ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

ON-FARM PHENOTYPIC CHARACTERIZATION OF ARADO CATTLE BREED IN NORTH WEST ZONE OF TIGRAY, ETHIOPIA

BY

DESSALEGN GENZEBU WELDEGEBRIEL

JUNE, 2009
DEBRE ZEIT, ETHIOPIA

ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

ON-FARM PHENOTYPIC CHARACTERIZATION OF ARADO CATTLE BREED IN NORTH WEST ZONE OF TIGRAY, ETHIOPIA

A thesis presented to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Science in Tropical Animal Production and Health

DESSALEGN GENZEBU WELDEGEBRIEL

JUNE, 2009
DEBRE ZEIT, ETHIOPIA

ON-FARM PHENOTYPIC CHARACTERIZATION OF ARADO CATTLE BREED IN NORTH WEST ZONE OF TIGRAY, ETHIOPIA

BY

DESALEGN GENZEBU WELDEGEBRIEL

Board of External Examiners: **Signature**

1. Dr Alemu Yami _____
2. Dr. Adugna Tolera _____
3. Dr. Kassahun Awgichew _____

Academic advisors:

1. Dr. Mekonnen Hailemariam (DVM. MVSc. Associate professor)
2. Dr. Kelay Belihu (DVM. PhD. Associate Professor)

ACKNOWLEDGEMENT

First, I would like to pass my great indebtedness to those individuals and institutions that were involved directly or indirectly in this work so that my study came to success. My earnest appreciation goes to my major advisors, Dr. Mekonnen H/Mariam, for spending his precious time to give meticulous and regular advice, and to correct this manuscript from the very beginning to very end. I also express my sincere gratitude to my co-advisor Dr. Kelay Belihu for his unreserved supports and guidance throughout the research work.

I would like also to express my sincere appreciation to Addis Ababa University for funding my study expenses. My heart-felt appreciation goes to the farmers of the woredas were willing to provide information on their households and animals. I would also like to thank all the woredas' livestock experts, together with development agents from the Asgede-Tsimbla, Tahtay-koraro and Medebay-Zana woredas agricultural offices, who apart from their routine engagement, magnanimously agreed to help in data collection.

My heart-felt appreciation goes to Ato Selomon Negash, Dr. Aynalem Haile, Dr.Yaneshet Tesfaye, Ato G/Egziabhier G/Yohans, and Ato Abereham Haftu for their providing me necessary materials and encouraged me to go ahead when the going got rough.

My deepest gratitude goes to my father Genzebu W/Gebriel and my mother Abeba G/Yohans, my sisters (Mihret, Azeb and Elleni) and brothers (Kelemework, Fkadu and Mululem), who offered me comprehensive moral support and treatment that enabled me succeed throughout my academic life. I owe them more than a mere expression of thanks.

Finally, I also extend my special thanks to friends, Nigusse Dessalegn, Negasi Goitom, Selomon Hintsa, Alemaw Berhe, Seid and Abdel-Aziz, thank you all. I am also indebted to all classmates in the department of TAPH at Debre Zeit for making my stay pleasant and memorable. Above all, I would like to praise the almighty God for his all time good will and assistance in general and for giving me the courage and endurance to start the graduate studies and finalize this thesis in particular.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AEZ	Agro ecological zone
AFC	Age at first calving
ANOVA	Analysis of variance
BOANRDT	Bureau of Agriculture and Natural Resource Development Regional State Tigray
BoARD	Bureau of agriculture and rural development
CACC	Central Agricultural Census Commission
CC	Calf crop
CI	Calving interval
CSA	Central Statistical Agency
DAGRIS	Domestic Animals Genetic Resource Information System
DMY	Daily Milk Yield
FAO	Food and Agricultural Organization
GDP	Gross domestic product
HH	House holds
IBC	Institute of Biodiversity Conservation
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
m.a.s.l	Meter above sea level
OADB	Oromiya Agricultural Development Bureau
PA	Peasant Association
SD	Standard Deviation
SE	Standard error
SPSS	Statistical package for social sciences
UNEP	United Nations Environment Program

