16.97	-38.07	13.08	-52.28	12.43	-54.64

[1]In the absence of heterosis, the expected performance level of F_2 progeny should remain same to that of F_1 without heterosis. [2]H_I = individual heterosis. [3]H_M = maternal heterosis. WT24 = body weight at 2 yr. of age; LMY = lactation milk yield; AFC = age at first calving; CINT = calving interval; SURV = calf survival; PCV = packed red cell volume; INFR = infection rate or parasitaemia.

Table 9. Expected crossbred performance (ECP) from Sheko (S) and Horro (H) crossing and percent improvements relative to the mean of dam breed

			F_1 (SxH)				F_2 (F_1 x F_1)[1]		Backcross (S x SH)			
	Purebred mean		H_I ignored		H_I considered		[2]H_I and [3]H_M considered		H_I and H_M ignored		H_I and H_M considered	
Traits	S	H	ECP	% change	ECP	% change	ECP	% change	ECP	% change	ECP	% change
1.WT24, kg	109.90	107.5	108.70	1.12	111.42	3.64	113.36	5.45	109.30	1.67	113.99	6.03
2.LMY, kg	627.00	550.00	588.50	7.00	603.21	9.67	613.73	11.59	607.75	10.50	633.81	15.23
3.AFC, mon.	48.00	50.40	49.20	-2.38	47.72	-5.31	46.77	-7.21	48.60	-3.57	46.20	-8.34
4.CINT, mon.	15.60	15.60	15.60	0.00	15.13	-3.00	14.83	-4.95	15.60	0.00	14.83	-4.95
5.SURV, %	85.00	80.00	82.50	3.13	84.15	5.18	85.41	6.76	83.75	4.69	86.70	8.37
6.PCV, %	25.10	26.20	25.65	-2.10	26.29	0.34	26.75	2.09	25.38	-3.15	26.46	1.00
7.INFR, freq.	8.30	23.20	15.75	-32.11	15.28	-34.14	14.97	-35.47	12.03	-48.17	11.43	-50.73

[1]In the absence of heterosis, the expected performance level of F_2 progeny should remain same to that of F_1 without heterosis. [2]H_I = individual heterosis. [3]H_M = maternal heterosis. WT24 = body weight at 2 yr. of age; LMY = lactation milk yield; AFC = age at first calving; CINT = calving interval; SURV = calf survival; PCV = packed red cell volume; INFR = infection rate or parasitaemia.

The expected performance levels of crossbred progeny of Sheko and Horro (SxH) are shown in Table 9. Unlike in the SxG crosses, expected improvement in performance of SxH relative to Horro was very trivial except for that of INFR which showed a reduction by 32.11%, 32.11% and 48.17% in SxH, SHxSH and SxSH, respectively; all based on mid-parent mean alone. In F1, LMY, WT24 and SURV resulted in increase of 7%, 1.12%, and 3.13% whereas AFC and PCV decreased by 2.38 and 2.1%, respectively, the latter in an undesirable direction. With heterosis, the F1 showed slightly better performance than Sheko for WT24, AFC, and CINT but the gain in percentage points still remained low for these traits (3.64%, -5.31%, and -3%, respectively), compared to the improvement obtained from SxG crosses.

The predicted annual genetic gains per trait that accrue when crossbreeding programs are concurrently run with selection programs in Sheko are presented in Table 10. The genetic gains in the crossbred progeny were not influenced by the size of dam breed population and stayed relatively unchanged across the four levels investigated. This may make sense as the female selection paths in the dam breed population do not actually contribute to the genetic gains. However, the three scenarios compared with respect to number of Sheko bulls in use i.e., number of cows per bull, influenced the magnitude of genetic gain among Sheko herds as well as SxG and SxH crossbreds.

