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# PRODUCTION SYSTEM AND PHENOTYPIC CHARACTERIZATION OF BEGAIT CATTLE, AND EFFECTS OF SUPPLEMENTATION WITH CONCENTRATE FEEDS ON MILK YIELD AND COMPOSITION OF BEGAIT COWS IN HUMERA RANCH, WESTERN TIGRAY, ETHIOPIA

PhD Dissertation

By

Mulugeta Ftiwi Gebreyohanes

Addis Ababa University, College of Veterinary Medicine and Agriculture

Department of Animal Production Studies

PhD Program in Animal Production

June, 2015

Debre Zeit, Ethiopia

# PRODUCTION SYSTEM AND PHENOTYPIC CHARACTERIZATION OF BEGAIT CATTLE, AND EFFECTS OF SUPPLEMENTATION WITH CONCENTRATE FEEDS ON MILK YIELD AND COMPOSITION OF BEGAIT COWS IN HUMERA RANCH, WESTERN TIGRAY, ETHIOPIA

A Thesis submitted to the College of Veterinary Medicine and Agriculture of Addis Ababa University in fulfillment of the requirements for the degree of Doctor of Philosophy in Animal Production

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June, 2015

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As members of the Examining Board of the final PhD open defense, we certify that we have read and evaluated the Dissertation prepared by Mulugeta Ftiwi Gebreyohanes titled: 'Production System and Phenotypic Characterization of Begait Cattle, and Effects of Supplementation with Concentrate Feeds on Milk Yield and Composition of Begait Cows in Humera Ranch, Western Tigray, Ethiopia' and recommend that it be accepted as fulfilling the Dissertation requirement for the Doctor of Philosophy in Animal Production.

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| Gebeyehu Goshu (PhD, Assoc.Prof) | _____ | _____ |
| Chairman | Signature | Date |
| Prof. Harpal Singh | _____ | _____ |
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| Ajebu Nurfeta (PhD, Assoc.prof) | _____ | _____ |
| External Examiner | Signature | Date |
| Prof. Berhan Tamir (PhD) | _____ | _____ |
| Major advisor | Signature | Date |

I hereby certify that I have read the revised version of this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

| | | |
|---|---|---|
| Professor Berhan Tamir (PhD) | _____ | _____ |
| Dissertation advisor | Signature | Date |
| Professor Berhan Tamir (PhD) | _____ | _____ |
| Department Chair | Signature | Date |

## BIOGRAPHICAL SKETCH

I, the author was born in Tigray in 1983. I attended my primary and secondary education in Atseyohanes School, Mekelle. After completion of my high school education, I joined Haramaya University (the former Alemaya University) in 2002 and awarded BSc Degree in Animal Sciences in 2005. Soon after graduation, I was employed by Agricultural Technical and Vocational Educational Training (ATVET) and served as instructor for six years. Then, I joined Mekelle University to pursue my Msc degree in livestock production and pastoral development in 2008. Immediately after graduation, I was employed Aksum University as an instructor. Over the past eight years of services in teaching, I have taught almost all types of animal science courses and published six scientific publications in reputable journals.

## STATEMENT OF THE AUTHOR

First, I declare that this thesis is my *bonafide* work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in fulfillment of the requirements for PhD degree at Addis Ababa University, College of Veterinary Medicine and Agriculture and is deposited at the College library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Name: Mulugeta Ftiwi Signature: _____

College of Veterinary Medicine and Agriculture

Date of Submission: _____

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ADF | Acid Detergent Fiber |
| AFC | Age at First Calving |
| AFS | Age at First Service |
| AI | Artificial Insemination |
| ANGR | Animal Genetic Resource |
| ANOVA | Analysis of Variance |
| BOFED | Bureau of Finance and Economic Development |
| CI | Calving Interval |
| CP | Crude Protein |
| CSA | Central Statistical Authority |
| CSC | Cotton Seed Cake |
| DAGRIS | Domestic Animal Genetic Resource Information System |
| DM | Dry Matter |
| DMY | Daily Milk Yield |
| ELDMPS | Ethiopian Livestock Development Master Plan Study |
| ESAP | Ethiopian Society of Animal Production |
| ETB | Ethiopian Birr |
| FAO | Food and Agricultural Organization of the United Nations |
| GDP | Gross Domestic Product |
| IBC | International Biodiversity Council |
| ILCA | International Livestock Research Center for Africa |
| ILRI | International Livestock Research Institute |
| IVOMD | In-vitro Organic Matter Digestibility |
| LL | Lactation Length |
| LMY | Lactation Milk Yield |
| LSD | Latin square design |

## LIST OF ABBREVIATION (Continued)

| | |
|---|---|
| NDF | Neutral Detergent fiber |
| NSC | Number of Service per Conception |
| OM | Organic Matter |
| PA | Peasant Association |
| SAS | Statistical Analysis System |
| SE | Standard error |
| SNF | Solids-Not-Fat |
| SPSS | Statistical Package for Social Sciences |
| SSA | Sub-Saharan Africa |
| TDN | Total Digestible Nutrients |
| TLU | Tropical Livestock Unit |
| TS | Total Solid |
| WB | Wheat bran |
| WOARD | Woreda Agriculture and Rural Development |

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By

Mulugeta Ftiwi Gebreyohanes

PhD Thesis

Addis Ababa University (2015)

## *ABSTRACT*

*The study was carried out in Kafta Humera Woreda of Tigray National Regional State with the objectives of Production System and Phenotypic Characterization of Begait Cattle, and Effects of Supplementation with Concentrate feeds on Milk Yield and Composition of Begait Cows. To collect the quantitative and qualitative data, questionnaire, group discussions, field observation, and morphometric measurements were employed. A total of 104 households owning Begait cattle were individually interviewed. The phenotypic body descriptors were directly measured using measuring tape, and morphological measurements including tail length, ear length, horn length, dewlap width; naval flap length, perpetual length, teat length, heart girth, height at withers, body length, and neck length were collected on 192 Begait cattle. The feeding trial was conducted in Humera Begait cattle breeding and multiplication ranch. Four lactating cows in second parity and in early stage of lactation (70 days after calving) were used in 4*4 Latin square design to receive four treatment diets. The Average body weight and initial milk yield of cows was 322 ± 11kg and 2.2±0.14 kg/cow/day, respectively. The treatments included: basal diet + wheat bran (T1), basal diet + wheat bran + noug seed cake (T2), basal diet +wheat bran + cotton seed cake (T3), and basal diet+ wheat bran + 50%(noug and cotton seed cake) (T4), where sorghum Stover was the basal diet and given adi libitum to all the treatments. The treatment rations were isonitrogenous. The survey result indicated that, mixed crop-livestock production system was the dominant farming system. The major livestock feed resources were natural pasture and natural pasture (standing hay) in wet and dry season respectively. Trypanosomiasis and Pasteurellosis were the major reported cattle diseases according to ranking index value. Lack of feed,*

*diseases and water scarcity were the major factors hampering cattle production. Farmers perceived that Begait cattle population decreased over the years mainly due to feed shortage, diseases and water scarcity. The mean linear measurements of female Begait cattle were: height at wither (131. 48±0.25cm), body length (128.13±0.16cm) heart girth (159.55±0.24). The naval flap and teats average mean values were 12.14±0.07cm and 10.47±0.03 cm, respectively. In male Begait cattle the values were: height at wither (137.10±0.10 cm), body length (136.0±0.09 cm), and heart girth (168.91±0.10cm). The study revealed the following results, age at first puberty (female) (35.51± 0.14 months), age at first calving (48.68±0.16 months), calving interval (17.06±0.11 months) and productive life time (8.2±0.07 years); daily milk yield (2.52±0.30 liter) and lactation length (6.38±0.28 months). In general, the production and reproduction performance of Begait cattle was relatively higher, even than other local breeds in the region specifically in terms of milk yield and fertility potential. Despite their high productive and reproductive performance, the current performance and population size was found to be interwoven by many constraints. Results related to the feeding trial showed that, a treatment supplemented with a mixture of wheat bran and noug seed cake(T2), wheat bran with cotton seed cake (T3), and wheat bran with noug and cotton seed cakes (T4) had significantly higher ($P<0.05$) milk yield and nutrient intake compared to basal diet + supplemented with wheat bran alone (T1). The lowest and highest milk yields were recorded for treatments ($T_1$) and ($T_4$), respectively. No differences were observed in milk composition between treatments. The partial budget analysis showed that supplementation of concentrate feed of protein and energy sources was profitable compared with supplementation with energy source alone (T1). Supplementations with protein and energy sources increased the net profit/cow/day by ETB 17.0 (T2), 32.0 (T3), and 44.1 (T4) over supplementation with energy source alone (T1). From the result of feeding trial, it could be concluded that a ration containing of 72% wheat bran+ 16% noug seed cake, and 12% cotton seed cake concentrate feeds improves milk yield and brings a high economic return in early-mid lactating Begait cows.*

*Key words: Begait cattle, phenotypic and performance characterization, concentrate feeds*

# 1 INTRODUCTION

Ethiopia is a landlocked country situated in East-Africa. Its population is growing and counts up to 90 million people (Gebremedhin *et al*., 2004). It has a diverse population and endowed with diverse ecosystems inhabited by an abundant diversity of animal, plant and microbial genetic resources. The existence of this diversity is due to in large part to its geographical location near the historical entry point of many livestock populations from Asia, its diverse topographic and climatic conditions, the huge livestock population size and the wide range in production systems (IBC, 2004; Mohamed *et al*., 2004). Ethiopian farmers rear various types of livestock species in the existing ecology. FAO (2001) reported that about 90% of the total land mass of Ethiopia is suitable for livestock production. The country ranks first in livestock population in Africa (FAO, 1988).

According CSA (2012/13), the estimated livestock population of Ethiopia is about 53,990,061 cattle, 25,489,204 sheep, 24,060,792 goats, 350,026 mules, 6,748,357donkeys, 915,518 camels, and 50,377,142 poultry. This survey excludes the non-sedentary livestock population of three zones of Afar and six zones of Somali regions. Of this huge livestock population, cattle population is highest among other livestock species; accounting for about 35% of the total livestock population (Geo, 1987). According to MoA (2000) report, the contribution of livestock to the national economy of Ethiopia is about 18% and 31% of the total employment of the country and has a share of 12-16 % of the total GDP and 30-35 % of the agricultural GDP (FAOSTAT, 2010). Out of the total contribution of the livestock sector, input from cattle is irreplaceable for domestic consumption and foreign exchange to national economy; providing food, drought power, manure and other social and cultural necessities (Anteneh, 1989; Geo, 1987; MoA, 2000).

Cattle milk contributes 83.4% of the total milk produced in the country (FAO 1993; Gebreweld *et al.*, 2000; Getachew and Gashaw, 2001). In addition, the livestock sector fulfills the domestic consumptions and provides a raw material for industries to generating foreign exchange. About 80% in the highland and 90% in the lowlands of the country, farmers get substantial cash income from this sector (Greesa and

Getachew, 1985; Anteneh, 1989). In the livestock sector, cattle play a pivotal role in prevailing traditional mixed livestock production system. Cattle are also the main source of draft power Geo ( 1987). Almost the whole cattle product of the country is from indigenous cattle, little being from the few newly introduced temperate cattle. According to Alberro and Hailemariam (1982); Workneh *et al. (*2004), the indigenous Ethiopian cattle breeds are classified in to four broad categories: the humpless Hametic Longhorn and Shorthorn, the Zebu, the Sanga, and the intermediate Sanga/Zebu.

The indigenous cattle breeds accounted for 98.95 percent, while the crossbred and pure exotic cattle breeds were represented by 0.94 and 0.11 percent, respectively. From the total cattle population, 44.52 percent are males and 55.48 percent females. Given its diversified ecology and very large number of animals, Ethiopia is considered a centre of diversity for animal genetic resources in general and cattle in particular, indigeneous. According to IBC (2004) report, Ethiopia has around 25 cattle breeds that are local in origin.

Cattle breeds in Ethiopia are a valuable source of genetic material because of their adaptation to harsh climatic conditions, their ability to better utilize the limited and poor quality feed resources and their tolerance to a range of diseases found in these regions. These cattle often possess valuable traits such as disease tolerance/resistance, high fertility, good maternal qualities, longevity, and adaptability to harsh conditions and poor-quality feeds, all qualities that form the basis for low-input, sustainable agriculture. Indigenous cattle are vital to subsistence and economic development in the country. They sustain the employment and income of millions of Ethiopians, 85% of whom are rural-based. They also provide transport, much of the draft used in cultivation of crops, as well as providing a large component of the manure essential to agriculture. In addition, they play an important role in culture as they are used for gifts, dowry and cultural rituals, and some of their products are being used for medicinal values.

Even though the country is having a high potential for livestock production, livestock productivity is below the African average. Total herd off take of cattle is estimated at about 7% annually; with carcass weight of 100-110 kg. Cows in Ethiopia do not reach

maturity until 4 years of age, calve every second year, and produce only 1.5 to 2 liters of milk daily over a 150 to 180 days lactation (ILCA, 1991). Poor health service, feed shortage and low genetic potential of animals are the main constraints to increased livestock productivity in the country (Ibrahim and Olaka, 2000).

Alberro and Hailemariam (1982) indicated that, the indigenous cattle breeds of Ethiopia, regardless of their ability to survive in harsh environmental conditions of the tropics, are known for their low production such as long calving interval, late puberty, and low total milk yield per lactation. Although such breeds have low producing ability, they are well known for their unique features: such as disease tolerance (resistance), high fertility, good maternal quality, longevity, and adaptation to harsh environmental conditions (Syrasted, 1992). However, in many parts of the tropical regions, due to the indiscriminate crossbreeding, biotic and abiotic factors, a considerable indigenous animal breeds are being threatened of extinction (Margart, 2002). Hence conserving the diversified indigenous tropical animals including cattle is security against environmental uncertainty (Smith, 1984; Regge, 1999), and assessing the national wealth of the livestock biodiversity is critical.

However, characterization of majority of indigenous breeds and production systems of East Africa including Ethiopia has not yet been undertaken (Ntombizakhe, 2002). The local breeds are generally named after the area they occupy. So far, little effort has been made to comprehensively describe the indigenous livestock populations of the country (Beyene & Beruk, 1992).

Tigray is one of the regional states of Ethiopia where livestock production plays an important role. In line with the national statistics, the cattle population in Tigray region is higher than the other livestock species of the region (CSA, 2004). The region has seven breeds: such as Raya-Azebo, Irrob, Abergelle, Adwa, Arado, Begait and Medense. Even though Begait breed is known for its higher milk production relative to the other breeds found in the region (BoNAR, 1999), its phenotypic and performance characteristics of the breed have yet not well assessed. Thus, this study was aimed at generating information on cattle production systems as well as on-farm phenotypic characterization of Begait cattle in western Tigray and evaluation of

production performance of Begait cattle breed supplemented with concentrate feedtures with the following objectives.

**General Objective:**

The overall objective of the study was to generate information related to production system and phenotypic characterization of Begait cattle breed and effects of supplementation with concentrate feed on milk yield and composition of Begait cows in Humera ranch, western part of Tigray region.

**Specific objectives:**

- Describe socio-economic importance, herd holding structure, and the traditional cattle husbandry practices and identify major constraints to Begait cattle production in Kafta Humera woreda,

- Determine production and phenotypic characteristics of Begait cattle under its natural environment Kafta Humera woreda,

- Evaluate feed intake, milk yield and milk composition of Begait cows supplemented with concentrate feeds in Humera ranch.

# 2 LITERATURE REVIEW

## 2.1 Importance of Livestock

Livestock fulfill several functions in the Ethiopian economy by providing food, traction power, cash income, fuel and organic fertilizer. Livestock is also an important provider of export commodities such as live animals, meat, hides and skins (Solomon *et al*., 2003; NABC, 2010). Over the past few years, livestock and its products has been Ethiopia's second most important source of export, after coffee. However, the share of live animal export in total livestock export earnings seems to have declined while hides and skins earnings increased and meat earnings remained relatively constant (Solomon *et al.,* 2003; Halderman, 2004). The main reason for the decline in export was not the increased domestic demand but an import ban by the Middle Eastern countries which are important importers of livestock and livestock products from the Horn of Africa, including Ethiopia. In 2000, the Middle Eastern countries applied a ban due to an outbreak of Rift Valley Fever. Although this Rift Valley Fever triggered the import ban of Ethiopian animals, other factors also played a major role in banning Ethiopian livestock and livestock products (Solomon *et al.,* 2003; NABC, 2010).

## 2.2 Role of Cattle

Ethiopia has the largest livestock population in sub-Saharan Africa constituting about 31% of the ruminant livestock of East Africa (FAO, 1988). According to Jahnke (1982) in the developing African countries, the livestock sector including cattle accounts for about 15% of the total GDP and 33% of the agricultural GDP of the countries without taking account of the value of draft power and manure. In contrast, only about 5% of the total GDP and 18% of the agricultural GDP in sub-Saharan Africa is accounted by this sector (Anteneh *et al.,* 1988). Similarly, according to recent reports of MoA (2000), the livestock sector contributes 18% of the national economy, and 31% of the total employment.

In addition, the sector mainly cattle plays a very important role for domestic consumption, it provides food, drought power, manure and other social and cultural

necessities to the farmers. As an example, throughout the country 1197650 liters of milk is produced every year in the rural, urban, and peri-urban areas. Out of the total milk produced, traditional (rural) producers produced about 95% of the national and 75% of the commercial milk from their different livestock species reared (Gebreweld *et al.,* 2000; Getachew & Gashaw, 2001). From the total milk produced in the country, cow milk constitutes 83.4% of the total milk produced by all livestock species (FAO, 1993). Moreover, Ethiopia next to Nigeria is the largest meat producer in sub-Saharan African countries but is lower in per capital meat production. According to the World Bank (1987) report for the human population and GNP figure, the country produces about 556,000 tones of meat per year. Beef contributes above 25% of the national meat production (FAO, 1986).

Draft power notably in the central highlands is a critical input, worth a great deal of value, and playing a pivotal role in the prevailing traditional mixed farming system. This is illustrated by the species composition, which is on average a household owned about two working oxen and the total population of oxen constitute 30% of the total cattle herd studied since 1982-1983 (Goe, 1987). Similarly, Gryseels (1988) indicated that, in the highlands of Ethiopia on average an ox works for 900 hours every year. In the lowlands, pastoralists get over 90% of their cash income from livestock (Anteneh, 1989).