ABSTRACT

The study was conducted in North West zone of Tigray (Asgede-Tsimbla, Medebay-Zana and Tahatay-Koraro districts) which is the main tract of Arado cattle breed in Northern Ethiopia from October 2008 to March 2009. To study the probable distribution pattern, husbandry practice, to characterize morphologically and to characterize in terms of productive and reproductive performance of the Arado cattle breed. Smallholders and Arado cattle breeds kept by them were represented the study population. This research was basically a retrospective and cross-sectional survey focused on the selected area. A total of 279 households were taken for the study using simple random sampling procedures and all Arado cattle owned by the 279 households were included in the morphometric study. Formal surveys were carried out with the help of standard; questionnaire, group discussions field observation, morphometric measurements and secondary data collection were employed to obtain data. Statistical procedures for social sciences (SPSS) software were applied to analyze the data. In the studied woredas, farmers follow extensive mixed farming system (crop and livestock production). The colours observed were; red, followed by red and white and black and white. The female Arado cattle linear body measurements; height at withers, body length, chest girth, horn length, pelvic width and neck length were 107, 103,138, 19.6, 31.6 and 38.4 cm respectively. Dewlap width, canon bone circumference, tail length, and ear length were 20.4, 13.4, 71.2, and 18.7cm respectively. The naval flap and teats average mean values were 2.5cm and 2.9cm, respectively. The estimated overall mean values for chest girth, body length, height at wither and cannon bone length of the male cattle breed were 144.6, 108.4, 115.6, and 20.5 cm respectively. Pelvic width, ear length, face length, horn length tail length, and dewlap width found to be 32.4, 20.1, 40.5, 22.2, 72.4 and 21.7 cm respectively. Almost all the variables had not significant ($p > 0.05$) difference except chest girth and horn length. Chest girth and horn length were significantly ($p < 0.05$) different among the woredas. The overall average milk yield from Arado cows was 1.7±0.03 liters/head/day. The estimated average lactation milk yield per cow was 372 liters over an average lactation period 7.3 months. The overall mean calf crop number for the Arado cows was 4.6±0.06 heads and had not significant variation among the woredas. The average reported lactation length of Arado cow was 7.3±0.05 months with significance difference ($P < 0.05$) among the woredas. The lactation length of animals in the study area depends mostly on the feed availability. The estimated overall mean (±SE) age at

puberty was reported to be 41.2 and 39.8 moths respectively in female and male cattle. The mean were significant ($P \leq 0.05$) variations among the woredas in age at puberty (AP) in male and female. Overall mean age at first calving was 56.9±0.37months and calving interval (CI) was 21.6±0.25 months. There were also significant ($P \leq 0.05$) variations among the woredas age at first calving and calving intervals. The study revealed further, molecular characterization of Arado cattle to determine their genetic constitution.

Key words: Arado, Breed, Production system, Tigray.

1. INTRODUCTION

Livestock play a vital role in supporting the livelihoods of millions of people throughout the developing world. From the households who keeps a few chickens in their backyards, to the pastoralists who treks their herds vast distances over barren hills and plains, animals serve people in many ways: they provide meat, milk, eggs, skins and hides; they haul carts and ploughs; they power wells and mills; they bring cash and prestige; they act as savings and insurance. Even their wastes are used: they are fertilizer, cement and fuel. Some 30% of the total human requirements for food and agriculture and some 70% of the world's rural poor depend on livestock as a component of their livelihoods (FAO, 1999).

Animal genetic resource diversity thus contributes in many ways to human survival and well-being, with differing animal characteristics and hence outputs being tailored to suit a variety of local community needs. However, an estimated 16% of these uniquely adapted breeds bred over thousands of years of domestication in a wide range of environments have been lost since the beginning of the 19th century (Hall and Ruane, 1993). A further 32% (22% of mammals and 48% of avian species) are at risk of becoming extinct and the rate of extinction, currently at two breeds per week, continues to accelerate (FAO, 2000). The large number of AnGR at risk in developing countries, together with the limited financial resources available for conservation, means that economic analysis can play an important role in ensuring an appropriate focus for conservation efforts (UNEP, 1995).