Table 10. Genetic gains per year for the single trait in the S x G or S x H crossbreeding schemes

	S			S x G			S x H		
Traits	[1]Case 1	[2]Case 2	[3]Case 3	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1.WT24, kg	1.80	1.56	1.48	1.15	1.02	0.98	1.25	1.13	1.09
2.LMY, kg	4.77	4.11	3.90	3.47	3.14	3.04	4.05	3.72	3.63
3.AFC, mon.	-0.15	-0.13	-0.13	-0.10	-0.09	-0.09	-0.12	-0.11	-0.10
4.CINT, mon.	-0.014	-0.012	-0.012	-0.009	-0.008	-0.008	-0.001	-0.009	-0.009
5.SURV, %	0.30	0.26	0.25	0.20	0.18	0.17	0.22	0.20	0.19
6.PCV, %	0.40	0.35	0.33	0.27	0.24	0.23	0.30	0.27	0.26
7.INFR, freq.	-0.064	-0.055	-0.053	-0.040	-0.036	-0.035	-0.044	-0.039	-0.038

[1]Case 1 = AI-based with 6 bulls in use (~CB55 in the nucleus); [2]Case 2 = AI-based with 16 bulls in use (~CB20 in the nucleus); [3]Case 3 = AI-based with 22 bulls in use (~CB15 in the nucleus). WT24 = body weight at 2 yr. of age; LMY = lactation milk yield; AFC = age at first calving; CINT = calving interval; SURV = calf survival; PCV = packed red cell volume; INFR = infection rate or parasitaemia.

CB55 (6 bulls in use, case 1) and CB15 (22 bulls in use, case 3) applied in the nucleus Sheko herd resulted in higher and lower genetic gains for all the objective traits considered and the scenarios compared. Case 1 is not realistic as it is bound to generate a ΔF of about 2% per generation and also has low N_e of ~24. Case 2 and 3, on the other hand, are safe with approximate ΔF per generation of 0.7% and 0.6%, and N_e of ~63 and ~83, respectively. It is worth noting that the changes for the reproductive traits remained very minimal as for AFC or very close to zero as in CINT.

Discussion

Pure breeding

The magnitude of genetic return per year per trait estimated in this study might appear very low for species such as cattle but should be viewed in relation to the small population sizes and the restrictions imposed to check ΔF and maintain relatively high N_e. Given the mean generation interval of 5.65 yr., progeny of the selected parents would, on average, weigh 8.40 kg at 2 yr., produce 27.70 kg milk per lactation, survive 1.5%, and have 2.03% PCV more than the base population even under the low genetic gain scenarios (e.g. scheme 12, CB20, and NM) that do not involve any risks due to low N_e and high ΔF. The corresponding reductions in AFC, CINT and INFR were 0.8 months, 0.08 months, and 0.3, respectively. The minimal genetic gains in reproductive and survival traits are typically the reflection of low heritability of these traits and are comparable with recent reports from tropical regions (e.g. Ilatsia et al., 2011; Rewe et al. 2011). Rewe et al. (2011) also reported a 0.04 to 0.2% genetic gains per year for PCV in Kenyan Boran cattle under different breeding programs. Improvements in PCV levels were reported to positively influence overall animal productivity. For instance, calf weaning weight improves by 0.90±0.40 kg for each 1% increase in calf average PCV and by 0.95±0.39 kg for each 1% increase in cow average PCV (Trail et al., 1993). Similar pathway of influence is also seen in cows with a 3.3±0.65 improvement in calving rate for each 1% increase in average PCV (Trail et al., 1993).