### 2.3 Composition, Herd Size and Structure of Livestock

In Ethiopia, depending on agro-ecology as well as on production objective of farming households, farmers own livestock species differently. Livestock management in pastoral system is characterized by three principles: adaptation to the environment in the attempt to ensure subsistence, risk averting strategy and adaptation to the institutional environment. As an example, the herd species and age composition in the high land and low land areas of Ethiopia is variable. The average household herd size of different livestock species for the low lands of the Abala woreda of Afar region, northern Ethiopia were 13 cattle, 17 sheep, 53 goats, 9 camel, 1 donkey (Dires, 1999). In the high lands of Ethiopia, the livestock number per household studied since 1979-84 was 6 cattle, 9.7 sheep and 0.1 goats (Goe, 1987; Gryseels, 1988). In the same study, the proportions of oxen were higher in the high lands relatively to the low lands

of the country. Similarly, According to Anteneh (1989), from the total herd in the high lands of Ethiopia, cattle were higher in proportion and it was almost 35 % of the total herd size of the country. In the case of the Massi pastoral area of Kenya, the condition is different, cow were higher than male population; amounting 35-37%, and 32-34 % of the total herd respectively (Leeuw *et al.,* 2000).

## 2.4 Cattle Management Practice

### 2.4.1 *Livestock feed resources*

Almost in all parts of Ethiopia, the commonly used livestock feed source is natural pasture, crop residue, industrial by product, and cultivated forges. The availability and quality of native pastures to livestock vary with altitude, rainfall, soil type and cropping intensity. Cultivated forage and industrial by products are insignificant comparatively to the other sources. Animals are predominantly depending on natural pasture and crop residue. Nevertheless, natural pasture and crop residue are mainly known for their low quality and quantity production in the country. As a result, livestock production of Ethiopia is mainly characterized by low production per animal, which is predominantly constrained by malnutrition and undernutrition (Alemu, 1990).

### 2.4.2 *Water resources and watering frequencies*

The water requirement of domestic animals varies between species, between breeds or varieties within species and between individuals within breeds. For example, heavy western breed cows have a higher water intake 60 to 90 litres/day than zebu cows 25 litres/day with 350 kg live weight (King, 1983). Streams, rivers, waterholes, pipes, dams, and pond water are the common water sources for all animal species in tropics including Ethiopia. Livestock are watered differently depending on the variation among species, breeds, and the ecological zones in which they are reared. As an example, in the Kola agro-ecological zone, animals travel longer distance to watering points (5-10 km) per day in dry season (Tessema *et al.,* 2003).

Herders copped the challenge by prioritizing animals, water restriction and, minimizing watering frequencies. Restricted watering is a long-held practice of the Boron's that has positive attributes in terms of conserving human labor, extending grazing distance from water points, and increasing water-use efficiency (peacock, 1996). Moreover, in Belessa woreda of Amhara region animals usually drink once per day (Tessema *et al.,* 2003). In Mensibu woreda of Welega, young animals watered clean water relatively to adult cattle (Alganesh *et al., 2004*).

### 2.4.3 *Cattle housing*

The indigenous livestock breed survey conducted in the regional state of Oromya on breed identification, livestock production system. According to the aforementioned study report, in the region based on the production system and household cattle holding size, cattle were housed differently. In crop-livestock production system, a third of the sampled households use the family house but only 4% did so in the pastoral system. The proportion of households who share housing with their cattle was directly related to livestock densities. In general, animals are housed in kraals in two-thirds of households, followed by the family house and sheds. A yard or veranda was only occasionally used for housing cattle (Workneh & Rowlands, 2004). Similarly, a survey conducted in Gambila regional state and Mensibu woreda of welega cattle housing is uncommon during the dry season. Calves are housed in an open circular house. Old cattle are kept in camps tethered by a rope tied to pegs. In the wet season, animals were residence they turn from grazing in Gambila (Mureja, 2001). However in Mensibu woreda, cattle were housed throughout the year in a Kraal, and calves are kept in homestead shades and in the living rooms with family (Alganesh *et al.,* 2004).

### 2.4.4 Cattle breeding/mating

In the traditional livestock production system of tropics, uncontrolled breeding is dominantly practiced. Some pastoralists who do have a large stock, they select breeding bull from their herds, moreover often favor particular breeds. In contrast, smallholders with their much smaller flocks or herds they rely heavily on formal or

informal exchange and transfer of breeding stock or genetic material between households, between villages, between government farms and their animal enterprise, or between the commercial and communal. According to Zewdu (2004), in Semien Mountains and Wegera, mating was completely uncontrolled in Semien Mountains and partially controlled in Wegera. However, in Dembia in the plains of Fogera, and in western lowlands; herders select male and female breeding cattle. Similarly, in Oromya regional state, around 70% farm households practice uncontrolled mating. In the region the proportion of households practicing controlled mating increases with increasing livestock densities. Households found in the pastoral area practice uncontrolled mating. Moreover, except in northern showa zone that practice artificial mating (amounting 10% of the total farm households) the rest part of the region used natural mating (Workneh & Rowlands, 2004).

## 2.5 Cattle Production Constraints

Cattle production in various production system of the developing counties like Ethiopia, is constrained by technical and biological, and socio economic and institutional factors: such as availability of quality and quantity feed resources, low producing cattle genotype, disease susceptibility, reproduction wastage, inadequate health service, management, and market access are some of the constraints (Ibrahim & Olaloku, 2000).

A study conducted in Belasa woreda of Amhara region indicate that the feed supply on a year round basis satisfies only 72.7 % of the maintenance DM requirement of livestock of the Woreda, about 10% were lost due to poor management practices, and the feeds were of low quality (Tessema and Ameha, 2003). Similarly, a study held at Welayta Sodo indicated that, too small grazing land and inadequate feed supply are the major problems. Most of the crop residues were used as a livestock feed. The residue supply was seasonal and used it traditionally; without any pre-treatment and or strategic supplementation. The feed production constraint in tropic and the possible intervention are classified in to two broad categories such as: seasonality of fodder production and fodder quality. As a consequence, the seasonal feed availability results in the seasonal regular cycle of live weight gain and loss of cattle usually occurred.

This is principal cause of the low annual average conversion efficiencies of fodder into meat, milk, and draught power.

The low access to health services and high prevalence of diseases in the country is anther limitation that affects the potential contribution of livestock production to the national economy of Ethiopia (Wondwosen, 2003). The coverage of animal health service at a national level is 30%, and it is worst for the pastoralists it is only 5 % (Mussa *et al.,* 2001). The most common cattle diseases prevailed in the country especially thus affect international trade are rinder-pest, foot and mouth disease, anthrax, blackleg, trypanosomosis, bovine tuberculosis, streptococcus and brucellosis (Wondwosen, 2003)

### 2.6 Phenotypic Diversity of Cattle

In livestock population, genetic diversity is expressed on the phenotypic level as variability in production traits, exterior traits, reproduction traits, health traits, and other characters. In comparison with natural populations, a wide phenotypic diversity is observed within and between livestock populations (Notter, 1999; Andersson, 2001). These phenotypic differences are the result of genetic diversity and environmental differences (Oldenbroek, 1999). Genetic diversity can be assessed between species, breeds, and specific lines and within those groups. The phenotypic difference of an animal is measured using what are called genetic parameters or, strictly speaking, phenotypic, genetic and environmental parameters (Andersson, 2001). FAO, 1998 defines a breed as a group of animals which belong to the same population based on certain characteristics.

### 2.7 Cattle Breeds of Ethiopian

The Ethiopian indigenous cattle breed so far identified are 25 such as: Arsi, Begait, Ogaden, Borena ,Goffa, Arado, Nuer, Gurage, Jidu, Karayu/ Afar, Harar, Horro, Smada, Fogera, Mursi, Raya–Azebo, Adwa, Jem-Jem, Sheko, Ambo, Jijiga, Bale, Hammer, Medense and Abergelle (IBC, 2004). All of those cattle types were described as having considerable adaptability to harsh climate, poor nutrition and diseases endemic to their respective areas. Those breeds are primarily of local origin

and not well characterized. Moreover, the local breeds are generally named after the area they occupy. According to Alberro and Hailemariam (1982), little effort has been made to comprehensively describe the indigenous livestock population of Ethiopia. Attempted to identify and classify some Ethiopia cattle types by compiling available literature and gathering information from field data and from Ministry of Agriculture provincial offices. Accordingly, the different Cattle breeds were classified into four broad categories: the humpless hametic Longhorn and Shorthorn, the Zebu, the Sanga and the intermediate Sanga/Zebu. Similarly, according to Workneh *et al.,* (2004), a total of 23 recognized indigenous cattle types are found in Ethiopia, that fall into 5 distinct breeds. The highest proportion that found in the highlands and low lands of the country is Small East African Zebu. Three other breeds, the Ethiopian Boran, Murle and Arsi are classified in the Large East African Zebu group. The Sanga mainly comprises the Danakil and Raya Azebo (from northern and northeastern Ethiopia) and Anuak and Aliab Dinka (from far southwest lowlands of the country). Three other breeds (Horro, Fogera and Arado) from central highlands are classified under Zenga (sanga-zebu interbreeds). There is only one representative of the hump-less Shorthorn group of cattle in Ethiopia which is the Sheko (from the mid-altitude southwest of the country). In addition, some reports indicate that recently four other cattle types are identified in the country which is the Babbawa, Jiddu, Red Bororo and Tigray. But the newly identified cattle types are not well studied clearly as to which group they belong (Workneh *et al.,* 2004).

## 2.8 Cattle Breeds of Tigray Region

According to CSA (2012/13) cattle population of Tigray is estimated at 4.06 million. Similar to the national livestock population figure, the proportion of cattle is highest among all other livestock species. Depending on the livestock production system and production objective, farmers have been using their livestock for different purposes such as: milk production, meat, a source of dung, and hide and skin. Moreover, in the majority of the crop- livestock mixed farming area of the region framers use oxen as a drought power (BoNAR, 1999). Excluding the introduced few exotic cattle breeds, cattle breeds of the region are categorized into six major types: such as Afar, Arrado, Begait, Fogera, Raya, and Medense.

## 2.9 Cattle Breed Improvement

Livestock productivity is influenced by a complex interaction of the genetic potential of the livestock breed kept, the production system and the production environment. Livestock has been undergoing constant genetic change, which is the normal state for AnGR. Breed development is a dynamic process of genetic change driven by environmental conditions and selection by humans. Natural and artificial selection, crossing between stocks and replacement of one stock with another stock are inherent features of livestock production systems (Hiemstra *et al.*, 2006).

Indigenous livestock are well adapted to tropical conditions and have high degree of heat tolerance, which are partly resistant to many of the diseases prevailing in Ethiopia and have the ability to survive long periods of feed and water shortage. These attributes have been acquired through natural selection over hundreds of generations. They are all essential for successful animal production (Rege and Lipner, 1992). Indigenous stocks represent a genetic resource which should not only be conserved for future use, but should also be fully exploited for short-term benefits. Due to the low genetic potential of indigenous cattle, milk meat production and productivity remain low in Ethiopia (Shiferaw *et al.*, 2003). Improvement of the genetic potential of indigenous cattle was achieved by cross breeding with high producing cattle of temperate origin.

## 2.10 Reproductively and Productivity Characteristics of Cattle

### 2.10.1 *Reproductive performances of dairy cattle in Ethiopia*

Reproductive traits describe the animal's ability to conceive, calve down and suckle the calf to weaning successfully (Davis, 1993); these traits are important since they affect the herd size. Reproductive performance is commonly evaluated by analyzing female reproductive traits (Aynalem *et al.*, 2011) of a combination of many traits (Olawumi and Salako, 2010). Reproduction is an indicator of reproductive efficiency and the rate of genetic progress in both selection and crossbreeding programs

particularly in dairy and beef production (Mukassa-Mugerewa and Azage, 1991). High reproductive efficiency is necessary for efficient milk production and has an important influence on herd profitability (Pryce *et al.,* 2004). Reproductive efficiency is expressed by the extent of reduction of reproductive wastage and it affects lifetime milk and meat production (Nuraddis, 2011). The main indicators that would be considered in assessing reproductive performance are age at puberty, age at first calving, calving interval, days open and number of services per conception (Yifat, 2009; Habtamu *et al.,* 2010; Aynalem *et al*., 2011; and Demissu *et al.,* 2013).

According to Gidey (2001), age at first service (AFS) is the age at which heifers attain body condition and sexual maturity for accepting service for the first time. Age at first service signals the beginning of the heifer's reproduction and production and influences both the productive and reproductive life of the female through its effect on her life time calf crop.

Age at first calving is the period between birth and first calving and influences both the productive and reproductive life of the female, directly through its effect on her lifetime calf crop and milk production and indirectly through its influence on the cost invested for up-bringing (Gebrekidan *et al*., 2012). Age at first calving is closely related to the rearing intensity, and in a breeding program has impact on generation interval and response to selection. It is affected by nutrition, year and month of birth (Kelay, 2002).

Calving interval is the period between successive parturitions and is a function of postpartum anestrus period (from calving to first estrus), service period (first postpartum estrus to conception) and gestation length. Estimates of calving interval in zebu cattle range from 12.2 to 26.6 months (Gebrekidan *et al.,* 2012; Mukassa-Mugrewa, 1989). Nutritional conditions that vary seasonally and yearly and parity (Prabhakar and Addisu, 2004) have major effect on calving interval (Hailemariam and Kassa, 1994). The effectiveness of estrus detection and conception rate has a great impact on the calving interval. Calving interval is probably the best indicator of cattle reproductive efficiency. It is fertility traits that can be used in selection programs to minimize the negative effects that selection for production have on fertility (Mostert *et al.,* 2010).

### 2.10.2 *Productivity of milk cattle in Ethiopia*

Average milk production of indigenous cattle per cow is very low. Milk production potential of indigenous cattle such as Boran, Barka, Arsi and Fogera is low and it ranges from 494-809 kg per lactation (Mukasa-Mugerwa, 1989). The average daily milk production and lactation period in the country is 1.318 liter and six months respectively which result in an estimated milk production of 3,804,991,102 liters per lactation for 10,711,484 lactating cows (CSA, 2012/13).

Total milk production is further affected by relatively short lactation length, and extended postpartum anoestrus period resulting in lower reproductive efficiency. This is basically due to the fact that these animals have been selected primarily for survival trait and possess well-established adaptive traits to the environment in which they are expected to survive and produce. In general, the reproductive efficiency of a breeding cow is determined by factors like age at first calving, calving interval and age of first service.

*Milk yield and lactation length*

The lactation milk yield and days of lactation in indigenous cattle in Ethiopia are reported by a number of studies (Table 1). The milk production potential of indigenous breeds of cattle is very low. In addition, milk production potential of temperate breeds in the tropical environments is higher than the indigenous breeds, but this yield is still far below the genetic potential.

Table 1. On-station milk production performance of cattle in Ethiopia

| Local breed | DMY (kg) | Management system | Source |
|---|---|---|---|
| Arsi | 2.97 | On station | Kiwuwa *et al.* (1983) |
| Barka | 4.31 | On station | Goshu (1981) |
| Boran | 2.84 | On station | Gebrewold *et al.* (2000) |
| Fogera | 4.49 | On station | ‘’ |
| Fogera | 2.56 | On-farm | Zewdu (2004) |
| Highland zebu | 1.91 | On-farm | Solomon (2000) |

*Factors affecting milk yield and composition*

Milk composition and production are the interaction of many elements within the cow and her external environments (O’Connor, 1994). High milk yield of satisfactory composition is the most important factor ensuring high economic returns. If the composition of milk varies widely, its implication is that nutritive value and its availability as a raw material will also vary. Chemical composition of milk is variable and influenced by intrinsic factors like breed, species, parity, stage of lactation; external factors like environmental stress, changes in feeding, etc.

However, it is generally accepted that the milkman can alter many of these factors to achieve milk production and increase profit. The major factors affecting milk composition are discussed hereunder. Breeds of milk cattle show obvious differences in their milk composition and yield. Differences among individuals among a breed are often greater than differences within breeds (O’Connor, 1994) such differences are due to partly genetic and partly to environmental factors. For instance, Jersey breed gives milk of higher fat content than Friesian cattle, while Zebu cows can give milk containing up to 7% fat (O’ Mahony, 1988). The milk from indigenous cows contains 6.1% fat, 3.3% protein, 4.5% lactose and 0.7% ash (Alganesh, 2002).

Nutrition has also major effect on milk composition. According to O’Connor (1993), underfeeding reduces the amount milk production, the fat and solids-not-fat (SNF)

contents of milk produced. As a general rule, any ration that increases milk production usually reduces the fat percentage of milk. It is also believed that the fat content is influenced more by roughage intake and the SNF content can fall if the cow is fed a low energy diet, but it is not greatly influenced by protein deficiency, unless the deficiency is acute (O'Connor, 1994). The fat, lactose and protein contents of milk also vary according to stage of lactation. In temperate type cows, the fat and SNF percentages tend to be higher in the early weeks of lactation, dropping by the third month then rising again as milk yield gradually declines (O' Manhony, 1988). The milk immediately after calving contains a very high percentage of total solids (up to 19%) mainly due to the very high fat and milk protein contents (O' Connor, 1993).

A study made by Asaminew (2007) in Mecha and Bahir Dar Zuria indicated that the overall mean fat, protein, total solids, ash and SNF contents of local cows' milk produced in the study area were 4.71, 3.25, 13.47, 0.73 and 8.78%, respectively. Schaar *et al*. (1981) in Arsi indicated that the percent fat content of milk for Arsi breeds during the first, second and third lactations were 5.73, 5.80 and 5.44, respectively, while the values for the Fogera, Borana, Barca, Arsi x Friesian and Arsi x Jersey breeds during their first lactation were 6.15, 6.02, 5.76, 4.5 and 5.14%, respectively.

The age of the cow has slight, but definite effect on the composition of milk. O' Connor (1994) suggested that as cows grow older, the fat content of their milk decreases by about 0.02 percentage units per lactation while the fall in solid-non-fat is about 0.04 percentage units. The decrease in SNF content seems to be due to a decline in casein content. When milking is done at longer intervals, the yield is also more with a corresponding smaller percentage of fat, whereas milk drawn at short intervals yield smaller quantities with higher amount of fat. The effect of milking interval is mainly on fat percentage rather than the SNF (Rai, 1985). The fat content of milk is usually lower in the morning than in the evening milking, because there is usually a much shorter interval between the morning and evening milking than between the evening and morning milking. Solid-not- fat content varies little even if the intervals between milking vary.

## 2.10 Cattle Linear Body Measurements

A linear body measurement of cattle varies for cattle breeds, sex, age, season, nutrition, and management condition and so on. According to Hamayunm (2003) live body weight of cattle was highly correlated with linear body measures (heart girth and body length) and the result proved that a significant increment in body weight was observed as the age of the animal advanced. Similarly, a study carried out in Ogden cattle breeds of Ethiopia revealed that only live body weight significantly varied between sexes (Ermias, 2007). Mature females measured 280.5 kg for body weight, 161.4 cm for heart girth, 116.4 cm for height at withers and 141.0 for body length. Similarly, males measured 321.0 kg for live weight, 161.3 cm for heart girth, and 118.0 cm for height at withers and 141.5 cm for body length (Ermias, 2007). Body measurements as reported by Oloruntobi, (1994); Sokefun, (1994) height at wither, heart girth and body length of N`Dama cattle breed ranged between 93 – 120, 109-162, 128 – 172 and for Muturu range 86.43 – 112.63, 103.79 – 118.73, 111.76 - 161.56 respectively.