There are many indigenous breeds of cattle in Africa adopted wide range of ecological conditions. This diversity, thus can serve as a genetic pool from which selection can be made for suitable strains and lines (FAO, 1986b). Moreover, in Africa indigenous livestock breeds support the majority of smallholder rural farmers for whom these genetic resources are important for improved nutrition, income and as investment assets. Africa's indigenous animals are, therefore, vital to the development of appropriate and sustainable agricultural systems in Africa and other tropical regions (Rege and Baker, 1994). However, today, many of these diverse breeds are being lost at an alarming rate. The Food and Agriculture Organization of the United Nations (FAO) estimates that globally 30% of livestock breeds are at risk of extinction and that about six breeds

are lost every month, most of them are in developing countries. Half of the breeds that existed in Europe at the turn of the century have disappeared (ILRI, 1998). Accelerating demand of a growing human population, indiscriminate breeds, breed substitution, natural disasters, civil strife, pressure of economic development, transformation of traditional agricultural systems, a tendency to concentrate on a few high-yielding breeds and animal mobility through trade and social exchanges have been affecting the security and survival of indigenous African animal genetic resource (Rege and Baker, 1994; FAO, 1999).

Greater efforts in the conservation and sustainable use of these farm animal genetic resources are required to stop and reverse this trend of erosion of diversity. Conservation is not simply the preservation of those breeds that are currently not in use; it also encompasses the characterization and monitoring over time of the gene pool of each species. The wise use of these resources also constitutes an important conservation element (FAO, 2000).

The varied and extensive agroecological zones of Ethiopia make the country suitable for many kinds of livestock in large numbers (ILCA, 1992). FAO (2001) reported that about 90% of the total land mass of Ethiopia is suitable for livestock production. Ethiopia has the largest livestock population in Africa estimated to be 47.57 million cattle, 26.1 million sheep, 21.7 million goats, 1.78 million horses, 5.57 million donkeys, 380 thousand mules, 1 million camels, 39.6 million chicken and 4.7 million beehives. Out of the total cattle population, the female cattle constitute about 55.64%. The majority (99.25%) of the cattle population are local breeds, which are found in rural areas under subsistence type of farming system and the remaining are hybrid and exotic breeds that accounted for about 0.65 percent and 0.09 percent, respectively (CSA, 2008). However, performance in the production of the major food commodities of livestock origin has been poor compared with other African countries (Befekadu and Birhanu, 2000). As in many countries, livestock, particularly cattle play multiple roles in Ethiopia being a source of milk, meat, hide, draft power and etc (Feleke and Geda, 2001). But the country's per capita milk consumption is estimated to be about 19.2kg per year, which is far below the average per capita consumption of Africa, 37.2kg per year (FAO, 2000).

The livestock sub sector plays a vital role as source of food, income, services and foreign exchange to the Ethiopian economy, and contributes to 12 and 33% of the total and agricultural GDP, respectively, and accounts for 12–15% of the total export earnings, second in order of importance (Ayele *et al.*, 2003). Livestock contribute to the livelihoods of 60-70% of the population (Ayele *et al.*, 2003; Ejigu 2003).

Indigenous cattle experience late maturity, short lactation length, long calving interval and poor production of milk but are more disease resistant and capable of thriving in harsh conditions (Al-Amin *et al*, 2007). In the developing world, the indiscriminate use of exotic animal genetic resources and poorly designed breeding schemes are the major reasons for the loss of animal genetic resources. The loss of locally adapted breeds will have long term negative implications, and in most instances, will reduce food security rather than ensure it.

Tigray is one of the regional states of Ethiopia where livestock production is practiced. In line with the national statistics, the cattle population is higher than the other livestock species of the region (CSA, 2004).The region has seven breeds, named Raya-azebo, Irrob, Abergele, Adwa, Arado, Begait and Medense. Arado is the most abundant breed of cattle in the highland parts of the region. The breed is influenced by activities like introduction of bulls from the lowland breeds and AI services conducted by different projects (Merha, 2006).

There is a need to maintain biodiversity through minimizing unmanaged introgression and by reducing loss of genetic variability within each breed as far as possible. According to DEFRA (2000), characterizing and conserving native breeds, which are at risk, especially those that are rare should constitute a priority among priorities. Although Arado is an important breed of cattle in the study area, it has got less attention so far and hence has never been studied properly. Therefore, this study was conducted with the following objectives:

- To study the probable distribution pattern and the husbandry practice of the breed;
- To characterize the breed morphologically;
- To characterize the breed in terms of productive and reproductive parameters.