With respect to ΔF and N_e, any one of the six village-based options and some of the nucleus-village herd combinations may safely be pursued. However, the most appropriate scheme(s) for the conservation and improvement of Sheko should be evaluated based on rates of genetic gain and practical limiting issues such as capacity to handle large herds and possibility to attain sufficient replacement male and female animals in addition to ΔF and N_e. When the nucleus herd is considered separately, ΔF per generation ranged from 0.42% in scheme 12 with CB10 to 2.92% in scheme 4 with CB20 under natural mating. Obviously, most of the schemes that had small herd sizes were unsafe with respect to buildup of risks associated with inbreeding depression. Under scenarios involving AI, all the schemes had a ΔF of greater than the recommended tolerable level of 1% per generation and extremely low N_e. Therefore, the main focus during the initial years should be to save Sheko breed through sound conservation schemes without much emphasis on genetic gains and hence the most feasible approach would be to establish a nucleus herd in its proper habitat with participation of the communities. A ranch designed to conserve Sheko cattle was established in 1985/86 (Eyayu Admasu, 2013, Pers. Comm.) at a place known as Bage in Jimma zone, W Ethiopia outside the traditional habitat of the breed. The ranch was abandoned during the regime change in 1991 and the herd was scattered. Some animals were later recovered and kept under the custody of the military at Tolley camp and never put back to a breeding scheme to this date. The conservation and improvement may be implemented in the two districts of Bench-Maji zone, i.e., Bench and Shay-Bench that were reported to have high number of existing Sheko cattle (2,130 and 1,150 out of the total 4,040 animal according to Taye et al., 2007). Unlike the West African trypanotolerant breeds, Sheko cattle is not being replaced by other zebu breeds because of low production potential; rather for its aggressive behavior and more feed requirement, under the ever decreasing land sizes in areas where the breed is endemic. Therefore, there is a need to integrate the conservation and genetic improvement interventions with comprehensive animal husbandry practices.

All the evaluated alternatives assume a young sire scheme. Dempfle and Jaitner (2000) also suggested young sire scheme as the best strategy for N'Dama breeding scheme in West Africa. Young sire scheme is the simplest to implement as there is no need to maintain bulls waiting progeny testing. Bulls can be screened at yr. 2 based on own performance records for growth, PCV and parasitaemia and on dam's performance for LMY, AFC, CINT, and calf survival and can be used for breeding. The main challenge would be to quantify and keep records on PCV and parasitaemia particularly in village herds. Although measurement of PCV is simple and accurate, biological interpretation of its variation in the field has no meaning unless other confounding factors affecting its levels are well identified, quantified or controlled as changes in PCV can be related to other anemia-causing pathogens or conditions (d'Ieteren and Trail, 1994). Degree of parasitaemia, on the other hand, is not easily quantified. The most sensitive practical field approach has been to detect the presence of trypanosomes by the dark ground/phase contrast buffy coat method (Murray et al., 1977) and quantify the intensity of the infection as a parasitaemia score.

Crossbreeding

The effect of heterosis is known to be generally higher for traits with low heritability such as reproduction traits. It is also known to be higher when there is more genetic distance between the breeds involved in the crossing. For instance, higher heterosis values were reported in literature for crosses involving *B. indicus x B. taurus* compared to *B. taurus x B. taurus* for beef cattle in temperate regions (Long, 1980; Olson, 2011). Syrstad (1985) reported heterosis values of -8.8%, 18.2%, and -6.7% for AFC, LMY and CINT, respectively for *B. taurus* x *B. indicus* crosses from various tropical regions. Thorpe et al. (1993) also reported significant H_I for AFC (-74 d), CINT (-82 d), LMY (73 kg), SURV (5%), and pre-weaning daily gain (32 g/d) for *B. taurus* x *B. indicus* crosses in Kenya. Demeke et al. (2004a, b) also estimated higher heterosis values for crosses of HF x Boran and Jersey x Boran in Ethiopia. Arthur et al. (1999) estimated H_I of 7%, 11%, and 10% for birth weight, pre-weaning daily gain, and weaning weight, respectively, in a subtropical environment of Australia for Brahman x Hereford crosses. Absence of significant H_I for calf birth weight, pre-weaning daily gain, and calf survival to weaning were also reported for *B. taurus* x *B. indicus* crosses in Kenya (Kahi et al., 1995). The magnitude of heterosis assumed in this study may therefore be taken as prudently realistic.