## 2.11 The Role of Nutrition on Animal Productivity

Genetic makeup; nutrition and management decide the productivity of an animal (Sethumadhavan, 2004). Improvements of genetic make up only contribute up to 30% to production, while the 70% is dependent on nutrition and management. Unfortunately, indigenous animals are low milk producers because of the shortage of nutrition. Poor nutritive values of feeds lower the production capacity and fertility potential of animals. If fed well, 20-25% more milk could be produced from the same livestock (Sethumadhavan, 2004).

In Ethiopia animal production systems are primarily based on native pasture and crop residues (Firew, 2007). Crop residues including cereal straws of teff, barley, wheat, oats and cereal stovers from maize, sorghum and millet and haulms from pulse crops including peas, beans, lentils, chick peas and vetch are very important feed resources (Rihirahe, 2001). However, the feed supply is seasonal and the shortage of green grass is one of the major causes of drastic deterioration of livestock nutrition (Firew, 2007 and Rihirahe, 2001).

They are inherently low in crude protein, digestibility and intake and are deficient in minerals (Rihirahe, 2001). The lower nutrient contents reduce rumen efficiency, rumen micro-fauna and milk production performance. Lactating cows for example are unable to meet their nutritional requirements i.e. they lose weight and body condition during lactation due to high nutrient demand for milk production. Poor nutrition in addition to causing low rates of production and reproduction also increases susceptibility of livestock to diseases and subsequently mortality. Biologically, about two-thirds of the improvement in livestock productivity is often attributed to nutrition since animal production is basically a conversion of feed into animal products. In economic terms, feed cost accounts for about 70% of the total cost of livestock production indicating the feasibility of livestock enterprises is a function of the type of feed and feeding system

Livestock production in Ethiopia suffers from feed shortages at all levels. It is estimated that there is a 40% deficit in the national feed balance. This is again aggravated by seasonal availability of forage and crop residues in the highlands and by erratic rainfall in the lowlands. The problem is further exacerbated by the associated poor husbandry practices that lower productivity further. One of the ways to bridge this gap is to chemically treat crop residues, the most suggested method in the tropics (Firew, 2007) and utilize concentrates for supplemental feeding for farm animals. Agro-industrial by-products are fed as supplement to roughage based diets, particularly in livestock production system for milking or peri-urban fattening activities. Concentrates rich in energy are feedstuffs such as grain, brans from different cereals, maize and middlings. Concentrates rich in protein include noug seed cake, linseed cake, cotton seed cake, brewers' grains, etc. How much energy and protein a concentrate feedture should contain will depend on the quality of the basal roughage and the level of production. As a rule of thumb, 1 kg good concentrate will increase milk production by 1.5 kg (SDDP, 1999).

Agro-industrial by-products can be utilized by mixing two or more of the ingredients to make concentrate at home or using a single ingredient. They have special value in feeding livestock mainly in urban and peri-urban livestock production systems, as well as in situations where the productive potential of the animals is relatively high and require high nutrient supply. Agro-industrial by-products are rich in energy and/or

protein contents or both. They have low fibre content, high digestibility and energy values compared with the other class of feeds. Alemu *et al*., (1991) have also reported more than 35% CP and 50- 70% in vitro organic matter digestibility (IVOMD) for oil seed cakes and 18-20% CP and more than 80% IVOMD for flour milling by-products. Therefore, due to their high IVOMD and CP contents, supplementing ruminants fed on low quality feeds with agro-industrial by-products enables them to perform well due to higher nutrient density to correct the nutrient deficiencies in the basal diet.

## 2.12 Nutritional Characteristics of Oil Seed Cakes

During processing, some seeds may have part of their outer, fibrous layers removed (dehulling or decortications) before the actual removal of oil, which may be achieved simply by crushing (expeller) or by crushing followed by the use of chemical solvents (extraction). The outer fibrous material is used as livestock feed. The residues remaining after removal of the oil contain most of the fibrous carbohydrate and protein fractions present in the original seeds (Lonsdale, 1989).

These residues form the group of feeds known as oil seed cakes. Oil seed cakes have broadly similar nutritional characteristics and to some extent they are interchangeable. Their nutritive value varies with the amount and digestibility of the carbohydrate fraction, the level and type of the protein present and the content of residual oil. The carbohydrate fraction comprises of different proportions of fiber, starch and sugar, which influences the digestibility, and therefore, the energy value of the cake. In general, the most fibrous materials are the least digestible (Lonsdale, 1989).

Chemical composition of oil seed cakes vary widely depending on species and methods of processing (Solomon, 1992). Oil seed cakes are generally characterized by high protein, fat and low fiber contents. The mean chemical composition of 68 samples of oil seed cakes belonging to genera resulted in CP content of 35%, ether extract (EE) content of 11%, neutral detergent fiber (NDF) content of 30% and lignin content of 7% (Solomon, 1992).

Because of processing effect, oil seed cakes exhibit higher contents of N bound to fiber; acid detergent fiber nitrogen (ADF-N) depending on the technology of

extraction. According to Solomon (1992), the content of ADF-N is higher in oil seed cakes obtained from small scale press mills than larger scale press mills, and oil seed cakes from solvent extraction. The author also indicated that the concentrations of P, K and Mg are higher than optimum level for ruminant diets, but lower in Ca and Na contents. Seyoum (1995) confirmed that oil seed cakes have medium to high EE, high CP and low cell wall constituents and medium to high IVOMD.

### 2.13.1 *Chemical composition and supplementary value of noug seed cake*

Noug is an oil crop cultivated in the mid altitude areas of Ethiopia. Noug seed cake is one of the important by-products, which is widely available and is a high protein meal with a CP value of 29.5% (SDDP, 1999). The supplementary value of noug seed cake is influenced by its protein quality which depends on variety, climate, cultural practices and methods of processing (Amaha, 1990). Tekeba (2005) reported the chemical composition of noug seed cake as 32.74% CP, 6.29% EE, 26.90% CF, and 1821 kcal ME/kg DM.

The high CP and ME values are indicative of the potential of the oil seed cake as a protein and energy supplement in crop residue based feeds off for ruminants. Seyoum (1995) reported that the EE content of oil seed cakes ranged from 5.5% in noug seed cake to 14.6% in sunflower cake with a mean of 10%, and the IVOMD of oil seed cakes ranged from 58% in noug seed cake to 88% in peanut cake. Earlier works indicated that noug seed cake and urea molasses blocks (UMB) can be used along with poor quality hay and teff (*Eragrostis teff*) straw for milk production (Little *et al.*, 1987) and fattening sheep (Solomon *et al.,* 1991; Lemma, 1991) as protein supplement.

Supplementation of animals with NSC improved live weight. Solomon *et al.* (1991) reported 94.89 -136.79 g/day body weight gain for grazing Begait sheep supplemented with graded level (200-500 g/day) of concentrate feedture of noug seed cake and maize. Lemma (1991), also reported body weight gain of 33 g/ day for Begait sheep fed teff straw and supplemented with noug seed cake and ground maize.

### 2.13.2 *Chemical composition and supplementary value of cotton seed cake*

Cotton seed (*Gossypium hirsutum*) cake, like other oil seed meals is obtained after the oil has been extracted from the cotton seed using either of two common methods of extraction, namely, expeller extraction (mechanical) and solvent extraction (chemical). The composition and nutritive value of the cake depend up on the raw material and the method of extraction used (Weiss, 1983). Cottonseed contains 6% oil, 41% CP, 10.6% fiber, 72% TDN, 6.2% ash, and 4.6% EE and the energy content ranges between 8.5 to 12.3 MJ ME/kg DM (McDonald, 2002). Cottonseed meal is one of the richest feeds in phosphorus, containing about 1% or more. In contrast to the high phosphorus content, it has only about 0.2% calcium. Cottonseed meal is used as a source of protein in concentrate feedture, rather than as the only supplement.

Cottonseed has a thick coat or husk, rich in fiber and of low digestibility, which lowers the nutritive value of the material (McDonald, 2002). It may be completely or partially removed by cracking and riddling, a process known as decortications. Removal of the husk lowers the crude fiber content and has an important effect in improving the apparent digestibility of the other constituents. As a result, the nutritive value of the decorticated cake is raised significantly above that of the un-decorticated. Cotton seed cake is an excellent protein supplement for fattening goats and is practically equal to linseed meal for fattening goats. When small ruminants are fed with large amounts of cottonseed meal, there is danger of cottonseed meal injury, unless they are offered plenty of good legume hay or other roughages (Morrison, 1984). A major constraint to the use of cottonseed and cottonseed meal as feedstuff is the presence of toxic constituents of gossypol, a yellowish pigment that occurs in seeds. Ruminants are more tolerant of gossypol, but even in ruminants prolonged feeding of whole cotton seed for many weeks or months can cause heart and liver damage (Cheeke, 1991).

Wheat bran is an important source of carbohydrates, protein, minerals and vitamins and considered as one of the feeds that can be used for fattening. Wheat bran is usually an abundant agro-industrial by-product that can be used in animal feeding and is readily available (Alemu *et al*., 1989). The CP content and fat content of wheat bran ranges from 13.3 to 17.0% and 3.0 to 4.5%, respectively (Lonsdale, 1989).

The CP in wheat bran reported by Solomon *et al*. (2004b) was 16.5%. (Tekeba, 2005) reported CP content of wheat bran at 16.40%, EE 4.20%, CF 10.98% and ME 2996 kcal/kg and 16.7% CP in wheat bran was also reported by (Zemicael, 2007). Lonsdale (1989), indicated that CF and CP contents of wheat bran may vary from 100 to 130 g/kg DM and 170 to 180 g/kg DM, respectively and its ME content may range from 10 to 11 MJ/kg DM. Devendra and McLeroy (1982) reported that, wheat bran is quite palatable, and well known for its ability to prevent constipation because of its swelling and water holding capacity. This capacity of wheat bran is due to its fiber and non-starch carbohydrate content. Wheat bran has an amino acid balance superior to whole wheat, high in phosphorus and low in calcium (Devendra and McLeroy, 1982). It consists of about 18% CP and 67.2% TDN. The CP of wheat bran has a digestibility coefficient of about 0.75 and has 0.51 to 0.70 rumen degradability (Lonsdale, 1989). Fiber and metabolizable energy content of wheat bran vary slightly depending on the specification of the wheat being milled and the exact processes used in the mill, as these factors affect the overall blend of bran components. Zemicael (2007) reported, 50 g of average daily body weight gain for Begait sheep fed on teff straw and supplemented with 300 g/day of wheat bran and 66-78.89 g/day for the same breed when supplemented with 300 g/day of wheat bran and sesame seed cake mixture. Similarly, Simret (2005) reported, daily body gain of 39.90 - 44.72 g/day for Somali goats fed on hay basal diet and supplemented with graded levels of peanut cake and wheat bran mixture.

# 3 MATERIALS AND METHODS

Two experiments namely, survey and feeding trial were undertaken. Accordingly, the materials and methods followed during the study are presented as follows.

## 3.1 Survey

### 3.1.1 *Description of the study area*

The study was conducted in Kafta Humera woreda, located in western zone of Tigray national regional state, 570 km northwest of Mekelle. Its location lies within the co-ordinates of $13^0$ 40'-$14^0$ 27' north latitude and $36^0$27'-37'32' east longitudes (Fig 1). It is bordered with Sudan to the West, Tahitay Adiyabo to the East, Wolkayt and the Amhara region to the South and Eritrea to the North. The total area coverage of the woreda is estimated to be 717,652 ha (WoARD 2011, unpublished). The agro-ecology of the woreda is hot to warm semi-arid lowland plains which are characterized by hot temperature, erratic rainfall, vast area of plain lowlands suitable for large scale and subsistence agriculture including crop and livestock production systems.

The topography of the woreda is almost flat or undulating flat, rolling to hilly plains, mountains and plateaus with slopes varying from 0.2% up to 15-30% in the lowlands and 15-30% in the highlands. The ranges of the altitude are 568 to 1861 meters above sea level. The dry season occurs during the months of October to May, and the wet season occurs in the months of June to September. It has unimodal rainfall pattern, 80 to 85% of the rain falling in the summer (wet season) and the annual rainfall is 448.8 and 1102.5mm for the lowland and highland areas of the woreda, respectively. The mean annual temperature of the area is $25^0$C to $27.5^0$C and $20^0$C to $25^0$C in the highlands. All the study kebeles were found within the lowland part (kola) of the woreda and share the mean annual rainfall and mean annual temperature recorded to the lowland areas (Woreda Bureau of agriculture 2011, unpublished).

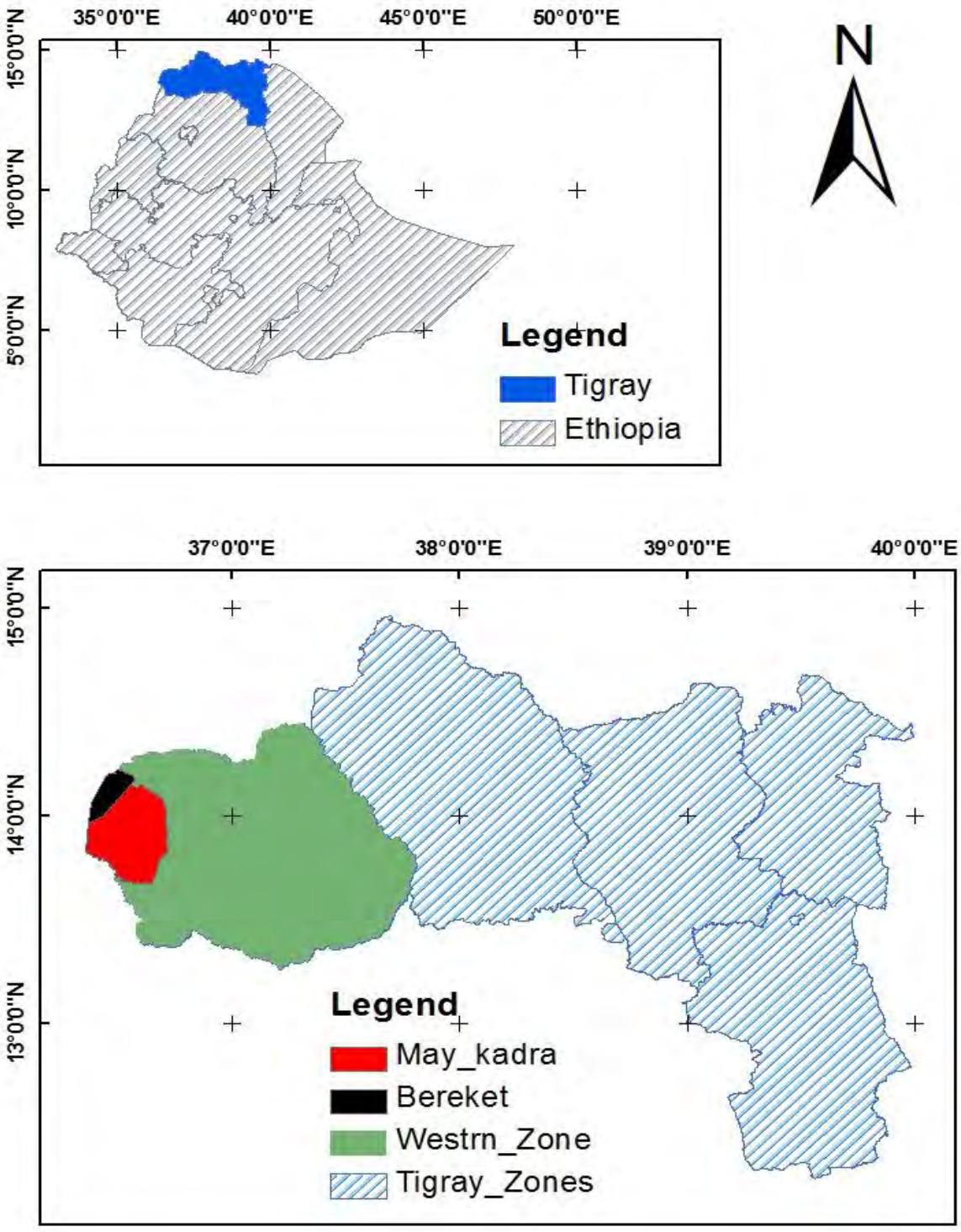


Figure 1. Location of the study area

The people of the study area practice mixed farming systems as means of livelihood. Crop production system (396,852 ha), similar to the other areas of this region, is targeted for subsistence with the major crops including, sesame, sorghum, maize, and cotton being the most common ones in the woreda. Crop production in the area is

largely rain-fed cultivation. In the study area, livestock are integral component of the farming system. Despite the large population of livestock in the area, the productivity is low as in many other parts of Tigray. Free grazing year round is the common grazing practice of the locality. Feed, diseases and other management practices are constraints of livestock production in the area (WoARD, 2011).

According to Kafta Humera Woreda Office of Agriculture and Rural Development (2011, unpublished) baseline data, the total area coverage of the woreda is 717,652 ha. This total area coverage is classified into cultivable land (396,852 ha), forest area (38,509 ha), grazing land (40,800 ha), enclosure area (36,491 ha) (communal), parks and sanctuaries (180,000 ha) and others (25,000 ha) land use types

Livestock are the valuable components of the farming system contributing enormously towards ensuring food security in the study area. There is considerably large number of livestock in the district. The total livestock population of the woreda for the year 2011 was 237,307 cattle (60,840 Begait cattle), 118, 180 goats, 77, 961 sheep, 112, 683 poultry, 23529 donkeys and 3674 camel (Fig 2). Livestock are valuable components of the farming system contributing enormously to smallholder producers' and investors' livelihoods systems.