2. LITERATURE REVIEW

2.1. Livestock production system

In most African countries, the livestock subsector comprises several or all of the following major small and large-scale production systems: (1) small-scale: Pastoralism, agro-Pastoralism, transhumance and mixed smallholder farming. (2) Large-scale: ranching, large-scale commercial farming, co-operative farming and state farming (ILRI, 1995).

2.1.1. Pastoral production system

Pastoralism in Africa is practiced predominantly by small family units. Herds and flocks are raised that vary considerably in size, from a few sheep and goats in the poorest families to many hundreds of cattle and/or camels in the wealthiest. The size of the herd/flock determines the share of feed resources obtained from pastures grazed communally under an open access or common property tenure system characterized by mobility (nomadism or transhumance) as a survival strategy (Milligan and de Leeuw, 1983). In the lowlands of Ethiopia, pastoralist production system with no or little farming is practiced and cattle and camels are kept to provide mainly milk. The climate in these areas is characterized by low, unreliable and unevenly distributed rainfall and by year round high temperatures. Animal production often concentrates around water points and herd size per family is usually large.

Transhumance production system

Transhumance can be defined as a system of animal production characterized by seasonal and cyclical migration of varying degrees between complementary ecological areas and supervised by a few people, with most of the group remaining sedentary' (Azage *et al.*, 2009). Also the term 'transhumance' refers to regular seasonal movements of livestock between well-defined pasture areas (dry to wet season, or low to highland). It can cover a wide range of pastoral production systems, ranging from fully transhumant systems (such as among the Northern Mauritanians and Namibians) to systems such as used by the Nilotic tribes of East Africa, the Berber of the high Atlas and herders in Morocco and Ethiopia. Transhumance also applies to settled populations who send their livestock short distances to pasture, such as in Zimbabwe. All these systems have

several elements in common: (1) they rely on common property (pastures, forests and natural waters), (2) they normally occupy arid lands with less than 400 mm of annual rainfall, and (3) mobility is managed by herders, rather than by fencing (Niamir, 1999). According to Pamo and Pieper (2000), there are two types of transhumance in Africa: the dry season and rainy season transhumance; and various motivations cause these movements, especially that of the rainy season.

2.1.2. Agro-pastoralists production system

Agro-Pastoralism in Africa is carried out by pastoral families or their descendants who have, to varying degrees, settled and taken up cropping. Often inhabiting dry areas where cropping is a high-risk enterprise, agro-pastoralists live under conditions resembling those of the subsistence oriented smallholder farmers. Apart from ethnic differences, the only major difference between the two groups in terms of production is the emphasis on livestock, which will be greater among agro-pastoralists, who frequently retain some degree of mobility as a survival strategy (ILRI, 1995). Cattle and cropping are complementary enterprises in the agro-pastoral system. Cattle provide milk, meat, draught power and manure. As in the pastoral community, large herds are a repository of savings and confer status and security on the owner. On the other hand, crops provide residues, which are used to feed cattle in drier periods of the year.

2.1.3. Crop and livestock integrated production system

Crop–livestock production systems are land-use systems in which livestock husbandry and cropping are practiced in association. This association may be close and complex or livestock husbandry and cropping may be parallel activities without interaction, possibly not even belonging to the same management unit. Crop–livestock interactions are few in the humid zone because animal diseases and cropping patterns based on root crops discourage animal production. Interactions become more frequent and more intense in the sub-humid and semi-arid zones. The interactions are based on using animal traction, manure (in cropping) and crop residues (as livestock feed). Interactions are most frequent in highland zones, where cereals are the major crops grown. Interaction in the highlands involves intensive milk production, animal traction, manure production and sown fodder crops (Jahnke, 1982).

The higher the population pressure and the cultivation intensity the more value is placed on manure. Livestock ownership is valued by farmers because it offers the following utilities: (1) investment capital, available for use in contingencies, relatively divisible; (2) individual wealth creation (including for women); (3) recurrent income (milk, meat and other products); (4) manure; (which, if supported by on-farm fodder, re-cycles nutrients at lower cost than inorganic fertilizers); (5) energy (traction, transport); and (6) productive uses for farm residuals (crop residues, browse, weeds, boundary plants, uncultivated grassland).

2.2. Cattle husbandry practice

Husbandry practices cover all aspects of management, which include housing, feeding, breeding, health care etc. Husbandry practices form part of the immediate environment of the animals, and thus directly influence their performance (Workneh and Rowlands, 2004).