The expected crossbred performance ought to be better than what is reported here due to the following reasons. Firstly, the ECPs were estimated from the population mean. It is envisaged that animals selected to be in the nucleus possess performance levels that are at least above the population average and hence higher mean values than those used in this study (assuming that crossbreeding is concurrently run with the conservation and improvement schemes for Sheko). Secondly, heterosis is expected to improve the total productivity of the cow herd particularly the composite fertility trait, and hence, calving rate which was not included in the current simulation studies as an objective trait should improve among the F1 dams resulting in higher calf crops. Thirdly, progressive improvement might be expected in later generations as a result of the accruing genetic gains from the selection activities within nucleus herd of Sheko. Finally, selection of better animals as dams of F1 among the dam breed population should also contribute to higher gains in the crossbred progeny.

Economic implications of breeding for trypanotolerance

Analyses of village herd monitoring studies conducted in Ghibe valley indicated that the impact of trypanosomiasis is immense: reduction in total cattle population by 30-50% through mortality; decreased fertility and higher incidence of abortion causing significant reduction in number of calves born per productive life time of a cow; at least 50% less milk and meat output; reduced efficiency or capacity of oxen for work to the extent that 40% less land is cultivated by affected pair of oxen compared to healthy ones; treatment costs (chemoprophylaxis and chemotherapy, each estimated at 2 and 1.3 times per animal and yr.); and reduction in total value of agricultural production by 5-10% (Jemal and Hugh-Jones, 1995; Kristjanson, et al., 1999; Swallow, 2000; McDermott and Coleman, 2001). McDermott and Coleman (2001) estimated 12.5 million doses of trypanocidal drugs were being used annually in river valley lowlands of Ethiopia at a 1.3 dose/animal. At a cost of an average of 1.5USD per dose (Shaw, 2004), 18.5 million USD (equivalent to 351.5 million ETB[1]) is lost annually to trypanocidal drugs alone. Frequency of infection and treatment under farmers' conditions can be very high as reported by Stein et al. (2011) reaching as high as 24 times in Gurage area indicating substantial underestimation of drug related costs borne by farmers. However, regular chemotherapy with trypanocidal drugs succeeded in maintaining productivity of animals at levels comparable with villages where trypanosomosis is not as such an important problem (Rowlands et al., 1994), enabling cattle production to generate attractive and profitable economic returns (Itty et al., 1995).

Use of trypanotolerant animals, on the other hand does not as such involve high investment particularly as in the case of Sheko where the genetic material already exists within the system, albeit severely low in population size. As indicated above the genetic gain per trait and generation in individual animal due to selection is substantial even under low genetic gain but realistic scenarios with respect to rate of inbreeding: 8.4 kg in WT24, 27.7 kg in LMY, -0.8 months in AFC, -0.08 months in CINT, 1.5% in SURV, 2.03% in PCV and -0.3 in INFR. The corresponding improvements due to crossbreeding between Sheko and Gurage were at least 17kg, 155.6kg, -7.6 months, -0.67 months, 6.6%, 1.8% and 10, in similar order, for each F1 animal. It is evident from these results that the negative impacts of trypanosomosis on cattle production systems can be reversed. The magnitude of reversal and improvement indeed depends on the size and type of cattle populations used and covered particularly under crossbreeding.

Conclusion

The current demographic trend in Ethiopia necessitates improvements in agricultural production. There is an enormous potential to increase production from the fertile areas of west and southwest parts of the country by creating mechanisms such as, but not limited to, exploiting trypanotolerance ability of existing cattle breeds to avert the tsetse-trypanosomiasis challenges. In these areas, there is a possibility to increase livestock production by both increasing animal numbers to optimal carrying capacity and by improving productivity of each animal using trypanotolerance attributes of Sheko cattle. The different alternatives compared for conservation and genetic improvement of Sheko clearly indicate the possibility to achieve substantial genetic

[1] 1 USD ≈ 19 Ethiopian Birr (ETB) in November 2013.

gains within a breed with relatively such small number of animals. It also highlighted the risks of inbreeding depression when extremely small numbers of animals are used as founders. It was not possible to compare the breeding programs for economic efficiency due to lack of estimates of economic values of the objective traits and costs associated with implementation of the schemes. However, it should still be possible to comprehend the potential economic benefits based on the predicted genetic gains in the objective traits considered in this study.