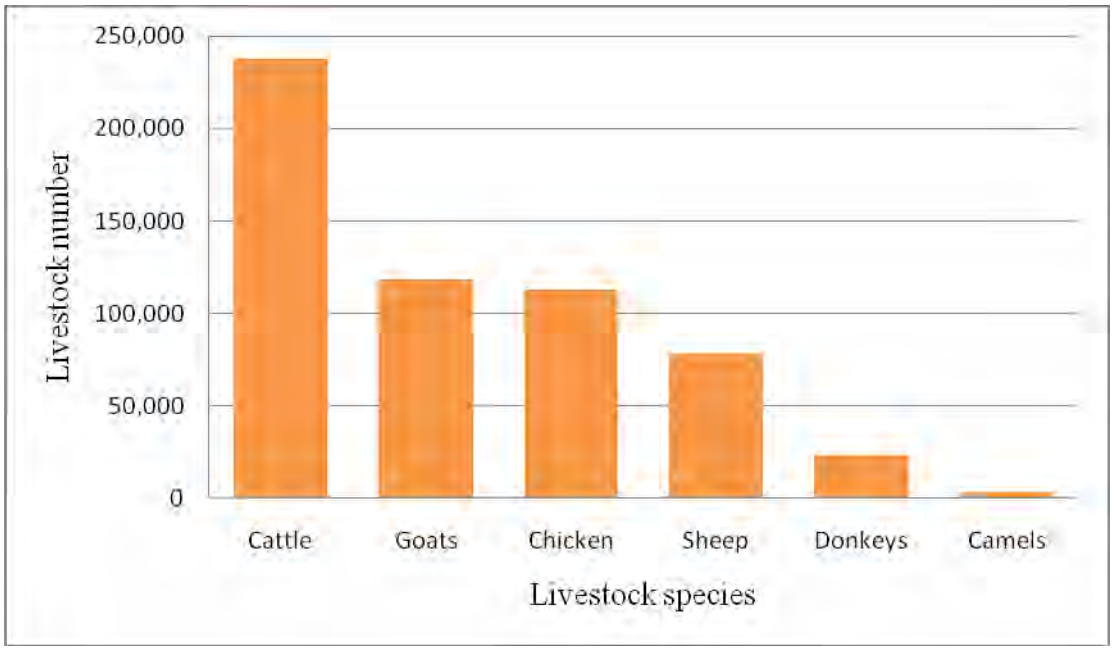


Figure 2. Livestock species number in the woreda

According to Yaynshet (2010), the major feed resources for livestock include grazing, hay, crop residues, and agro-industrial by-products. From cereal residues, sorghum stover has the largest contribution as illustrated in (Table 2).

Table 2. Availability of crop residues in Kafta Humera district in Tigray region

| **Crop residues** | Production (Quintal) | Contribution (%) |
|---|---|---|
| Finger millet | 2054.8 | 0.8 |
| Maize | 2162 | 0.8 |
| Sorghum | 33302 | 12.6 |
| Teff | 1621.5 | 0.6 |
| Pulses | 382.8 | 0.1 |
| Oil seed | 225468 | 85.1 |

Source : (Yaynshet, 2010)

In the study area, the most soil classes comprise Vertisols (35%), Leptosols (35%), Regosols (16%), Fluvisols (8%), Cambisols (6%), and Luvisols (3%). Soil classes of vertisols and leptosols constitute the largest soil group that covers about 70% of the soils in the woreda. In the study area, the vegetation resources diminished from time to time. In the grazing lands much of the indigenous plants have been removed due to overutilization. *Acacia spp and hyperheania spp*, were the most dominant for woody and grass species respectively (WoARD 2011, unpublished).

### *3.1.2 Sampling methodology*

Prior to sampling of the kebeles, discussions were held with Woreda livestock experts and development agents by preparing workshop to make clear the purpose of the study. Two kebeles (Maycadra and Bereket) were purposively selected from the district/woreda based on the population of livestock, cattle rearing experience and willingness of the farmers to participate in the program. A total of 104 households (52 from each kebeles) were randomly selected. Fifteen key farmers from each kebeles

were purposively chosen for group discussion based on their willingness' and experiences keeping/rearing Begait cattle for longer period of time (>10 years).

### 3.1.2 *Questionnaire*

A set of detailed opened and closed type structured questionnaire (appendix I) were prepared and used to collect the information in one visited interview. The questionnaire was pre-tested for clarity and appropriateness of the questions. Some of the information collected during interview were supported by observation and group discussion. Some of the points mentioned for group discussion were cattle production constraints, trend of breed, and some characteristics of the breed. The questionnaire was designed to obtain information on general household characteristics, livestock and herd holding, herd management, purpose of keeping cattle, breeding practices, disease prevalence, production objectives, feeding management, production constraints, and production and reproduction performance of Begait cattle breed. Survey questionnaire and descriptor of phenotypic characteristics of animals with additional color chart and Tigrigna translated version of the questionnaire were utilized.

### 3.1.3 *Production and reproduction performance*

Most of the parameters used to evaluate production and reproduction performance of Begait cattle were obtained through questionnaire, personal observations, and discussion with the cattle owners. Some of the production and reproduction parameters taken included daily milk yield (DMY), lactation length (LL), calving interval (CI), age at first calving (AFC), life time reproduction (LP).

### 3.1.4 *Phenotypic characterization*

Preliminary information of the breed was acquired from key farmers and woreda agricultural experts through informal discussions. The points of discussion were: the habitat of pure Begait cattle; if different category of Begait cattle in the zone is available, and concerning the size of Begait cattle population.

As FAO (2005) report, 100 adult female and 34 adult male are required for characterization. Taking this into consideration 52 adult male and 140 adult female Begait cattle were taken for the phenotypic characterization purpose.


Figure 3. Body measurements of cattle

A=Body length (length from the point of shoulder to pin bone), B=Height at withers (height at shoulder including the hump height), C= cannon length, D= Heart girth/chest girth, E= Tail length (head to end of tail), F= Perpetual sheath G=Dewlap width, H= Ear length, J= horn length (base of the horn to the pointed end) (Tesfaye *et al.,* 2003)

Data on quantitative and qualitative characters were collected and recorded on the format adopted from the standard description list developed by FAO (2005). Quantitative traits including body length, height at wither; Heart (chest) girth, Horn length, Ear length, Tail length, pelvic width , body length, and height at wither were measured using measuring tape. The age of the animals were estimated by dentitions and information from cattle owners. Qualitative and major quantitative characters were recorded for each animal sampled as per the following breed descriptor list (FAO, 2005). All measurements were repeated with the animal being moved to a "normal" position for each measurement

Table 3. Standard breed descriptor list for qualitative traits of cattle

| **No** | Qualitative traits | Characteristics |
|---|---|---|
| 1 | Body hair coat color pattern | uniform, pied, spotted |
| 2 | Body hair coat color | White and Black pied, white and black spotty, light brown, light gray, white and dark |
| 6 | Horn presence | Horned, polled |
| 7 | Horn shape | Straight, curved, absent |
| 8 | Ear orientation | Erect, lateral, dropping |
| 9 | Hump size | Absent, small, medium, large |
| 10 | Naval flap (in cows) | Absent, small, medium, large |
| 12 | Tail length | Short (above the hock), medium (about the hock), long (below the hock) |

Table 4. Standard breed descriptor for quantities traits

| **NO** | **Quantities traits** | **Definitions** |
|---|---|---|
| 1 | Ear length | Length (cm) of extreme part of ear from its roots to tip |
| 2 | Body length | Horizontal length (cm) from the point of shoulder to the pin bone |
| 3 | Chest girth | The distance around the animal (cm) measured directly behind the front leg |
| 4 | Horn length | Distance from the base of the tip of the horn to tip horn |
| 5 | Tail length | Distance from the base of the tip of the tail on the outer side of the tail |
| 6 | Height at withers | The height (cm) from the bottom of the front foot to the highest point of the shoulder between the withers |
| 7 | Pelvic width | The horizontal distance (cm) between the extreme later points of the hook bone (tuber coxae) of the pelvis. |

Source: (FAO, 2005)

### 3.1.5 *Estimation of age*

Cattle age was determined by the eruption of permanent pair of incisors. As described by Kikule (1953); Wilson and Durkin (1984) 1st, 2nd, 3rd and 4th pairs of permanent incisors erupts are approximate an age groups of 27-32, 32-36, 40-44 and 47-54 months respectively.

## 3.2 Feeding Trial

### 3.2.1 *Study site*

The feeding trial was conducted in Humera Begait cattle Breeding and Multiplication Ranch of the Regional Government. The ranch was established with 160 Begait cattle in 2004 E.C. During the study period, the ranch had 200 Begait cattle. The ranch was established on 2000 ha of land and it is located in western zone of Tigray national regional state, 570 km northwest of Mekelle. Its geographical location lies within the co-ordinates of $13^0$ $40^{'}$-$14^0$ 27' north latitude and $36^0$27'-37'32' east longitude.

### 3.2.2 *Animals and their management*

Four Begait cows in second parity and in early stage of lactation (70 days after calving) were used. Weight of cows was taken using heart girth meter early in the morning before feed was offered. Average body weight of the selected cows was 322± 11 kg, with an average initial milk yield of 2.2 kg cow-1 day-1. Three week before the commencement of the experiments, all animals were treated with a broad spectrum de-wormer against internal or GIT parasites and external parasites were controlled by spraying once a week with a broad-spectrum acaricide for control of ticks. The cows were tested for presence of mastitis using the California Mastitis Test (CMT) before the onset of the experiment.

### 3.2.3 *Experimental feeds and design*

The feeds used constituted sorghum stover as basal feed and supplements either wheat bran alone (T1) representing famers practices of supplementing their dairy cows, or mixtures of wheat bran with either of the oil seedcakes, noug seedcake (T2) or cotton

seedcake (T3) and wheat bran with mixtures of noug seedcake and cotton seed cake at proportions given in (Table 5). The feed ingredients were purchased locally. The oil was extracted locally using the expeller method. The chopped sorghum stover (5-8 cm) was obtained from Humera feed sales corporative. Water and common salt were available *ad libitum* all the time and the basal feed were offered *ad libitum* by providing 20% more feed than their daily requirements. The trial was conducted in 4 × 4 Latin square design. Experimental periods were 30 days (14 days of adaptation and 16 days of data collection). The treatment supplements except for T1 were formulated to be iso-nitrogenous with 18% CP and isocaloric with 13.06 ME (Mcal) per kg of diet to meet the nutrient requirements of lactating dairy cows (sen *et al.*, 1978) and (Ranjhan, 1990).

Table 5. A formulated ration for experimental animals

| **Feed ingredients** | **Treatments** | | | |
|---|---|---|---|---|
| | T1 | T2 | T3 | T4 |
| Sorghum stover | *Ad libitum* | *Ad libitum* | *Ad libitum* | *Ad libitum* |
| Wheat bran | 100% | 68% | 76% | 72% |
| Noug seedcake | 0 | 32% | 0 | 16% |
| Cotton seedcake | 0 | 0 | 24% | 12% |
| Total | 100% | 100% | 100% | 100% |

Supplementation level for the treatment groups was based on milk yield of experimental cows. About 0.25 kg supplement was given kg-1 milk yield cow-1 day-1 (Holleta Research Center, 2004 cited by BoFED, 2006). Accordingly, each cow was supplemented with 3 kg per day as fed basis of the respective concentrate feed with half the amount given during morning (7am) and the other half during the evening (5 pm) after milking.

### 3.2.4 *Feed intake*

During a preliminary 14 days adaptation period, cows were adapted to the treatment rations. This was followed by 16 days of measurement period. The basal feed and water were given *ad libitum*. Amounts feed offered and refusals were collected and weighed before a new meal was given. The weights of feeds offered were taken each morning and that of refusals the next morning. The feed intake was determined by subtracting the amount of feed refused from the amount offered.

### 3.2.5 *Milk yield and composition*

Calves were used to initiate milk let-down by suckling their dams for 1-2 minutes. Then, the calf will be tied in front of the cow until the cow was handed milked in the morning and evening. The milked milk was then weighed. Milk yield was recorded twice each day. For milk composition analysis, milk samples from the a.m. and p.m. were collected on 3 consecutive days (day 28 to 30 of each period) into plastic bottles containing a pinch (0.1g/50ml) of potassium dichromate ($K_2CrO_4$) powder to maintain homogeneity and prevent clotting. The bottles were kept in ice packed cool boxes. The samples were kept chilled until analyzed for milk components. Milk fat, protein and solid-not-fat (SNF) were analyzed using EKOMILK Ultrasonic Analyzer (Model: Bulteh 2000, Bulgaria) in Meat and Milk Industry Development Institution (the former ILCA), Bishoftu.

### 3.2.6 *Cost-benefit analysis*

The production costs were computed from the major costs of feeds and labour charges in relation to the revenue realized from sale of the extra milk obtained due to the supplements.

### 3.2.7 *Feed chemical analysis*

The weights and samples of forage offered were taken each morning and of refusals the next morning. Representative samples of daily feeds were taken and ground to

pass through a screen size of 1mm. The analysis for each sample was done in duplicate in Hawassa University, college of agriculture nutrition laboratory. The DM and ash content of feed offered and refusal were determined by the standard methods of AOAC, (1990). Total nitrogen (N) content of the feed samples was determined using micro-Kjeldahl method. The CP content was calculated as N*6.25. The ADF and NDF content were determined according to Van Soest *et al.,* (1991) using ANKOM ®200 Fiver Analyzer (ANKOM Technology corp., Fairport, NY, USA).

### 3.2.8 *Data management and analysis*

Data collected from each site were coded and entered into the computer for further analysis. Data collected were entered into Statistical Package for Social Sciences (SPSS 20.0 for windows, 2004). Preliminary data analysis like normality test and screening of outliers were employed before conducting the main data analysis. Index was computed by employing the principle of weighted average of Musa *et al*. (2006) as cited by Tsegereda and Mengistu (2011).

$$\text{Index} = \frac{Rn*C1+Rn-1*C2\ldots. +R1*Cn}{\Sigma Rn*C1+Rn-1*C2\ldots+R1*Cn;}$$

Where, Rn = Value given for the least ranked level (if the least rank is 5th, then Rn = 5, Rn-1 = 4, R1 = 1) Cn = Counts of the least ranked level (in the above example, the count of the 5th rank = Cn, and the count of the 1st rank = C1).

Average feed intake, milk yield and milk composition for all experimental animals were analyzed using Statistical Package for Social Sciences (SPSS 20.0 for windows, 2004). Significance differences among treatments means were separated using Tukey HSD at $P<0.05$.

The model used for the analysis of data was:

$Y_{ijk}=\mu+ \alpha_i+ \beta_j +T_k+ E_{ijk}$ : Where, $Y_{ijk}$ is the dependent variable (intake, milk yield& composition), $\mu$ = overall mean, $\alpha_i$ = effect of period (i=1-4), $\beta_j$ = cow effect (j=1-4), $T_k$= effect of treatment (diet) (k=1-4), $E_{ijk}$ = residual error

# 4. RESULTS

## 4.1 Survey

### 4.1.1 *Household characteristics*

From the total of 104 sample households interviewed, about 81.7% and 18.3% were male and female headed household, respectively. The mean age of the respondents was 45 years (Table 6). The average family and land size was 4.06 persons, 1.53ha per household, respectively. From the interviewed households, about 51% could read and write while 49% were illiterate

Table 6. Household characteristics

| | Kebeles | | |
|---|---|---|---|
| Parameters | Maycadra (N=52) | Bereket (N=52) | Total (N=104) |
| | Mean ± SD | Mean ± SD | Mean ± SE |
| Age (years) | 43.12±0.83 | 47.0±0.86 | 45.06±0.23 |
| Family size | 3.63±0.53 | 4.48±0.54 | 4.06±0.07 |
| Land size (ha) | 1.33±0.24 | 1.74±0.27 | 1.53±0.03 |
| Gender head ratio | N (%) | N (%) | N (%) |
| Male | 42(80.8) | 43(82.7) | 85(81.7) |
| Female | 10(19.2) | 9(17.3) | 19(18.3) |
| Educational status | N (%) | N (%) | N (%) |
| Illiterate | 17(32.7) | 36(69.2) | 53(51) |
| Read and write | 35(67.3) | 16(30.8) | 51(49) |

N= number of households; SD=standard deviation; SE=standard error; figures in the brackets are percentages from respondents.

### 4.1.2 *Sources of livelihood*

The primary sources of livelihood of the farmers in the study area are given in (Table 7). The majority of farmers 58.7% reported livestock and crop production as the most important source for their livelihood followed by crop, livestock and off-farm activities 18.3%, livestock and off-farm activities 9.6%, livestock production only 6.7%, crop and off-farm activities 4.8%, and crop production only 1.9%.

Table 7. Household income sources in the study area

| | Kebeles | | |
|---|---|---|---|
| Income source | Maycadra(N=52) | Bereket(N=52) | Total (104) |
| Livestock production only | 2(3.8) | 5(9.6) | 7(6.7) |
| Crop production only | 1(1.9) | 1(1.9) | 2(1.9) |
| Livestock and crop production | 27(51.9) | 34(65.3) | 61(58.7) |
| Livestock and off-farm activities | 7(13.5) | 3(5.8) | 10(9.6) |
| Crop and off-farm activities | 3(5.8) | 2(3.8) | 5(4.8) |
| Crop, livestock and off-farm | 12(24.0) | 7(13.5) | 19(18.3) |

N=Sample respondents, the figures in the brackets are percentages from N

### 4.1.3 *Livestock feed resources and feeding practices*

Natural pasture was the first and the most common feed resources used for all livestock species during wet and dry seasons. Grazing land in the studied area was entirely communally owned. Farmers used different feeding/grazing practice. Herded were the most common practices during wet and dry season in the study area (Table 8). A few farmers in tethered their animals during dry and wet season. Free grazing was less practiced due the fear of theft and predators. The natural pasture dries up and becomes standing hay (Fig 4) and animals graze up on this. Moreover, feed

conservation was practiced in the form of crop residue (sorghum stover teff straw, millet straw, and maize).

Figure 4. Standing hay in the dry season (kafta mesil)

These conserved feeds were given to cattle during feed shortage (dry season) primarily to lactating cows and work oxen during the cropping season. Results showed that supplementation using commercial feeds (energy and protein concentrates) were practiced (Table 9). The major concentrate utilized under farmers management was wheat bran as it was cheap. Few farmers were also used a mix of concentrates like wheat bran with noug seed cake or wheat bran with cotton seed cake. Mixtures of wheat bran, noug and cotton seed cake was rarely practices as obtained from the discussion with the key farmers.