2.2.1. Feeding and feed resources

According to Kedija *et al.* (2008) cattle, camels and goats were fed principally on natural pasture or pasture on non-arable land maintained under rain-fed conditions. Kurtu (2003), on the other hand, indicated that only 72% of the rural livestock keepers in Harar area make use of natural pasture. Agricultural by-products such as crop residues, mainly obtained from sorghum and maize stover, and house waste are also used as feed sources. Feeding systems included communal or private natural grazing and browsing, and cut-and-carry system and stall feeding. Cereal straw from teff, barley and wheat is the largest component of livestock diet in the intermediate and highland areas of Ethiopia. Straw is stacked after threshing and fed to animals during the dry season, as are pulse–crop residues (e.g. horse beans, chickpeas, haricot beans, field peas and lentils). At lower altitudes in the highland areas maize, sorghum and millet stovers occur to a greater extent than at higher altitudes. Teff is grown at intermediate altitudes and barley replaces wheat at the higher altitudes, where pulses are also grown to a great extent. The nutritive value of teff straw is equivalent to medium-quality hay and the residue of other cereal crops is only of poor to fair quality. On the other hand, pulse haulms are high-quality roughage with 5–8% protein content (Alemayehu, 1985).

Farmers supplement their lactating cows with extracted oil by-product: while almost all or about 75% of them provide salt lick. to their cattle. Few farmers. those who are incorporated in development of government household package. manage their animal in door: while the majority of the livestock owned by the rest of the farmers graze freely. The livestock herders were expected to drive their animal 2-6 hours per day on average in search of rangeland. The distance herders have to cover in search of grazing land. therefore. varies considerably. Grazing in many areas usually is in daytime. but in some areas during night time. In the cropping season starting early June to late September cattle were forbidden to graze in marginal arable land (land between cultivating land) and even near rangelands of cultivated crop by the cultivating cropland owners. Therefore. herders were forced to take their animals far apart from cropping land and stay there for about 3 months (Abraham. 2009).

2.2.2. Water resources

Workneh and Rowlands (2004) classified sources of water by season. agro-ecological zones (AEZs). livestock densities and production systems. In general. rivers are the most important source of water during both wet and dry seasons, followed by rain. springs and dams. Dams are particularly important sources of water for pastoral and agro-pastoral production systems during the wet season. as are bore wells during the dry season. Rivers. as a source of water, are more frequently used in dega and weinadega than kolla AEZ. Dams and bore wells are more important water sources in kola than in weinadega and dega AEZs.

Stream, pipes, rivers, water holes and pond water are the major sources of water for livestock in western zone of Tigray. Cattle were mostly watered in a dry season in water holes; and in rainy season despite the poor water quality for fear of traveling long distances to watering holes they were watered in a natural water sources (stream, rivers and rainwater). Shortage of water was common in dry season as compared to wet season. 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(Abraham. 2009).

2.2.3. Housing

The traditional livestock husbandry practiced across the Ethiopian highlands is similar. Livestock are kept in a 'kraal' (a pen or enclosure for cattle) during the night. During the day time, they are

herded on communal pasture, private grazing lands or in stubble depending on the season (Getachew *et al*, 1993). About 20% of western zone, 75% of Adwa, and 60% Kola-Tembein households built house for their livestock inside their residence site (Abraham, 2009). Only a small proportion of the producers (less than 7%) use corrugated iron sheet cover while the large majority use locally available materials; mainly grass and wood. Thorn enclosures are also used in some cases, especially at night. Newly born calves are generally housed inside family houses. Calves and small ruminants in most cases are housed separated from other livestock (Abraham, 2009).

2.2.4. Cattle production constraints

Overall, the major constraints identified and prioritized according to their importance in the highland areas were shortage of land, theft, livestock diseases, human diseases, tick infestation, bloating and fly infestation (Kedija *et al*., 2008). The major cattle production constraints in Western zone of Tigray identified by Abraham (2009) were water scarcity, feed shortage, health problem and low productivity of animals. Inadequacy of animal health care or improved health management is also one of the major constraints of dairy development in Ethiopia, which caused poor performance across the production systems. Many of the problems result from the interaction among the technical and non-technical constraints themselves. For instance, poorly fed animals have low disease resistance, fertility problems, partly because the animal health care system relays heavily on veterinary measures.