Crossbreeding Sheko with other trypano-susceptible breeds like Gurage may provide an opportunity to improve both trypanotolerance and production levels of cattle in areas affected by tsetse-trypanosomosis challenge and keeping other more productive breeds is not possible. However, the benefits of Sheko x Horro cross appear very insignificant to justify the practice. Rather, there was strong signal from the simulation studies that Horro responds well to within breed selection.

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Review of indigenous Sheko cattle Breed conservation

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Abstract

Sheko breed is one of the Ethiopian indigenous cattle breeds which represent the last remnants of Africa's original Bos taurus cattle that were probably the first to be domesticated in eastern Africa. The geographical distribution of Sheko cattle is mainly restricted to south west Ethiopia. The breed is valued for its milk yield, adaptation and exhibit superior trypanotolerance than any other indigenous cattle populations found in Ethiopia. Despite the unique characteristic there has been rapid shrinkage in effective population size of this breed. According to a recent estimate the population of the breed has come to 2400 heads. Strong physique and aggressive temperament of Sheko cattle for the herders as well as indiscriminate crossbreeding and replacement mainly with thoracic-humped zebu cattle were among the reasons for declining trend of the breed. Different phenotypic and genetic studies revealed that Sheko breed is characterized by high levels of genetic diversity and several unique alleles which are vital for future conservation and sustainable utilization of genetic resources. Although this unique breed is currently facing a clear risk of extinction there are no organized and visible efforts targeted for saving the breed from extinction. In addition, information is lacking on productive and reproductive performance of the breed. The current Artificial Insemination service and introduction of Borana cattle breed by the office of Ministry of Agriculture and rural development into the home area of Sheko breed will exacerbate the extinction of the breed. Thus, it is important to designing in situ conservation schemes to reverse the declining in the Sheko population. Alternatively, organizing a Sheko cattle owners' society, establishing breed studs in its breeding tract, promoting niche market and improving the husbandry practices, were also essential for this breed conservation.

Keywords: Sheko cattle, conservation, trypanotolerance, Ethiopia

Introduction

According to FAO (2007), about 30% of the world's farm animal breeds are subjected to the risk of extinction. In Ethiopia, local communities still remain custodian of the diversified farm animal genetic resources and the indigenous knowledge associated with it. Sheko cattle breed is the only surviving indigenous *taurine* breed of the Abyssinian region (Hanotte *et al*., 2000), and is one of the 23 recognized cattle breeds in Ethiopia. Recent genetic studies on some Ethiopian cattle breeds revealed that the Sheko is distantly related to Sanga cattle breeds in Ethiopia (Dadi *et al*., 2009). The breed is known to have evolved in the tsetse belt of southwestern Ethiopia. Sheko's unique evolutionary history, status and trypanotolerance have attracted research attention (Hanotte *et al*., 2000; Lemecha *et al*., 2006; ILRI, 2006; Dadi *et al*., 2009). The long held view that the breed is endangered (Epstein, 1971; Alberro and Haile-Mariam, 1982), was corroborated by molecular genetic evidence that showed about 90 percent of the sampled Sheko bulls have had their specific *taurine* allele replaced by indicant allele confirming an alarming introgression of Zebu genes (Hanotte *et al*., 2000). These cattle are generally smaller in body size and have shorter or no horns than the Humpless Longhorns, which made them much easier to manage. They also appear to have been deliberately developed for milk production (Rege, 1999). The breed is valued for its milk yield, adaptation to humid tsetse infested environment and trypanotolerance (Lemecha, *et al*., 2006). Sheko is restricted to the humid Sheko and Bench districts in Southwest Ethiopia where they are maintained by a small number of local farmers. Sheko breed possesses unique genetic traits that may be useful in confronting new tropical diseases and unpredictable changes in environment conditions in the future. Characters related to disease resistance and adaptation to extreme environments could prove fundamental to food security for the present and future human generations (Dadi et al., 2009). Sheko exhibit superior trypanotolerance than other indigenous cattle populations found in Ethiopia (Lemecha, *et al*., 2006), implicating the genetic potential of this breed to perform cost effectively in humid tsetse infested habitats where thoracic humped cattle may not survive in the absence of veterinary intervention. Despite the unique characteristics and attributes of the breed, there is a drastic decline in effective population size of this breed (Dadi *et al*., 2009; Taye *et al*., 2007).