Table 8. Feed sources in wet and dry season

| | Kebeles | | |
|---|---|---|---|
| Wet season | Maycadra (52) | Bereket (52) | Total (104) |
| Pasture | 52(100) | 52(100) | 104(100) |
| Browse trees | 49(94.2) | 51(98) | 100(96.2) |
| Feed supplements | 16(11.5) | 13(5.8) | 19(18.7) |
| Dry season | | | |
| Pasture(standing hay) | 52(100) | 52(100) | 104(100) |
| Crop residues | 52(100) | 52(100) | 104(100) |
| Crop after math | 47(90.4) | 49(94.2) | 96(92.3) |
| Browse trees | 12(23.0) | 16(30.8) | 28(26.9) |
| Feed supplement | 26(30.8) | 19(17.4) | 35(33.7) |

Figures in the brackets are percentages

Table 9. Feed supplements in the study area

| Feed supplements | Maycadra | Bereket | Total |
|---|---|---|---|
| Wheat bran (WB) | 24(46.2) | 22(42.3) | 46(44.2) |
| Cotton seed cake (CSC) | 11(21.2) | 8(15.4) | 19(18.3) |
| Noug seed cake (NSC) | 7(13.5) | 3(5.8) | 10(9.6) |
| WB + CSC | 6(11.5) | 9(17.3) | 15(14.4) |
| WB + NSC | 4(7.7) | 7(13.5) | 11(10.6) |
| WB, CSC, and NSC | 2(3.8) | 3(5.8) | 5(4.8) |
| Total respondents | 52(100) | 52(100) | 104(100) |

Percentages in bracket and totals are based on respondents;

Table 10. Feeding practices and strategies

| Feeding practices | Dry season | | | Wet season | | |
|---|---|---|---|---|---|---|
| | Maycadra | Bereket | Total | Maycadra | Bereket | Total |
| | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
| Herded | 42(80.8) | 43(82.7) | 85(81.7) | 45(86.5) | 47(90.4) | 92(88.5) |
| Tethering | 6(11.5) | 7(13.5) | 13(12.5) | 6(11.5) | 3(5.8) | 9(8.7) |
| Free grazing | 4(7.7) | 2(3.8) | 6(5.8) | 1(1.9) | 2(3.8) | 3(2.9) |

N= number of respondents; the figure in bracket represents percentages

### 4.1.4 *Livestock holding*

The livestock possession of the study areas is summarized in (Table 11). There was significant difference ($P<0.05$) in livestock holding for cattle, sheep, goats and honeybee among Maycadra and Bereket kebeles. However, there was no significant ($P>0.05$) difference for equines and chicken holding for the two villages. Equines were mainly kept for transportation and packing purposes.

The overall mean of livestock possession (head/HH) in the study area was 12, 3.88, 7.71, 1.07, 0.5 and 0.37 for cattle, sheep, goats, equines, chicken and honeybee, respectively. In both study areas, farmers possessed more cattle than other livestock species. The average herd size was higher in Bereket and significantly different from Maycadra may be due to the availability of feed and long tradition of raising livestock as a source of income.

Table 11. Household livestock holding

| Parameters | Kebeles | | |
|---|---|---|---|
| | Maycadra (N=52) | Bereket (N=52) | Total (104) |
| | Mean ±SD | Mean ±SD | Mean ±SE |
| Cattle | 9.52 ±1.32 | 14.54± 1.43 | 12.0±0.28 |
| Sheep | 2.94±1.59 | 4.81± 0.69 | 3.88±0.15 |
| Goats | 4.52± 2.57 | 10.9± 1.94 | 7.71±0.39 |
| Equines | 1.0± 0.57 | 1.13± 0.63 | 1.07±0.06 |
| Chicken | 0.38± 0.93 | 0.62± 0.99 | 0.50±0.10 |
| Honeybees | 0.54± 0.78 | 0.19± 0.40 | 0.37±0.06 |

N=Sample respondents; Ns =Non-significant (P > 0.05); **significant (P < 0.05);

Table 12. Cattle herd composition

| Parameters | Kebeles | | |
|---|---|---|---|
| | Maycadra (N=52) | Bereket (N=52) | Total (N=104) |
| | Mean ±SD | Mean ±SD | Mean ±SE |
| Cattle | 9.54 ±1.32 | 14.54± 1.43 | 12.0±0.28 |
| Adult intact males>3 yrs | 0.96±0.56 | 1.5± 0.58 | 1.23±0.06 |
| Adult castrate male>3yrs | 0.27± 0.45 | 0.57± 0.58 | 0.42±0.05 |
| Young intact male1-3yrs | 0.52± 0.51 | 0.96± 0.60 | 0.74±0.06 |
| Young castratemale1-3yrs | 0.12± 0.32 | 0.15± 0.36 | 0.13±0.03 |
| Immature male 0-1yrs | 0.85± 0.61 | 1.04± 0.93 | 0.94±0.08 |
| Young female 1-3 yrs | 1.25± 0.68 | 2.10± 0.91 | 1.67±0.09 |
| Matured female>3 yrs | 4.75± 0.68 | 7.17± 0.90 | 5.9±0.14 |
| Immature female 0-1yrs | 0.83± 0.67 | 1.17± 0.68 | 1.0±0.07 |

### 4.1.5 *Family labour utilization*

Household members were participating in various cattle management practices in the studied area and this was dependent not only on the sex and age of the family members, but also on the type of the activities. Details of the responsibilities of family members in cattle management activities categorized by age and gender were shown in (Table 13). The selling and purchasing of cattle was mostly the responsibility of males greater than or equal to 15 years of age. This group was also responsible for breeding, healthcare and feeding activities whereas their female counterparts were responsible for milking, making and selling dairy products and feeding cattle. Males and females under 15 years of age were given responsibilities mainly for feeding. Young females were also involved in helping older women in dairying activities.

Table 13. Labour distribution among family member in cattle rearing

| | Age and gender category in Maycadra kebele | | | | |
|---|---|---|---|---|---|
| **Activities** | Male>=15 | Female>=15 | Male<15 | Female<15 | labour |
| Healthcare | 25(49.0) | 10(19.6) | - | - | 28(54.9) |
| Herding | 20(39.2) | - | - | - | 31(60.8) |
| Making dairy products | 2(3.8) | 52(100) | - | 22(42.3) | 29(55.8) |
| Selling dairy products | 15(28.8) | 52(100) | - | - | - |
| Selling animal | 42(80.8) | 10(19.6) | - | - | - |
| Purchasing animal | 52(100) | 2(3.8) | - | - | - |
| Feeding | 32(61.5) | 28(53.8) | 27(51.9) | 21(40.4) | 34(65.4) |
| Breeding | 29(56.9) | 8(15.7) | - | - | 28(54.9) |

Table 14. Age and gender category in Bereket Kebele

| | Age and gender category in Bereket Kebele | | | | |
|---|---|---|---|---|---|
| **Activities** | Male>=15 | Female>=15 | Male<15 | Female<15 | labour |
| Healthcare | 35(67.3) | 9(17.3) | - | | 17(32.7) |
| Herding | 37(71.2) | - | - | | 15(28.8) |
| Making dairy products | 9(17.3) | 52(100) | - | 34(65.4) | 17(32.7) |
| Selling dairy products | 19(36.5) | 52(100) | - | | |
| Selling animal | 43(82.7) | 9(17.3) | - | | |
| Purchasing animal | 52(100) | 3(5.8) | - | | |
| Feeding | 39(75.0) | 29(55.8) | 44(84.6) | 43(82.7) | 17(32.7) |
| Breeding | 38(77.6) | 12(24.5) | - | - | 12(24.5) |

### 4.1.6 *Water sources and watering frequency*

Rivers (Bahreselam and Tekeze), bore wells and pond water were the major sources of water for livestock in western zone of the region. Cattle were mostly watered in a dry season in rivers, pond, and bore wells; and in rainy season they were watered in rivers, bore wells, and ponds. Shortage of water was common in dry season as compared to wet season. Sources and distance of water by season is presented in (Table 15).

Figure 5. Watering own animals during dry season

During dry season, the majority 65.4% of the households obtained water supply from rivers, while some got water bore wells 24.0%, and 2.9% from pond, and the rest 5.8% from piped sources. In wet season the majority 35.6% of the respondents obtained water from rivers while the rest got water from bore wells 34.6%, ponds 17.3% and 12.5% from piped. The distances to the nearest watering points from homestead during dry season was 71.2% traveled 1-5 km, 26.0% traveled < 1km, and 4.8% at their home. During the wet season, majority 44.2% got water traveling < 1km and followed by 39.4% for 1-5km, and 16.3% at their home to get watered for their cattle.

Table 15. Sources of water

| | Kebeles | | |
|---|---|---|---|
| Dry season | Maycadra (52) | Bereket (52) | Total (104) |
| Ponds | 1(1.9) | 2(3.8) | 3(2.9) |
| Rivers | 31(59.6) | 37(71.2) | 68(65.4) |
| Bore wells | 14(26.9) | 13(25.0) | 27(26.0) |
| piped | 6(11.5) | 0 | 6(5.8) |
| Wet season | | | |
| Ponds | 7(13.5) | 11(21.2) | 18(17.3) |
| Rivers | 17(32.7) | 20(38.5) | 37(35.6) |
| Bore wells | 15(28.9) | 21(40.4) | 36(34.6) |
| piped | 13(25.0) | 0 | 13(12.5) |

Table 16. Distance to watering point

| | Kebeles | | |
|---|---|---|---|
| Dry season | Maycadra (52) | Bereket (52) | Total (104) |
| House hold level | 3(5.8) | 2(3.8) | 5(4.8) |
| < 1km | 16(30.8) | 9(17.3) | 25(24.0) |
| 1-5km | 33(63.5) | 41(78.8) | 74(71.2) |
| 6-10km | 0 | 0 | 0 |
| > 10km | 0 | 0 | 0 |
| Wet season | | | |
| Household level | 11(21.2) | 6(11.5) | 17(16.3) |
| < 1km | 25(48.1) | 21(40.4) | 46(44.2) |
| 1-5km | 16(30.8) | 25(48.1) | 41(39.4) |
| 6-10km | 0 | 0 | 0 |
| > 10km | 0 | 0 | 0 |

Animals travel longer distance to watering points (1-5km) per day leading to waste of their energy during the dry season, but in wet season animals were watered in a nearby natural water sources. Almost all the respondents allow their cattle to drink once per a day during dry season. But during wet season water was supplied freely without any restriction

### 4.1.7 *Cattle housing*

According to the discussion held, most of the households in the study area kept their livestock inside their residence. Cattle houses were using locally available materials; mainly grasses and woods. Majority of the livestock houses were all sides open for better ventilation. The floor of livestock houses were made of earth material and house was roofed temporarily using grasses and sorghum residues shown in (Fig 6).

Figure 6. Animals under shed

In addition, in all cases of the study area calves and small ruminants were housed separated from other cattle.

### 4.1.8 *Cattle breeding/mating system*

Breeding in the study area was uncontrolled and seasonal and depended on feed quality and availability. Most of the cows showed heat during late rainy season (mid

September to December). None of the sampled farm households in study area used AI or improved bull to inseminate or mating their cattle. Cows were freely grazed and bred with their own bull or their neighbor's. Out of the total sampled household respondents in study area, about 79.8% used their own bull while the remaining 20.2% used bull from their neighbors.

Table 17. Mating methods and sources of bull used

| | Kebeles | | |
|---|---|---|---|
| **Mating** | Maycadra (52) | Bereket (52) | Total (104) |
| Uncontrolled | 41(78.8) | 35(67.3) | 76(73.1) |
| Hand mating | 11(21.2) | 17(32.7) | 28(26.9) |
| A.I. | 0 | 0 | 0 |
| **Source of bull** | | | |
| Own bull (bred) | 31(59.6) | 35(67.3) | 66(63.5) |
| Own bull(bought) | 5(9.6) | 12(23.1) | 17(16.3) |
| Neighbor bull | 16(30.8) | 5(9.6) | 21(20.2) |

Regarding birth of calves, there was no mating season preferred by farmers. However, the most common months of the year with frequent calves births were May 10.6%, June 40.4% and July 24%.

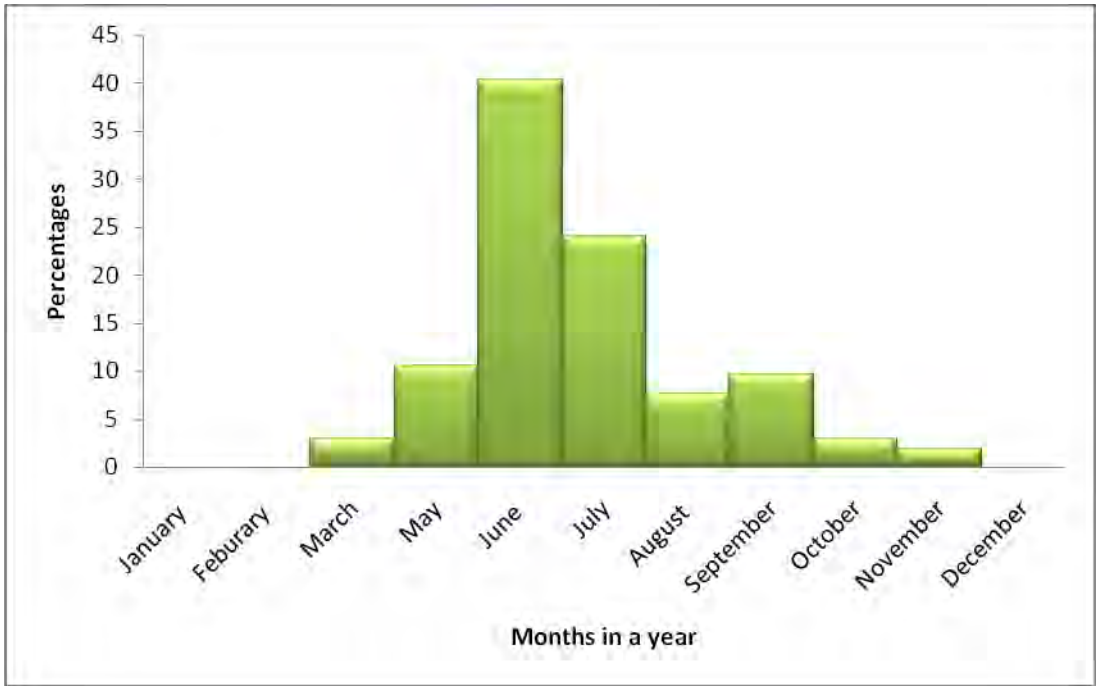


Figure 7. Calf birth in different months of the year

### 4.1.9 *Milking and calf rearing practices*

According to the open discussion held, calves were grazed and housed separately from the dams except when calves were used to stimulate milk let-down. Traditional hand milking was the only type of milking practiced in the district. Washing of teats before milking was not practiced and they believe that during calf suckling for milk letdown, the teats got washed by the saliva of calf and, therefore, it was not as such important to wash the teats before milking ignoring hygienic case for the calf. Milking was mainly done by women. Traditionally, calves were allowed to suckle their dams before (to initiate milk letdown) and after milking (to drain whatever was left in the udder). As the farmers indicated, milking frequency was done mostly twice a day and this also depended on feed availability and body condition of the calf.

### 4.1.10 *Entries and off-take of cattle*

Entries to cattle herd were mainly due to birth 100%, gift 40.4% purchasing 19.2%, and exchange to some extent 5.8%. There was no entry of cattle through theft, but this could be due the unwillingness of the respondent to say exactness. The reasons of cattle off take in the last five years include sales 100%, gift 41.3% and death 40.4%.

Table 18. Cattle entries and off take in the herd

| Category | Kebeles | | |
|---|---|---|---|
| **Entries** | Maycadra (52) | Bereket (52) | Total (104) |
| Birth | 52(100) | 52(100) | 104(100) |
| Purchase | 14(26.9) | 6(11.5) | 20(19.2) |
| Gift | 17(32.7) | 25(48.1) | 42(40.4) |
| Exchange | 2(3.8) | 4(7.7) | 6(5.8) |
| **Off take** | | | |
| Death | 15(28.8) | 27(51.9) | 42(40.4) |
| Sales | 52(100) | 52(100) | 104(100) |
| Slaughter | 4(7.7) | 4(7.7) | 8(7.7) |
| Gift | 16(30.8) | 27(51.9) | 43(41.3) |
| Exchange | 5(9.6) | 3(5.8) | 8(7.7) |
| Theft | 6(11.5) | 14(26.9) | 20(19.2) |

Values in brackets are in percentage

### 4.1.11 *Begait cattle population size and distribution*

The number of breeding females relative to the pervious herd appears to be not promising for breeding purposes and the number of replacement calves was relatively small, suggesting difficulties encountered in breed replacement. According to discussion held, the population of Begait cattle breed was in a gradual decreasing trend over time. Apparently, shortage of feed, diseases, and water scarcity were identified as the most important threats to the breed based on the index value.

Regarding the origin of Begait cattle, most of the farmers did not have any idea. Some believed that Begait cattle was first originated from highlands of Eritrea and later spread to northern part of Ethiopia and some believed as they are originated from Sudan. As per the respondents of interviewed farmers, 75% indicated that the Begait breed population had decreased over the years and 12.5% responded that the breed were stable and this followed by unknown which was 12.5 as seen in (Table 19).

Table 19. Perception of farmers on trend of Begait population

| | Kafta Humera district | | |
|---|---|---|---|
| **Category** | Maycadra (52) | Bereket(52) | Total(104) |
| Increasing | 0 | 0 | 0 |
| Decreasing | 33(63.5) | 45(86.5) | 78(75.0) |
| Stable | 10(19.2) | 3(5.8) | 13(12.5) |
| Unknown | 9(17.3) | 4(7.7) | 13(12.5) |

Values in brackets are in percentages

### 4.1.12 *Merits and demerits of Begait cattle*

The merits and demerits of Begait cattle with regard to different traits are presented in (Table 20). Begait cattle were rated high in all the study areas for disease tolerance, drought tolerance, heat tolerance, milk yield, growth rate, and fertility while they were considered as poor for temperament.

Table 20. Physical and biological characteristics of Begait cattle as rated by farmers

| Maycadra | Diseases tolerance | Draught tolerance | Heat tolerance | Temperament | Work rate | Milk yield | Growth rate | Fertility |
|---|---|---|---|---|---|---|---|---|
| Poor | - | - | - | 23.1 | - | - | - | - |
| Average | 7.7 | 30.8 | 9.6 | 48.1 | 24.6 | 7.7 | 11.5 | 7.7 |
| Good | 78.8 | 61.5 | 86.5 | 28.8 | 47.7 | 90.4 | 88.5 | 92.3 |
| No opinion | 13.5 | 7.7 | 3.8 | - | 27.7 | 1.9 | - | - |
| Bereket | | | | | | | | |
| Poor | - | 5.8 | - | 32.7 | - | - | - | - |
| Average | 25.0 | 26.9 | 23.1 | 38.5 | 16.2 | 3.8 | 9.6 | 4.8 |
| Good | 71.2 | 67.3 | 73.1 | 21.2 | 55.0 | 96.2 | 90.4 | 90.4 |
| No opinion | 3.8 | - | 3.8 | 7.7 | 28.8 | - | - | - |

### 4.1.13 *Phenotypic Characteristics of Begait Cattle*

The present study revealed that the majority of Begait female cattle had coat color which was pied 52.1%, uniform 24.3% and spotty 23.6%. Out of the sampled female cattle black and white pied 49.3%, black and white spotty 23.6%, light gray 8.6%, white 7.9%, light brown 5.7%, and dark 5.0% coat colours were the most frequently observed. Black and white pied color constituted was the dominant color out of the sample taken and black with white spotty color being the next prevailing color in both sexes.

Table 21. Color pattern and coat color of Begait female cattle

| | Kebeles | | |
|---|---|---|---|
| Category | Maycadra (70) | Bereket (70) | Total (140) |
| **Coat color pattern** | | | |
| Uniform | 18(25.7) | 16(22.9) | 34(24.3) |
| Pied | 37(52.9) | 36(51.4) | 73(52.1) |
| Spotty | 15(21.4) | 18(25.7) | 33(23.6) |
| **Coat color** | | | |
| black and white paid | 32(45.7) | 37(52.9) | 69(49.3) |
| black and white spotty | 16(22.9) | 17(24.3) | 33(23.6) |
| Light brown | 3(4.3) | 5(7.1) | 8(5.7) |
| Light gray | 7(10) | 5(7.1) | 12(8.6) |
| White | 8(11.4) | 3(4.3) | 11(7.9) |
| Dark | 4(5.7) | 3(4.3) | 7(5.0) |

Values in brackets are in percentages

The sampled male Begait cattle had pied 75%, uniform 19.2%, and spotty 5.8% coat color. The most frequent colours observed were black and white pied 44.2%, light brown 26.9% and dark 11.5% as illustrated in (Table 22).

Table 22. Coat color pattern and body color of Begait male cattle

| | Kebeles | | |
|---|---|---|---|
| Category | Maycadra (26) | Bereket (26) | Total (52) |
| **Coat color pattern** | | | |
| Uniform | 7(26.9) | 3(11.5) | 10(19.2) |
| Pied | 17(65.4) | 22(84.6) | 39(75) |
| Spotty | 2(7.7) | 1(3.8) | 3(5.8) |
| **Coat color** | | | |
| Black and white paid | 8(30.8) | 15(57.7) | 23(44.2) |
| Black and white spotty | 3(11.5) | 1(3.8) | 4(7.7) |
| Light brown | 6(23.1) | 8(30.8) | 14(26.9) |
| Light gray | 3(11.5) | 0 | 3(5.8) |
| White | 2(7.7) | 0 | 2(3.8) |
| Dark | 4(15.4) | 2(7.7) | 6(11.5) |

Both sex of Begait cattle breed were horned. Out of the total number male and female Begait cattle breed, 96.4% of female and 90.4% male were horned. Up right horn orientation was common to male Begait cattle. Out of the total horned male Begait cattle, 69.2% have upright type of horn orientation, but forward horn orientation type being prevailing for female Begait cattle, and held 82.1% of the total horned female Begait cattle. Angular ear shapes type was observed in Begait cattle breed. Angular shape was highest prevailing in both sexes. Begait cattle ear orientation also varied between the two sexes. The dropping ear orientation was predominated in both females and males. Another phenotypic characteristic of Begait cattle breed that distinguished it from other breeds of the region was the fact that female cattle of this breed had a long naval flap and large teat size as shown in (Table 23).

Table 23. Morphological measurement of male and female Begait cattle

| | Female (140) | | | Male (52) | | |
|---|---|---|---|---|---|---|
| **Variables** | Maycadra | Bereket | Total | Maycadra | Bereket | Total |
| **Hump presence** | | | | | | |
| Absent | 70(100) | 70(100) | 140(100) | 0 | 0 | 0 |
| Present | 0 | 0 | 0 | 26(100) | 26(100) | 52(100) |
| **Hump shape** | | | | | | |
| Dropped | | | | 12(46.2) | 6(23.1) | 18(34.6) |
| Erected | | | | 14(53.8) | 20(76.9) | 34(65.4) |
| **Horn presence** | | | | | | |
| Horned | 68(97.1) | 67(95.7) | 135(96.4) | 23(88.5) | 24(92.3) | 47(90.4) |
| Polled | 2(2.9) | 3(4.3) | 5(3.6) | 3(11.5) | 2(7.7) | 5(9.6) |
| **Horn shape** | | | | | | |
| Straight | 6(8.6) | 1(1.4) | 7(5) | 9(34.6) | 12(46.2) | 21(40.4) |
| Curved | 62(88.6) | 66(94.3) | 128(91.4) | 17(65.7) | 14(53.8) | 31(59.6) |
| Absent | 2(2.9) | 3(4.3) | 5(3.6) | 0 | 0 | 0 |
| **Horn orientation** | | | | | | |
| Forward | 54(77.10 | 61(87.1) | 115(82.1) | 8(30.8) | 7(26.9) | 15(28.8) |
| Dropping | 7(10) | 3(4.3) | 10(7.1) | 1(3.8) | 0 | 1(1.9) |
| Upright | 7(10) | 3(4.3) | 10(7.1) | 17(65.4) | 19(73.1) | 36(69.2) |
| Absent | 2(2.9) | 3(4.3) | 5(3.6) | 0 | 0 | 0 |
| **Ear shape** | | | | | | |
| Angular | 70(100) | 70(100) | 140(100) | 24(92.3) | 26(100) | 50(96.2) |
| Circular | 0 | 0 | 0 | 2(7.7) | 0 | 2(3.8) |
| **Ear orientation** | | | | | | |
| Dropping | 67(95.7) | 70(100) | 137(97.9) | 24(92.3) | 26(100) | 50(96.2) |
| Lateral | 3(4.3) | 0 | 3(2.1) | 2(7.7) | 0 | 2(3.8) |

All the morphological characteristics measured for Begait cattle breed are given in (Table 24). The mean size for male was higher than female. The horn length for females and males was 21.1 cm and 19.87 cm long respectively. Usually dropping horn type was common for females than males Begait cattle breed. The mean dewlap

width for female and male Begait cattle was 18.60 cm and 19.68 cm respectively. Female Begait cattle had a magnified undeveloped dewlap. Moreover, 70.0% of females and 67.3% of males had a medium dewlap. In general, unlike the Fogera cattle breed (Alberro and Solomon, 1982), the dewlap of female Begait cattle was not well developed and uniform along its length. It was longer in the side to end of the sternum.

The mean length of naval flap of Begait cattle was about 12.14 cm. The teat was longer compared to other local cattle of the region. The mean teat of Begait cattle was 11.47 cm, which was much longer than other zebu cattle breeds. The highest proportion of male Begait cattle relative to the female had a tail length below hock joint, no any male cattle registered in the list which had a short tail length (above hock joint). Similarly, the average perpetual sheath of Begait cattle was 12.05 cm respectively.

Table 24. Linear body measurement of Begait cattle

| | Kebeles | | | | | |
|---|---|---|---|---|---|---|
| | Female | | | Male | | |
| **Parameters (cm)** | Maycadra (N=70) | Bereket (N=70) | Total (N=140) | Maycadra (N=26) | Bereket (N=26) | Total (N=52) |
| | Mean ±SD | Mean ±SD | Mean ±SE | Mean ±SD | Mean ±SD | Mean ±SE |
| Height at wither | 131.4±2.10 | 131.7±3.02 | 131.5±0.25 | 136.9±0.96 | 137.1±0.97 | 137.0±0.10 |
| Body length | 127.9±1.86 | 128.4±1.87 | 128.1±0.16 | 135.9±0.87 | 136.1±0.88 | 136.0±0.09 |
| Heart girth | 157.2±2.77 | 159.9±2.81 | 159.6±0.24 | 169.0±0.99 | 168.8±0.97 | 168.9±0.10 |
| Ear length | 18.5±3.83 | 18.3±4.31 | 18.4±0.34 | 18.0±0.70 | 18.2±0.71 | 18.1±0.07 |
| Horn length | 21.1±1.40 | 21.0±1.20 | 21.1±0.11 | 19.8±0.71 | 19.9±0.71 | 19.9±0.07 |
| Neck length | 45.1±3.18 | 44.3±3.23 | 44.7±0.27 | 47.1±0.88 | 47.2±0.97 | 47.1±0.09 |
| Tail length | 97.4±04.33 | 98.0±4.43 | 97.7±0.37 | 98.5±0.48 | 102.2±0.70 | 100.3±0.06 |
| Cannon length | 25.9±2.78 | 25.1±2.80 | 25.5±0.24 | 26.4±0.50 | 26.5±0.35 | 26.4±0.04 |
| Pelvic width | 40.3±3.65 | 39.6±3.67 | 40.0±0.31 | 41.1±0.61 | 42.4±0.58 | 41.5±0.06 |
| Dewlap width | 18.6±2.76 | 18.6±3.00 | 18.6±0.24 | 19.6±0.35 | 19.7±0.68 | 19.7±0.05 |
| Teat length | 10.4±0.41 | 10.5±0.28 | 11.5±0.03 | Not taken | Not taken | Not taken |
| Naval flap leng | 12.1±0.82 | 12.2±0.82 | 12.1±0.07 | Not taken | Not taken | Not taken |
| Perpetual sheath | Not taken | Not taken | Not taken | 11.97±0.29 | 12.34±0.53 | 12.05±0.04 |

### 4.1.14 *Utility of keeping Begait cattle*

Knowledge of reasons for keeping animals is prerequisite for deriving operational breeding goals (Rewe *et al.,* 2006). The result of this survey revealed that Begait cattle played multi-functional roles in the study area. Based on the ranking of purposes for keeping Begait cattle (Table 25), it was observed that farmers kept these animals for breeding, milk production, income source, draft power, meat, manure and social value. Most farmers in the study areas kept Begait female cattle primarily for breeding purpose followed by milk production. This indicates the importance of

inclusion of breeding and milk production in any breeding programme aimed at Begait cattle in the study area.

The use of cattle as a source of draft power was still very low because majority of the farmers used tractors for ploughing their land. But the importance of draft animal technology is expected to increase in the future as the farm size getting smaller due to population growth. Begait cattle were also used as a source of manure and manure was used mainly as a fertilizer. Functions like source of meat for consumption ranked relatively low among the reasons of keeping Begait cattle. This could be mainly because cattle are slaughtered during specific occasions and functions such as weddings, funerals, religious festivity and cultural festivals when rare slaughter of animals is conducted outside these days. For home consumption the majority of households preferred to slaughter small ruminants and chickens or to purchased beef from local butcheries rather than to slaughter cattle.

Table 25. Ranking of utility of keeping Begait cattle in the study area

| Parameters | Kebeles | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Maycadra (N=52) | | | | Bereket (N=52) | | | |
| | Rank1 | Rank2 | Rank3 | Index | Rank1 | Rank2 | Rank3 | Index |
| Breeding | 69.2 | 28.9 | 1.9 | 0.4455 | 75 | 23.1 | 1.9 | 0.4615 |
| Milk | 26.9 | 65.4 | 5.8 | 0.3622 | 19.2 | 53.8 | 23.1 | 0.3141 |
| Income source | 3.8 | 5.8 | 59.6 | 0.1378 | 5.8 | 21.2 | 57.7 | 0.1955 |
| Draught power | 0 | 0 | 21.2 | 0.0351 | 0 | 1.9 | 7.7 | 0.0192 |
| Meat | 0 | 0 | 5.8 | 0.0096 | 0 | 0 | 5.8 | 0.0032 |
| manure | 0 | 0 | 3.8 | 0.0064 | 0 | 0 | 1.9 | 0.0032 |
| Social values | 0 | 0 | 1.9 | 0.0032 | 0 | 0 | 1.9 | 0.0096 |

### 4.1.15 *Reproductive and productive performance*

The mean of the reproductive attributes for Begait cattle was shorter in maycadra than bereket and varies significantly. The average age at first service of Begait female cattle was 35.5 months in the study area. .the average age at first calving for Begait cattle was 48.7 months .The average calving interval of Begait cattle was between 17.06 months. The mean daily milk yield and lactation length of Begait cattle were 2.52 liters and 6.38 months, respectively. The better-managed and well-fed heifers grew faster, served earlier and resulted in more milk and calves produced during the lifetime of the animal.

Table 26. Reproductive and productive performance of Begait cattle

| Parameters | Mean ±SD | Mean ±SD | Mean ±SE |
|---|---|---|---|
| Age at puberty in male (month) | 37.6±1.46 | 38.6±1.88 | 38.1±0.17 |
| Age at puberty in female (month) | 35.08±0.99 | 35.94±1.67 | 35.51±0.14 |
| Age at first calving (month) | 48.04±1.28 | 49.33±1.66 | 48.68±0.16 |
| Calving interval (month) | 17.10±1.05 | 17.02±1.15 | 17.06±0.11 |
| Productivity life (year) | 8.06±0.64 | 8.35±0.71 | 8.20±0.07 |
| Average milk yield (kg/day) | 2.52±0.306[a] | 2.49±0.293 | 2.52±0.29 |
| Lactation length (months) | 6.40±0.265[a] | 6.36±0.286 | 6.38±0.026 |

N=Sample respondents; Ns=Non-significant ($P > 0.05$); $^{**}$=significant ($P < 0.05$); SD= standard deviation; SE=standard error

### 4.1.16 *Breeding system and selection*

The most common breeding system in the study area was natural pure-breeding using natural bulls. Most farmers were forced to allow their heifers/cows to natural uncontrolled mating because of restricted land sizes and the lack of enough resources to demarcate the grazing grounds to facilitate separation of male and female animals. An advantage of natural uncontrolled mating is that it allows for all year round supply of milk. In systems characterized by seasonal availability of feeds, calving throughout the year is a disadvantage, especially when calving occurs during a time when feed is scarce. At such time, the dam is under nutritional stress leading to low milk yield, slow growth rates of calves and low calf survival rates.

The bases of selection of breeding animals were based on quantitative and qualitative traits. Much emphasis was put on breeding potential, milk production, body size and physical appearance for selecting breeding animals. Large animals were preferred as they provided better draft power and higher milk yields, fetched better market prices, had better growth rates and reached market weights sooner. Physical appearance and coat color were valued but this could be due to more aesthetic reasons than economic considerations.

The ranking of important traits for selecting breeding males and females as perceived by farmers are summarized in (Table 27). Traits like body size, physical appearance, coat color and hump size were all considered as important in both of the study areas and were given due emphasis in selecting breeding bulls (Fig 8). The preference of farmers for a particular coat color might be associated with social and cultural practices, market demand and environmental adaptation. Pedigree and temperament were given relatively little emphasis in selecting breeding bulls.

Figure 8. Adult breeding male Begait cattle

Figure 9. Adult female Begait cattle

Breeding potential, milk yield, Body size, mothering ability and physical appearance were the most highly rated traits in selecting breeding females as showed in (Fig 9). Udder size, pedigree and coat color were slightly considered in selecting breeding female. Generally, farmers gave special emphasis on production and reproduction traits in selecting of females and males animal.

Cattle owners in the study areas had developed a culling mechanism for maintaining the desired quality of their animals. Primary reasons for culling animals from the herd were old age, reproductive failure, and reduction of production performance, health problems, needed for some cash for household used and needed for slaughtering as obtained from the discussion held with key farmers.

Table 27. Ranking on selection criteria for breeding male and female Begait cattle

| | Maycadra | | | | | Bereket | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Male** | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Index | $R_1$ | $R_2$ | $R_3$ | $R_4$ | Index |
| Body size | 67.3 | 25.0 | 7.7 | 0 | 0.359 | 78.8 | 21.2 | 0 | 0 | 0.3212 |
| Physical appearance | 26.9 | 71.2 | 1.9 | 0 | 0.325 | 13.5 | 59.6 | 26.9 | 0 | 0.2865 |
| Coat color | 5.8 | 3.8 | 65.4 | 25.0 | 0.190 | 7.7 | 9.6 | 42.3 | 25.8 | 0.1500 |
| Hump size | 0 | 0 | 23.1 | 48.1 | 0.094 | 0 | 9.6 | 23.1 | 53.8 | 0.1288 |
| Pedigree | 0 | 0 | 1.9 | 15.4 | 0.019 | 0 | 0 | 7.7 | 15.4 | 0.0308 |
| Horn | 0 | 0 | 0 | 7.7 | 0.007 | 0 | 0 | 0 | 3.8 | 0.0038 |
| Other * | 0 | 0 | 0 | 3.8 | 0.003 | 0 | 0 | 0 | 1.9 | 0.0019 |
| **Female** | | | | | | | | | | |
| Breeding | 73.1 | 26.9 | 0 | 0 | 0.373 | 84.6 | 15.4 | 0 | 0 | 0.3846 |
| Milk production | 26.9 | 73.1 | 0 | 0 | 0.326 | 15.4 | 84.6 | 0 | 0 | 0.3154 |
| Body size | 0 | 0 | 88.5 | 5.8 | 0.182 | 0 | 0 | 92.3 | 1.9 | 0.1865 |
| Mothering ability | 0 | 0 | 0 | 38.5 | 0.038 | 0 | 0 | 0 | 38.5 | 0.0385 |
| Physical appearance | 0 | 0 | 11.5 | 21.2 | 0.044 | 0 | 0 | 7.7 | 19.2 | 0.0346 |
| Pedigree | 0 | 0 | 0 | 15.4 | 0.015 | 0 | 0 | 0 | 13.5 | 0.0135 |
| Coat color | 0 | 0 | 0 | 7.7 | 0.005 | 0 | 0 | 0 | 11.5 | 0.0135 |
| Udder size | 0 | 0 | 0 | 5.8 | 0.007 | 0 | 0 | 0 | 11.5 | 0.0115 |
| Other qualitative ** | 0 | 0 | 0 | 5.8 | 0.005 | 0 | 0 | 0 | 3.8 | 0.0038 |

*Other qualitative traits include extended dewlap, long neck, long tail, long prepuce, and temperament;** Other qualitative traits include extended dewlap, long neck, long tail, temperament, and long navel flap; R= ranking

### 4.1.17 *Health management*

Diseases that appear to cause most problems in the study area showed (Table 29). Animal health management was characterized by low levels of inputs. The conventional control measures, such as spraying with acaricide and used of traditional herbs were being employed by farmers, although sometimes in the wrong way. Vaccination was rarely administered through the office of agriculture and animals normally survived in the locality.

The frequent intermingling of different groups of animals in the utilization of common resources provides ideal opportunities for the extensive spread of infectious diseases and parasites. The exposure of livestock to wildlife, which was common in the study area, provides opportunities of contagious diseases spread. Wildlife species act as the major hosts and as reservoirs for these infectious diseases.