Origin

Despite recent evidence for possible presence of an African centre of domestication (Grigson, 1991; Bradley *et al*., 1996; Hanotte *et al*., 2002), archaeological evidence indicates that the first cattle on the African continent were of *taurine* origin introduced from Asia, through the Nile Valley in Egypt, or via the Horn of Africa (Epstein, 1971). They occupied most of the areas surrounding the present day Saharan desert and the Abyssinian region. They also expanded to the humid habitat of the West African coast, with the present trypanotolerant breeds, and on the East part of the continent down to the Mount Elgon area at the Kenyan-Ugandan border). Today However, the *taurine* breed distribution pattern was deeply modified with the massive importation of zebu cattle to the continent, mainly after 700 AD, and later with the rinder pest epidemics affecting more especially *taurine* cattle (Epstein, 1971; Blench, 1993 the Abyssinian region, and to an extent, the Lake Victoria region are the cradle of the largest number of African zebu breeds and have the highest density of zebu populations on the continent (Rege and Bester, 1998). Only one breed is still classified as *taurine* in the region, the Sheko, but several others are still considered as crossbred populations and classified as Sanga (Felius, 1995; Rege *et al*., 1996). Studies on mitochondrial DNA show that these breeds still have a *taurine* mitochondrial DNA (Bradley *et al*., 1996).

Population Size

The geographical distribution of Sheko cattle is mainly restricted to Bench Maji Zone and partly in the adjoining parts of Kaffa and Shaka Zones of south west Ethiopia (Taye *et al*., 2007).The population estimate of the breed by the year 1999 was about 31,000 (Rege, 1999), However, another estimates indicated that the population size declined to 4040 (Taye *et al*., 2007), a recent estimates reported by Dadi, *et al*., (2009) revealed that the population of the breed become as low as 2400 heads. A secondary data from the office of south bench district Ministry of Agriculture in

2011 revealed that the population size of the breed was around 1967 heads of which 562, 231, 421, 651, and 102 were heifers, bulls, oxen, cows and calf, respectively. The population estimates reported so far at different periods clearly indicate the sharply declining trend in the total population size of the breed. Different reasons can be attributed for the declining population trend of the breed, the most prominent reason mentioned was by Takele *et al.,* (2010) who contend that due to the high feed requirements of Sheko cattle, which cannot match with ever increasing feed shortage because of expansion of farm land to feed the rapidly growing population, Sheko breed is less preferred to other local breeds by herders. Moreover, due to the strong physique and aggressive temperament of Sheko cattle, especially older individuals face difficulties in practicing tethered feeding which is now becoming the most common feeding strategy since there is shrinkage of grazing land. As a result, Farmers are compelled to continuously replace the breed with other local humped zebu cattle. Another reason could be due to indiscriminate crossbreeding and replacement mainly with thoracic-humped zebu cattle (Dadi et al., 2009). Desta *et al.* (2011) found that only 3 % livestock keepers have pure Sheko herd. There is also significant reduction in labor force as children in the area are regularly attend school now (Sheko is considered needing more labor for herding compared to tethered Zebu).