Table 28. Ranking of disease and parasite prevalence

| | Kebeles | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Maycadra | | | | | Bereket | | | | |
| Categories | R1 | R2 | R3 | R4 | index | R1 | R2 | R3 | R4 | index |
| **Diseases** | | | | | | | | | | |
| Trypanosomosis | 48.1 | 36.5 | 15.4 | 0 | 0.333 | 53.9 | 19.2 | 26.9 | 0 | 0.327 |
| Pasteurellosis | 40.4 | 48.1 | 11.5 | 0 | 0.329 | 28.9 | 63.5 | 7.7 | 0 | 0.321 |
| Anthrax | 11.5 | 15.3 | 65.4 | 5.8 | 0.229 | 17.3 | 9.6 | 59.6 | 13.5 | 0.231 |
| Brucellosis | 0 | 0 | 7.7 | 69.2 | 0.085 | 0 | 7.7 | 5.8 | 57.7 | 0.092 |
| Black leg | 0 | 0 | 0 | 11.5 | 0.012 | 0 | 0 | 0 | 5.8 | 0.006 |
| Foot and mouth | 0 | 0 | 0 | 3.8 | 0.004 | 0 | 0 | 0 | 17.3 | 0.017 |
| **Parasite** | | | | | | | | | | |
| External parasite | 0 | 0 | 0 | 5.8 | 0.006 | 0 | 0 | 0 | 3.8 | 0.004 |
| Internal parasite | 0 | 0 | 0 | 3.8 | 0.004 | 0 | 0 | 0 | 1.9 | 0.002 |

### 4.1.18 *Cattle production constraints*

Consideration of the relative significance of the different constraints for cattle production was basic priority to beginning any genetic improvement program. Ranking of cattle production constraints in the study area is given in (Table 30). Among the constraints feed shortage, diseases and water shortage were considered as the most important problems ranked first, second and third with different index values, respectively.

This study revealed that in both areas farmers stressed the lack of livestock feed to be the most important limiting factor for productivity of their cattle, and indicated the importance of improving their feeding regime as an essential step towards any improvement program. Communal grazing was the most important feeding system in the area. However, communal grazing land was decreasing from year to year due to expansion of crop fields, over grazing and human population growth. Seasonal scarcity of livestock feed was mentioned as one of the critical problems in cattle production in the area. In addition, during the dry season both quantity and quality of the pasture herbage declined and failed to met nutrient requirements for good performance.

Table 29. Ranking of Begait cattle production constraints

| | Kebeles | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Maycadra | | | | Bereket | | | |
| **Parameters** | Rank1 | Rank2 | Rank3 | Index | Rank1 | Rank2 | Rank3 | Index |
| Feed shortage | 88.46 | 3.85 | 1.92 | 0.4583 | 78.85 | 11.54 | 9.62 | 0.4487 |
| Health problem | 1.92 | 61.54 | 25.0 | 0.2564 | 5.77 | 76.92 | 17.3 | 0.3141 |
| Water scarcity | 3.85 | 17.30 | 51.92 | 0.1635 | 5.77 | 3.85 | 50.0 | 0.125 |
| Market problem | 3.85 | 15.38 | 13.46 | 0.0929 | 3.85 | 3.85 | 17.3 | 0.0609 |
| Theft | 1.92 | 1.92 | 7.69 | 0.0289 | 5.77 | 3.85 | 5.77 | 0.0513 |

## 4.2 Feeding Trial

### 4.2.1 *Feed chemical composition*

The percent chemical composition of the concentrate feed and sorghum stover fed to the experimental animal are presented in (Table 30). The crude protein content of the concentrate feed were 22.31, 22.69, and 22.89 while that of sorghum stover was 7.67 on DM basis.

Table 30. Chemical composition of feed treatments

| | | | DM % | | | | |
|---|---|---|---|---|---|---|---|
| Feed items | DM | OM | ASH | CP | NDF | ADF | ADL |
| Sorghum Stover | 89.56 | 85.43 | 11.27 | 7.67 | 50.62 | 24.67 | 5.51 |
| Wheat bran(WB) | 89.41 | 92.57 | 4.17 | 14.15 | 25.54 | 6.64 | 1.25 |
| Noug seed cake (NSC) | 92.70 | 84.97 | 12.89 | 26.86 | 46.15 | 27.73 | 10.38 |
| Cotton seed cake (CSC) | 91.03 | 85.48 | 11.69 | 30.49 | 41.76 | 25.78 | 4.45 |
| WB+NSC | 91.39 | 90.35 | 7.17 | 22.31 | 30.51 | 9.59 | 1.82 |
| WB+CSC | 90.77 | 91.74 | 5.37 | 22.69 | 30.72 | 7.29 | 1.61 |
| WB+CSC+NSC | 90.50 | 90.68 | 6.70 | 22.89 | 27.21 | 8.40 | 0.82 |

### 4.2.2 *Feed and nutrient intake*

The average feed intake from the groups is given in (Table 31). The average sorghum stover intake (kg/day/DM basis) of DMI, CPI, and NDFI were 5.28, 0.41 and 2.67; 6.69, 0.51, and 3.39; 6.90, 0.51, and 3.49; 7.07, 0.54, and 3.58 for treatment I, II, III, and IV, respectively. The average concentrate feed intake of DMI, CPI, and NDFI were 2.68, 0.38 and 0.69; 2.74, 0.61, and 0.84; 2.72, 0.61, and 0.84; 2.72, 0.62, and 0.74 for treatment I, II, III, and IV, respectively.

Table 31. Dry matter and nutrient intake (kg/DM/day)

| DMI, Kg | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Sorghum stover (SS) | 5.28[a] | 6.69[b] | 6.90[b] | 7.07[b] |
| Concentrate feed (CF) | 2.68 [a] | 2.74 [b] | 2.72 [c] | 2.72 [c] |
| Total | 7.83 [a] | 9.06 [b] | 9.22 [b] | 9.36 [b] |
| Nutrient intake, kg | | | | |
| CP from SS | 0.41 [a] | 0.51 [b] | 0.53 [b] | 0.54 [b] |
| CP from CF | 0.38 [a] | 0.61 [b] | 0.61 [b] | 0.62 [b] |
| Total CP | 0.79 [a] | 1.10 [b] | 1.12 [b] | 1.13 [b] |
| NDF From SS | 2.67 [a] | 3.39 [b] | 3.49 [b] | 3.58 [b] |
| NDF From CF | 0.69 [a] | 0.84 [b] | 0.84 [b] | 0.74 [b] |
| Total NDF | 3.29 [a] | 4.03 [b] | 4.12 [b] | 4.10 [b] |
| ADF From SS | 1.30 [a] | 1.65 [b] | 1.70 [b] | 1.75 [b] |
| ADF From CF | 0.19 [a] | 0.26 [b] | 0.20 [c] | 0.23 [d] |
| Total ADF | 1.45 [a] | 1.82 [b] | 1.80 [b] | 1.82 [b] |

[Abc] Means with different superscripts with in columns are significantly different ($P<0.01$); DMI = dry matter intake; SS = Sorghum stover; CF = Concentrate feed; CPI = crude protein intake; NDFI = neutral detergent fiber intake; ADFI = acid detergent fiber intake; ASHI = ash intake

### 4.2.3 *Milk yield composition*

The average milk yield and the total solid, fat, solid not fat, protein of the milk collected from the experimental animals are given in (Table 32). The net income output for all the treatments is given in (Table 34). The average milk yield was 3.73, 4.93, 5.63, and 6.23. The average milk composition was 4.13, 4.18, 4.08, and 3.75 percent of fat; 12.93, 13.03, 12.75, and 12.48 percent for total solid; and 3.65, 3.68, 3.55, and 3.63 percent of protein. The net income was 32.4, 48.9, 64.4, and 76.5 for animals of treatments I, II, III and IV, respectively.

Table 32. Mean milk yield (kg/day) and milk composition (%) of Begait cattle

| | T1 | T2 | T3 | T4 | p-value |
|---|---|---|---|---|---|
| Milk parameters | | | | | |
| Milk yield, kg/day | 3.73 [a] | 4.93[b] | 5.63 [c] | 6.25 [d] | ** |
| Milk fat, % | 4.13 | 4.18 | 4.08 | 3.75 | NS |
| protein, % | 3.65 | 3.68 | 3.55 | 3.63 | NS |
| Lactose, % | 4.40 | 4.48 | 4.35 | 4.45 | NS |
| Ash, % | 0.78 | 0.73 | 0.73 | 0.68 | NS |
| Total solid, % | 12.93 | 13.03 | 12.75 | 12.48 | NS |

### 4.2.4 *Profit cost analysis*

Table 33. Average intake of feed (kg) for the last sixteen days of the experiment

| **Ingredients** | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Sorghum Stover | 92.00 | 112.80 | 116.00 | 118.80 |
| Wheat bran | 48.00 | 24.00 | 31.36 | 26.40 |
| Noug seed cake | 0.00 | 24.00 | 0.00 | 9.60 |
| Cotton seed cake | 0.00 | 0.00 | 16.64 | 12.00 |
| Total feed intake (kg) | | | | |
| Mineral (kg) | 0.96 | 0.96 | 0.96 | 0.96 |

Table 34. Costs of feeds, minerals and labour in the sixteen days

| | Total price required for the entire period | | | | |
|---|---|---|---|---|---|
| Ingredients | Price/kg | T1 | T2 | T3 | T4 |
| Sorghum Stover | 2.2 Birr | 202.40 | 248.15 | 255.20 | 261.35 |
| Wheat bran | 3.6 Birr | 172.80 | 86.40 | 112.90 | 95.04 |
| Noug seed cake | 6.0 Birr | 0.00 | 144.00 | 0.00 | 57.60 |
| Cotton seed cake | 6.0 Birr | 0.00 | 0.00 | 99.84 | 57.60 |
| Mineral | 3.0 Birr | 0.96 | 0.96 | 0.96 | 0.96 |
| Labor cost (month) | 300 Birr | 300 | 300 | 300 | 300 |
| Total expense | Birr | 678.08 | 781.45 | 770.85 | 774.48 |
| Milk yield, kg/day | 20 Birr/liter | 3.73 | 4.93 | 5.63 | 6.25 |
| Total income from milk sale | Birr/liter | 1196.00 | 1571.00 | 1801.60 | 1998.40 |
| Net income | Birr | 517.93 | 789.75 | 1030.75 | 1223.93 |
| Net income/day | Birr | 32.37 | 49.35 | 64.42 | 76.50 |

# 5. DISCUSSION

The average household size 4.1 observed in this study was smaller than reported for Aseged-Tsimbla (6.5), Tahtay-Koraro (6.2) and Medebay-Zana (6.6) (Dessalegn, 2007). The average land holding size of the respondents was 1.53 ha, which was much lesser than the national average land holding size of 2.5 ha. The land holding size in the area was reduced due to the involvement of many investors to the area for sesame and cotton production and the re-distribution land policy by the government (an evenly distribution of land to male or female headed household).

In this study, the percentage of illiterate family members was 51.0% which was less than the reported 54.8% for north-western Tigray. The role of education is obvious in affecting household income, adopting technologies, demography, health, and as a whole the socio-economic status of the family as well (Kerealem, 2005).

Most of the respondents in the study areas reported the breeding as the primary purpose for keeping cattle followed by milk which were in line with the index values of 0.4535 and 0.3382, respectively. Similar results were reported earlier by Mukasa-Mugrewa (1989) in Ethiopia and Rege *et al.* (2001) in Kenya; multiple functions are particularly relevant in high-risk production environments. According to Scarpa *et al*. (2002), in developing countries, especially in low input smallholder production system, the most valuable livestock attributes are often those that successfully guarantee multi functionality, flexibility and resilience in order to deal with variable environmental conditions.

Breeding in the study area was uncontrolled (73.1%) and seasonal and directly depended on feed quality and availability. Most of the cows were coming in heat during late rainy season (mid September to December). None of the sampled farm households in study area used AI or improved bull to enhance productivity of their cattle. Their cows freely grazed and were bred with their own bull or their neighbor's. This was in line with Kohler and Orber (2000) who reported that farmers in East Africa exchanged genetic material freely.

Animals traveled longer distances to watering points (1-5Km) per day losing of their energy during the dry season, but in wet season animals were watered in a nearby

natural water sources. This was in line with the findings of Tessema *et al*. (2003), who reported for the livestock production system in Belessa woreda of Amhara regional state of Ethiopia. Almost all the respondents allowed their cattle to drink once per day during dry season. But during wet season water was supplied freely without any restriction. Cattle housing was using locally available materials; mainly grasses and woods. Majority of the livestock houses were all sides open for better ventilation. The floor of livestock houses were made of earth material. Calves and small ruminants were housed separated from other cattle.

The population of Begait cattle breed is in a gradual decreasing trend over time. This result was in line with the report by Merha (2006) who reported that the population size of Begait cattle breed was reducing and it was at a higher risk of extinction due to famine and man-made problems in the past 20-30 years. Currently, on the basis of index value, shortage of feeds 0.4535, diseases 0.2853, and water scarcity 0.1443 were identified as the most important threats to the breed. Regarding the origin of Begait cattle, most of the farmers had no any idea. Some believed that Begait cattle was first originated from highlands of Eritrea and later spread to northern part of Ethiopia and some believed as they were originated from Sudan.

According to the discussion, communal grazing was the most important feeding system in the area. However, communal grazing land was decreasing from year to year due to expansion of crop fields, over grazing and human population growth. Seasonal scarcity of livestock feed was mentioned as one of the critical problems of cattle production in the area. In addition, during the dry season both quantity and quality of the pasture herbage declined and failed to meet nutrient requirements for production and reproduction. Therefore, suitable multipurpose trees, fodder trees, improved forage species and grasses can be integrated into crop-livestock production practices. In addition to grazing land management, improvement of crop residues, supplements available in the area and forage development strategy should be given due attention to improve the situation.

Trypanosomiasis and pasteurellosis were the major reported cattle diseases according to ranking index value of 0.330 and 0.325, respectively. Diseases are impacting livestock production in various ways such as premature death, reduced body weight and fertility, reduced yield of meat, milk as well as reduced capacity for work. Each

disease caused some of these effects and almost all had severe effects on overall production efficiency of animals (Suzuki, 2005).

The sampled Begait cattle had uniform, pied and spotty skin colors. The most frequent colours observed were black and white pied and followed by black and white spotty. Concerning the body conformation of Begait cattle, dewlap size varied from small to medium, longer teat and naval flap length. The cattle were horned with curved and straight horn shape, with lateral, forward and upright horn orientation. Begait cattle had short, medium and long horn length. Incidence of polledness was low. They had medium and large ear size, angular ear shape, and lateral and drooping ear orientation. Hump size in male cattle ranged from medium to large. The sampled animals had long tail (well below the hock), medium tail length (at the hock) and short tail (above the hock).

Among morphometric measurements (body length, height at withers and heart girth were collected), heart girth was the highest measured values followed by height at wither and body length. Males had greater body measurements when compared to females. From the study it was observed that the body length, height at withers and heart girth of adult females and male Begait cattle were longer than Arado cattle breed reported by Dessalegn (2007).

The average lactation length (LL) was reported to be 6.4 months. The result of the present study was a bit smaller than the finding of Kedija *et al*. (2008), regarding the lactation length of the local cattle breed in the Mieso district, Oromia Regional State, which was 7.29 ±0.17 months.

The overall average milk yield from Begait cows was 2.52 liters/head/day. The daily milk yield for Begait cattle was higher than the reported from extensive livestock breed survey done in Oromia Regional State with average daily milk yield of 1.4 liters (Workneh and Rowlands, 2004) and report on-farm daily milk yield of 1.8 and 1.9 liters per day for Raya Sanga and Wello highland zebu cattle (Dereje, 2005). Azage *et al*. (2009), reported an average daily milk yield under transhumance cattle production system in Amhara region in North Gondar to be 2±0.13 litters which is again smaller than to the results of the present study.

The average age at first service of Begait female cattle was 35.5 months in the study area. The average age at puberty of Begait cattle was shorter than the average for white Fulani zebu cattle of Nigeria, 40.2 months; but longer than average age at puberty for the Ethiopian zebu cattle which is about 22.5 months (Alberro, 1983). The average age at first calving for Begait cattle was 48.7 months which is lower than Sheko breed 54.1 months (Takele, 2005). Overall mean calving interval (CI) in this study was 17.06 months. The result of the present study was shorter than the calving interval of 22±3 months Begait cattle reported by Merha (2006). Al-Amin *et al*. (2007), reported calving interval of 14.7 months of North Bengal cattle breed in Bangladesh. This is shorter than the overall mean calving interval of the present study. The management factor especially nutrition determines pre-pubertal growth rate and reproductive development (Masama *et al.,* 2003).

For the feeding trial, the average sorghum stover intake (kg /day) of DM, CP, and NDF was 5.28, 0.41 and 2.67; 6.69, 0.51, and 3.39; 6.90, 0.51, and 3.49; 7.07, 0.54, and 3.58 for treatment I, II, III, and IV, respectively. The average concentrate feedtures intake of DM, CP, and NDF was 2.68, 0.38 and 0.69; 2.74, 0.61, and 0.84; 2.72, 0.61, and 0.84; 2.72, 0.62, and 0.74 for treatment I, II, III, and IV, respectively.

Dry matter intake significantly ($p<0.01$) varied between treatments. Treatment groups supplemented with concentrate feed had greater DM intake than those fed on wheat bran alone (control). Crude protein intake was significantly different ($p<0.01$) that concentrate feed supplemented cows had better intake than fed on wheat bran. Neutral detergent fiber and ADF intakes were also significantly different ($P<0.01$) among treatment groups. This might be because of the differences in the crude protein content. In general, cows fed with better protein content had better intake (Steinshamn, 2010).

The average milk yield per day per cow of the treatments I, II, III, and IV was 3.73, 4.93, 5.63, and 6.25 kg. Milk yield from cows supplemented with a mixture of cotton seed cake and noug seed cake at 1:1 ratio along with wheat bran was relatively higher than their counterparts supplemented. The results of the present study were in agreement with that reported by Egger *et al.* (2007) who indicated that dairy cows supplemented with oil seed produced significantly higher milk yield than non-supplemented animals. The difference in milk yield between treatment groups could

be attributed, among other factors, to the differences in the protein type and quality in the oil seed cake feeds.

The average fat content of the milk of the cows of the treatments I, II, III, and IV was 4.13, 4.18, 4.08, and 3.75% respectively. A comparable value of 4.32 percent and, 4.06 and 3.48 percent were reported by Sathian (2001), Joseph (2005) and Ally *et al.* (2007), respectively in the cross bred dairy cows in early lactation.

The average total solids (TS) in the milk from the cows of the treatments I, II, III and IV was 12.93, 13.03, 12.75 and 12.48 per cent, respectively, while solids not fat (SNF) was 8.83, 8.89, 8.63 and 8.76 per cent, respectively. The observed values of TS and SNF were comparable with the values of 12.56, 8.39 and 12.9, 8.61 per cent reported by Sathian (2001) and Hareesh (2007) respectively in lactating crossbred cows.

The average protein content of the milk from the animals of the treatments I, II, III and IV was 3.65, 3.68, 3.55 and 3.63 per cent, respectively and statistical analysis did not reveal any significant difference between the groups. Similar milk protein levels were reported by Joseph (2005), Ally *et al.* (2007) and Augustine (2008) in early lactation cows fed concentrate feedture with 18 per cent CP. But Reis *et al.* (2001) observed an increase in the milk protein percentage with the corn supplementation in cows fed alfalfa legume as sole roughages.