Genetic Diversity

Different molecular characterization studies have been conducted on indigenous breeds of Ethiopia (Fedlu *et al*., 2007; Dadi *et al*., 2009). Genetic variability assessment between and within breed of five indigenous Ethiopian cattle (Horro, Sheko, Arsi, Abigar and Guraghe highland) using RAPD markers indicated that Sheko breed formed a distinct cluster whereas the remaining breeds formed another cluster (Fedlu *et al*., 2007). The study further indicated that the higher diversity value observed in Sheko may be due to the divergent breed group of the breed when the other four breeds share some Zebu type background. Moreover, the Sheko is believed to have a different and longer evolutionary history (Epstein, 1971), perhaps associated with a different pattern of natural selection for adaptation under harsh environmental conditions of the warm and humid climate of southwestern Ethiopia and continual exposure for 'Trypanosomosis'. A more recent study on genetic differentiation, population structure and levels of admixture among Ethiopian cattle populations by using analysis of microsatellite markers indicated that the overall estimate of population differentiation is low due to high level of inbreeding within populations. Similarly, low magnitudes of genetic distances were observed between all possible pairs of Ethiopian cattle populations. The lowest and highest genetic distances were observed between the Arsi and Ambo populations and between the Sheko and Sanga populations, respectively. Other study by Dadi *et al*., (2008) also revealed that Sheko breed is characterized by high levels of genetic diversity and several unique alleles (CSRM60: 91 bp; MM12: 137 bp, 139 bp; BM 2113: 122 bp; MB 1824: 185 bp; ILSTS006: 299 bp) which may be vital for future breed conservation in spite of demographic population contraction in recent years. Sheko breed which is locally named as "Godda" (meaning hornless or polled) by the local community has been recognized as one of Africa's "Big Five" vintage cows having great potential to form the genetic backbone for future survival (ILRI, 2007).

Desirable and undesirable traits of Sheko cattle

As compared to some Ethiopia cattle breeds Sheko cattle was found to have better feed conversion efficiency, longevity, fertility, faster growth rate, larger body size, good mothering ability and larger teats. Some key informants also reported that unlike their horned zebu counterparts the polled Sheko do not have difficulty to move around in dense forest for grazing.

However, on the other hand the negative aspect of this breed is its occasional aggressive temperament and voracious feeding. Sheko cattle owners also identified special desirable adaptive attributes of the Sheko cattle against common stressor variables. Early information claims that the Sheko possess trypanotolerant attributes (Alberro and Haile-Mariam, 1982; Epstein, 1971) and later research has supported this (Taye *et al.*, 2007). A comparative study on the response of four indigenous cattle breeds of Ethiopia, namely Abigar, Horro, Sheko and Gurage, to natural challenge of trypanosomosis Sheko breed had the lowest mean trypanosome prevalence rate and the least number of trypanocidal treatments and lower mortality rate as compared to the other studied breeds (Lemecha *et al*., 2006).

Phenotypic Characteristics and Productive Performance

Detailed studies and characterization on productive and reproductive performance of the breed is not yet conducted. However, there are few and scanty surveys and monitoring research activities undertaken so far (Alberro, and Haile-Mariam, 1982; Ayalew and Mulatu, 2004; Taye et al, 2007). Different color patterns were reported for the breed and the coat color is predominantly red in plain (75%), patchy (15%) or spotted (9%) (Workeneh, *et al*., 2001), the study of Taye *et al*., (2007) indicated the color is dominated by glossy red hair coat, while Alberro and Haile-Mariam, (1982) reported the dominant color as Brown or black and white. These studies reveled that there is lack of uniformity in color pattern and presence of possible admixture of the breed with other local cattle population. These studies also indicated that majority of the Sheko population is polled and having a small or no hump.