# 6. CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Conclusions

From the total of 104 sample households interviewed, about 81.7% and 18.3% were male and female headed household, respectively. The majority of farmers 58.7% reported livestock and crop production as the most important source for their livelihood followed by crop, livestock and off-farm activities 18.3%, livestock and off-farm activities 9.6%, livestock production only 6.7%, crop and off-farm activities 4.8%, and crop production only 1.9%.

Natural pasture was the first and the most common feed resources used for all livestock species during wet and dry seasons. Grazing land in the studied area was entirely communally owned. Farmers used different feeding/grazing practice whereby herding was the most common practices during wet and dry season in the study area. Rivers (Bahreselam and Tekeze), bore wells and pond water were the major sources of water for livestock in western zone of the region. Shortage of water was common in dry season as compared to wet season. Most of the households in the study area kept their livestock inside their residence. Cattle houses were using locally available materials; mainly grasses and woods. Majority of the livestock houses were all sides open for better ventilation.

The overall mean of livestock possession (head/HH) in the study area was 12, 3.88, 7.71, 1.07, 0.5 and 0.37 for cattle, sheep, goats, equines, chicken and honeybee, respectively. Household members were participating in various cattle management practices in the studied area and this was dependent not only on the sex and age of the family members, but also on the type of the activities. The selling and purchasing of cattle was mostly the responsibility of males greater than or equal to 15 years of age. This group was also responsible for breeding, healthcare and feeding activities whereas their female counterparts were responsible for milking, making and selling dairy products and feeding cattle.

Begait cattle play multi-functional roles in this production system and owners preferred both marketable (reproductive performances, milk yield, and growth rate) and non-marketable (draught power output, coat color and adaptability) traits. Hence, farmers preferred composite traits for their livelihood.

Natural uncontrolled mating was the most common system of mating in the area mainly due to the herding/grazing system practiced in the area. An advantage of natural uncontrolled mating is that it allows for all year round supply of milk. In systems characterized by seasonal availability of feeds, calving throughout the year is a disadvantage, especially when calving occurs during a time when feed is scarce.

This study revealed that in both areas farmers stressed the lack of livestock feed to be the most important limiting factor for productivity of their cattle, and indicated the importance of improving their feeding regime as an essential step towards any improvement program. Communal grazing was the most important feeding system in the area. However, communal grazing land was decreasing from year to year due to expansion of crop fields, over grazing and human population growth.

Seasonal scarcity of livestock feed was mentioned as one of the critical problems in cattle production in the area. In addition, during the dry season both quantity and quality of the pasture herbage declined and failed to meet nutrient requirements for good performance. The most important constraints of Begait cattle production system were problems of feed shortage, water scarcity and diseases such as Trypanosomiasis and Bovine pasteurellosis.

The unique features of Begait cattle breed which is commonly observed were large body size, long naval flap, short-medium dewlap, long teat size with black and white pied body color. The linear body measurements of the breed were higher than other breeds of the region. Male Begait cattle breed had higher linear body measurements than female animals, whereas females had higher horn length than males.

Regarding the origin of Begait cattle, most of the farmers did not have any idea. Some believed that Begait cattle was first originated from highlands of Eritrea and later spread to northern part of Ethiopia and some believed as they are originated from Sudan.

The average age at first service, age at first calving, calving interval of Begait female cattle were 35.5, 48.7, and 17.06 months in the study area, respectively. The mean daily milk yield and lactation length of Begait cattle were 2.52 liters and 6.38 months, respectively. The better-managed and well-fed heifers grew faster, served earlier and resulted in more milk and calves produced during the lifetime of the animal.

The Reproductive and productive performance of the Begait cattle excels that of other local cattle breeds. It was often characterized by early puberty, early maturity, short calving interval, and better milk yield. In addition, the breed could be considered as one of the few capable of surviving under the very harsh environment and produce under limited level of feed and water sources.

Most farmers practiced supplementation using commercial feeds (energy and protein concentrates) were practiced. The major concentrate utilized under farmers management was wheat bran as it was cheap. Few farmers were also used a mix of concentrates like wheat bran with noug seed cake or wheat bran with cotton seed cake.

Milk yield from cows supplemented with mixture of cotton seed cake, noug seed cake and wheat bran was relatively higher than their counterparts supplemented. Supplementation did not affect fat, protein, total solid, and ash contents of the milk across the treatments. Economic evaluation of feed treatments showed that the concentrate feedture supplementation increased the net profit to ETB 17.0/cow/day (T2), ETB 32.0/cow/day (T3), 44.0/cow/day (T4) over the control group (T1). From the overall evaluation of results obtained during the course of this feeding trial, it could be concluded that the supplementation of energy and protein mixtures in the form of wheat bran (72%), noug seed cake (16%), and cotton seed cake (12%) in early-to mid lactation of Begait cows were found to be more efficient in milk yield and economic return.

## 6.1 Recommendations

Education is an important entry point for empowerment of rural communities and an instrument to sustain development. Halved of the household in the study area was illiterate and this might be affecting household income, adopting technologies, demography, health, and socio-economic status of the family. More ever, Education is important to identify and determine the type of development and extension service approach. Hence due attention has to be given to address this problem.

The findings of the present study on the Begait cattle revealed that more longitudinal studies are needed to compare the production and reproductive performance of this breed of cattle with that of other indigenous cattle.

Special attention is required to address the major constraints affecting cattle production system and considering selection practices under improved management systems will be very important.

Even though the genetic potential of the breed is impressive, the population of the breed is decreasing from time to time due to feed shortage, water scarcity and health. It is high time for further study to be made to on extinction probability of the breed and take a conservation measures if it is on the verge of extinction.

To fully describe the Begait cattle, there should be a comparative quantative data to prove some of the information on their physical, adaptive and special genetic attributes. The dairy production potential of the breed is relatively high and evidently the cattle could compete with more productive breeds under high input production environment.

On station concentrate supplementation improves feed intake and milk yield of Begait cattle. The trial should be conducted with grazing animals under farmer management for a recommendable result.

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APPENDIX

Questionnaire

Questionnaire number: _____ Date of interview _____/_____

Enumerator name_____ _____ Keble name_____

1. Education level of the respondent
    I. Illiterate
    II. Read and write
    III. Primary
    IV. Secondary
    V. Religious school
2. If household head
   Yes ○ no ○
3. Sex of head
   Male ○ female ○
4. Age of the respondent (yrs)___
5. Number of people residing in the household___
6. Land holding/farm size (hectares)
   Crop ____
   Grazing* ___
   Forest _____
   Total size_____
   *other than communal grazing
7. Land ownership (Tick one or more)
   Own ____⬭
   Lease ___⬭
   Other ___⬭

8. Livestock kept (Enter number in the boxes)
   Cattle ____ ☐
   Sheep ____ ☐
   Goat _____ ☐
   Chickens+__☐
   Donkeys___☐
   Others_____☐
   + adult birds
9. Most important species (rank up to 3)
   Cattle ____ ☐
   Sheep ____ ☐
   Goat _____ ☐

Chickens+__☐ + (adult birds only)
Donkeys___☐
Others___ ☐

10. Is livestock the major activity on your farm?
    Yes ○ No ○
11. Source of income (tick first column as appropriate)
    Crops ☐
    Livestock and products * ☐
    Home industries ☐
    Salary/wages ☐
    Others ☐
12. Livestock production category
    Cattle dairy☐ meat☐ dual purpose☐
    Sheep dairy☐ meat☐ dual purpose☐
    Goat dairy ☐ meat ☐ dual purpose ☐
13. Production system (tick one or more)
    Industrial /intensive ☐
    Semi-intensive ☐
    Extensive/pastoral ☐
    Free rang/backyard ☐
    Others ☐
14. Mobility
    Sedentary ☐
    Transhumant ☐
    Nomadic ☐
    Others (specify) _____
15. Purpose of keeping cattle (rank 1-3)
    Breeding ☐
    Milk ☐
    Meat ☐
    Work/draft ☐
    Manure ☐
    Hide ☐
    Cash from sales ☐
    Ceremonies ☐
    Dowry ☐
    Cultural ☐
16. Members of household responsible for cattle activities (tick as appropriate; more than one column in a row may be ticked)
17. Grazing/feeding <u>Dry season</u> <u>Wet season</u>
    Herded ☐ ☐
    Paddock ☐ ☐
    Tethered ☐ ☐
    Stall ☐ ☐

Yard ☐ ☐
Free grazing ☐ ☐
Other specify_____

18. Housing Dry season Wet season
Kraal ☐ ☐
Stall/shed ☐ ☐
Yard ☐ ☐
None ☐ ☐

19. Are calves housed together with adults
Yes ○ No ○

20. Are calves grazed/fed together with adults
Yes ○ No ○

21. Supplementation Dry season Wet season
Roughages/ crop residues ☐ ☐
Minerals /vitamins ☐ ☐
Bought in feed/concentrates ☐ ☐
None ☐ ☐
Others _____

22. How cattle are watered Dry season Wet season
Animals go to water ☐ ☐
Water if fetched/provided ☐ ☐
Both ☐ ☐

23. Sources of water watered Dry season Wet season
Borehole ☐ ☐
Dam /pond ☐ ☐
River ☐ ☐
Water well ☐ ☐
Spring ☐ ☐
Municipal/piped ☐ ☐
others_____

24. Distance to watering point watered Dry season Wet season
at household level ☐ ☐
<1km ☐ ☐
1-5km ☐ ☐
6-10km ☐ ☐
>10km ☐ ☐

25. Frequency of watering Dry season Wet season
Freely available ☐ ☐
Once a day ☐ ☐
Twice a day ☐ ☐
Every other day ☐ ☐
Once in 3 days ☐ ☐
Others _

26. Water quality Dry season Wet season

| | | |
|---|---|---|
| Good/clear | ☐ | ☐ |
| Muddy | ☐ | ☐ |
| Salty | ☐ | ☐ |
| Smelly | ☐ | ☐ |

27. Major cattle production constraints

| List | Rank (1-3) |
|---|---|
| 1. _____ | ☐ |
| 2. _____ | ☐ |
| 3. _____ | ☐ |
| 4. _____ | ☐ |
| 5. _____ | ☐ |
| 6. _____ | ☐ |

28. Access to veterinary services
    - Government vet ☐
    - Private vet ☐
    - Veterinary drug supplier ☐
    - Extension service ☐
    - None ☐
    - Others_____

29. Prevalent diseases that occur on farm (i.e. diseases that are seen by farmers on their farms)

    Local name or symptoms of disease (Rank most common 1-3) — Are animals treated when sick?

    I. _____ Yes ○ No ○
    II. _____
    III. _____
    IV. _____
    V. _____

30. Vaccination/preventive treatments given

    Done routinely ○ done when need arises ○ not given ○

31. Ecto-parasite control

| Methods | Done when Need arises (Tick) | Dry season | Wet season |
|---|---|---|---|
| I. None | ☐ | ☐ | ☐ |
| II. Dip | ☐ | ☐ | ☐ |
| III. Spray | ☐ | ☐ | ☐ |
| IV. Pour –on | ☐ | ☐ | ☐ |
| V. Hand dressing | ☐ | ☐ | ☐ |
| VI. Inject able | ☐ | ☐ | ☐ |

VII. Traditional (specify)

_____

_____

_____

| | Done Routinely (Tick) | Dry season | Wet season |
|---|---|---|---|
| VIII. None | ☐ | ☐ | ☐ |
| IX. Dip | ☐ | ☐ | ☐ |
| X. Spray | ☐ | ☐ | ☐ |
| XI. Pour –on | ☐ | ☐ | ☐ |
| XII. Hand dressin | ☐ | ☐ | ☐ |
| XIII. Inject able | ☐ | ☐ | ☐ |
| XIV. Traditional (specify) | | | |

32. Do you castrate? Yes ○ No ○
33. If yes, say why
    - Control breeding ☐
    - Improving meat quality ☐
    - Better price ☐
    - Better draft power ☐
    - Better temperament ☐
    - Others_____ and at what age _____
34. Numbers of entries within last 12 months

| | Calves | Weaners | Males * | Females* |
|---|---|---|---|---|
| Born | _ ____ | _____ | _____ | _____ |
| Bought | _____ | _____ | _____ | _____ |
| Gift | _____ | _____ | _____ | _____ |
| Exchange/lent | _____ | _____ | _____ | _____ |

    *adult animas
35. Numbers of exists within last 12 months

| | Calves | Weaners | Males * | Females* |
|---|---|---|---|---|
| Died | _ ____ | _____ | _____ | _____ |
| Sold | _____ | _____ | _____ | _____ |
| Slaughtered | _____ | _____ | _____ | _____ |
| Donated/gift | _____ | _____ | _____ | _____ |
| Exchanged/lent | _____ | _____ | _____ | _____ |
| Stolen | _____ | _____ | _____ | _____ |

    *adult animas
36. If sold in the last 12 months, where did you sell?
    - Sold at auction ☐
    - Sold to butcher ☐
    - Sold privately ☐
    - Sold to abattoir ☐
    - Others_____
37. Reasons for culling/disposal males animals

| | (Tick) | Rank (1-3) |
|---|---|---|
| Size | ☐ | ☐ |
| Conformation | ☐ | ☐ |

| | | |
|---|---|---|
| Color | ☐ | ☐ |
| Health | ☐ | ☐ |
| Body condition | ☐ | ☐ |
| Performance | ☐ | ☐ |
| Old age | ☐ | ☐ |
| Poor fertility | ☐ | ☐ |
| Others | ☐ | ☐ |
| | ☐ | ☐ |

38. Reasons for culling/disposal female animals

| | (Tick) | Rank (1-3) |
|---|---|---|
| Size | ☐ | ☐ |
| Conformation | ☐ | ☐ |
| Color | ☐ | ☐ |
| Health | ☐ | ☐ |
| Body condition | ☐ | ☐ |
| Performance | ☐ | ☐ |
| Old age | ☐ | ☐ |
| Poor fertility | ☐ | ☐ |
| Others | ☐ | ☐ |
| | ☐ | ☐ |

39. Primary reason for keeping bull (s)

| | |
|---|---|
| Breeding | ☐ |
| Socio-cultural | ☐ |
| Work/draft | ☐ |

40. Reasons for choice of bulls for breeding

| | (Tick) | Rank (1-3) |
|---|---|---|
| Size | ☐ | ☐ |
| Conformation | ☐ | ☐ |
| Color | ☐ | ☐ |
| Horns | ☐ | ☐ |
| Temperament | ☐ | ☐ |
| Performance | ☐ | ☐ |
| Availability | ☐ | ☐ |
| Others | ☐ | ☐ |
| | ☐ | ☐ |

41. Mating

| | |
|---|---|
| UN controlling | ☐ |
| Hand mating | ☐ |
| Group mating | ☐ |
| A.I. | ☐ |
| Others | ☐ |

42. Source and breed used in the herd
    - Own bull (bred) ☐
    - Own bull (bought) ☐
    - Bull donated ☐
    - A.I. ☐
    - Bull borrowed ☐
    - Communal bull ☐

43. Begait cattle breed/age/ sex structure
    - Common breed name_____
    - Local breed name _____

44. Trend with in herd
    - Increasing ☐
    - Decreasing ☐
    - Stable ☐
    - Unknown ☐

45. Number by age and sex

| | Calves | weaners | adults |
|---|---|---|---|
| Intact male | _____ | _____ | _____ |
| Castrated | _____ | _____ | _____ |
| Female | _____ | _____ | _____ |

46. Origin/source of breed
    - Inherited
    - Communal area form
    - Commercial farm
    - Market
    - Specify location if known_____

47. Quality of traits perceived by owner

| | Poor | average | good | no opinion |
|---|---|---|---|---|
| Size | ☐ | ☐ | ☐ | ☐ |
| Conformation | ☐ | ☐ | ☐ | ☐ |
| Color | ☐ | ☐ | ☐ | ☐ |
| Horns | ☐ | ☐ | ☐ | ☐ |
| Disease tolerance | ☐ | ☐ | ☐ | ☐ |
| Heat tolerance | ☐ | ☐ | ☐ | ☐ |
| Temperament | ☐ | ☐ | ☐ | ☐ |
| Work rate | ☐ | ☐ | ☐ | ☐ |
| Growth rate | ☐ | ☐ | ☐ | ☐ |
| Fertility | ☐ | ☐ | ☐ | ☐ |

48. Average age at sexual maturity
    - Male animals (months) ☐
    - Female animals (months) ☐

49. Average at first calving
    - Average (months) ☐

Maximum (months) ☐
Minimum (months) ☐

50. Calving interval
    Average (months) ☐
    Maximum (months) ☐
    Minimum (months) ☐
51. Calving pattern, occurrence of most births

| | | | | | |
|---|---|---|---|---|---|
| January | ☐ | July | ☐ | | ☐ |
| February | ☐ | August | ☐ | | ☐ |
| March | ☐ | September | ☐ | | ☐ |
| April | ☐ | October | ☐ | | ☐ |
| May | ☐ | November | ☐ | | ☐ |
| June | ☐ | December | ☐ | | ☐ |

52. Is the breed milked Yes ⬭ No ⬭
53. Milking production per animal per day
    Average (liters) ☐
    Maximum (liters) ☐
    Minimum (liters) ☐
54. Lactation length
    Average (liters) ☐
    Maximum (liters) ☐
    Minimum (liters) ☐
55. Frequency of milking
    Ones a day ☐
    Twice a day ☐
    Three times a day ☐
56. Average weaning age of calves
    <3 months ☐
    3-4 months ☐
    5-6 months ☐
    >6 months ☐
57. Milk feeding up to weaning
    Unrestricted suckling ☐
    Restricted suckling ☐
    Bucket feeding ☐
    Others ☐

Appendix 3: Check list for group discussions

• What is the status of Begait cattle breed? In what numbers, and where are they?

• What do they look like?

• What is the environment in which the breed of animals are raised in terms of prevalent diseases, agro-ecological zone etc?

• For what purposes are cattle used, how are they bred?

• What are farmers' opinions on the main attributes of the breeds, in particular in their adaptation to heat, drought and disease tolerance?

• Performance characterizations in terms of reproduction and reproductive?

• How are the herd's structures?

• What are the gender roles in livestock production?

• How are the livestock managed in terms of housing, watering, feeding, castration, culling, and disease control?

• What are the socio-cultural practices and indigenous knowledge used in raising and managing the cattle?

• What is the influence of external factors such as proximity to marketing/urban areas, commercial farms and bordering countries?

• Planning a policy framework on livestock production such as classification of different production systems, areas that need attention for conservation and full characterization of the breed

• Planning breed improvement strategies