The productive and reproductive performance of the breed is summarized on table 1. A survey by Taye *et al*., (2007) revealed that Average age at puberty for male and female population is 41.6 and 42.1 months, respectively and average age at first calving and mean calving interval is 54.1 and 15.6 month, respectively. The same survey reveled that average lactation milk yield is 698.3 liter with associated average lactation length of 9.9 month, nearly, 22.1 and 7.8 percent of the sampled Sheko cows were reported to produce on average more than 1000 and 1400 liter of milk per lactation, respectively. Sheko oxen on average start draught work at 3.4±0.81 year and have an average draught work life of 8.5±2.67 year. Moreover, majority of herders reported as Sheko oxen surpass their Zebu counterparts in draught stamina and speed (Taye *et al*., 2007). Ayalew and Mulatu., (2004) reported height at withers for adults, 105 cm; body length, 102 cm; heart girth, 136.7 cm, and live weight 179 kg.

Table 1: Summary of Sheko Breed performance reported by different authors

Traits	Values/ descriptions	Source
Average age at puberty for male (months)	41.6	Taye *et al*., 2007
Average age at puberty for female (months	42.1	Taye *et al*., 2007
Average age at p parturition (months)	36-48	Alberro & Haile-Mariam,1982
Average calving interval (months)	54.1	Taye *et al*., 2007
Average daily Milk Yield (liter)	15.6	Taye *et al*., 2007
Average lactation milk yield	1-2	Alberro & Haile Mariam, 1982
Average lactatio n length (months)	698.3	Taye *et al*., 2007
Adult live weight Female (kg)	9.39	Workneh, 2001
Adult live weight Male (kg)	6-8	Workneh, 2001
Adult live weight overall (kg)	188.4	Workneh, 2001

Conservation of Sheko Breed

Endangered populations should be conserved for their potential economic use in the future. Their economic potential may be the production of meat, milk, fiber, skin or draught power and most importantly disease resistance qualities. This potential production may be in diverse climatic and environmental conditions. Endangered populations with economic potential may have regional adaptation developed for the country of origin, or adaptations which may be beneficial in other areas of the world where similar or complementary conditions exist. For example the successful use of the Zebu cattle breeds in diverse regions of the world and the use of the trypanotolerant N'Dama cattle breed from the Republic of Guinea in other countries of West Africa (Devillard, 1983). At present there is no active research and development work targeted towards conservation of the endangered Sheko breed. An observation during the year 2011 (Jennie Stein) at Bench Maji zone indicated that there is awareness by the district bureau of agriculture and rural development on the declining population trend of the breed although there is no clear plan and action to be implemented by concerned stakeholders. On the contrary, the current efforts on provision of AI service in the home land of Sheko breed by Ministry of Agriculture and introduction of Borana breed and distribution to farmers with a subsidized cost in some selected districts of Bench Maji zone are the major treats and challenges identified for conservation of the breed.

Conclusions

Sheko is a unique cattle breed of Ethiopia with trypanotolerant characteristics. The current scientific evidences showed that Sheko breed can thrive well in areas with high level of tsetse infestation. Genetic and phenotypic studies undertaken on Ethiopian indigenous cattle population described the unique genetic makeup of this breed which makes it different from the rest of the breeds. Despite these attributes there is a rapid decline effective population size of this breed. Many reasons can be attributed for the reduction in population size viz. high feed intake, aggressive nature, reduction in labor force, etc., have left this breed in a critically endangered stage. Urgent efforts are required to conserve this unique breed from become extinct. The future for livestock production in tsetse infested areas of Ethiopia has never been brighter. This ability to take unproductive land and make it productive, through trypanotolerant livestock, will help to ensure sustainable agriculture for generations to come. This breed reflects historical and cultural identity of local communities and represents a unique component of the global domestic animal biodiversity that deserve priority for further research and conservation.

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