Diseases are impacting livestock production in various ways such as premature death, reduced body weight and fertility, reduced yield of meat, milk or eggs as well as reduced capacity for work. Each disease causes some of these effects and almost all have severe effects on overall production efficiency of animals (Suzuki, 2005). Moreover, poor grazing management systems continue to cause high mortality and morbidity (e.g. internal parasites), many of the diseases constraints which effect supply are also a consequence of the non-technical constraints, for example, insufficient money to purchase drugs or vaccines (Ibrahim and Olaloku, 2002).

2.3. Phenotypic characterization of cattle breeds

Phenotypic characterization refers to the morphological description of farm animal genetic resource (AnGR) (Ayalew *et al.*, 2003). Phenotypic characterization provides basic evidence for the variation between and within cattle breeds which could be utilized for selection purposes. Physical description of a breed should focus on characters which, in the view of keepers of the breed and local experts, facilitate identification of animals as being members of the breed or strains. Physical or morphological can be particularly useful in the classification of population/strains/breeds within a species (FAO, 1986).

2.3.1. The need for breed characterization

It is important that livestock breeds are identified, characterized and documented for any type of development or improvement work. Without such documentation it would be difficult to know the animals and their potential (FAO, 1986). According Pashu-Palak and Koholer-Rollefson (2005), the main reasons behind characterization of animal genetic resources are; threat to the indigenous livestock, and a numbers of different breeds are named after their location, ethnic group or by physical characteristics and may not necessarily be genetically different. The authors also stated that the rationales behind characterization of animal genetic resources in developing countries are the following;

Most censuses of livestock are done by species which does not give an accurate picture of the population trend of individual breeds over time in order to determine populations at risk of extinction.Little knowledge is available about existing breeds to understand: Unique qualities of the breed, *e.g.* Particular adaptation to the local environment, the potential contribution to productivity if treated as improved breeds, the potential to make the greatest variety for future contribution and determine special genes that could be useful in the future.

2.3.2. Characterization and classification methodology

Characterization consists of collecting information on available livestock and the environment in which the livestock are performing (Matheron and Planchenault, 1992). Basic information includes preliminary characteristics such as type breed/variety; predominant location and climatic conditions; utility, management and production systems; physical and production traits (Pashu-

Palak and Kohhler-Rollefson, 2005). Knowledge of animal performance, including understanding the livestock production system, is a central component of the approach. The approach should put as much emphasis on the production environment which plays a vital role in treat expression on the performance of the animal under consideration. According to Matheron and Planchenault (1992), characterization exercises based on quantitative criteria such as body measurement or different phenotypic data have been conducted on many livestock population for a long time. Different levels of description, varying from the general to the specific, can be considered depending on the level of knowledge one is looking for, the amount of available data or the time and means available, different methods for breed characterization can be used and many breeds have been identified on the basis of physical, morphological and functional characteristics in tropical Africa (FAO, 1984; Matheron and Planchenault, 1992; Rege and Okeyo, 2006).

2.3.3. Breed descriptors

Breed descriptors are the priority elements in breed characterization. The purpose of descriptors developed by FAO (1986) is to facilitate valid comparison, classification or enumeration of breeds within species in the context of the environment existing in different countries and regions. The following lists of seven broad categories of breed descriptors selected are from a longer catalogue used in compiling the FAO Global Data Bank (FAO. 1986). The objective should first be to secure a reliable set of information corresponding to these seven descriptors.
Priority elements include the following seven points: General identification consisting of: country (and source of data); species. breed or population and location within country where breed is found. Population size during the reporting year broken down into number of breeding females. number of males of service age. indication of number of purebreds in mating group and changing trends in breeding females up to the reporting year. average herd size during the reporting year. average age of animals used for breeding by sex. Physical characteristics including coat colour giving details of special colours and colour combination. horns shape and size (by sex); presence or absence of hair/wool and other specific visible traits (e.g. fat tail, hump). Measures of adult size and weight including wither height. live weight. body length (for each sex). Current uses (purposes) as indicated by producers and ranked by priority. Possession of special unique adaptive traits such as resistance to major diseases and to climate. qualitative description of predominant management system such as stationary. transhumant. nomadic: housing. feeding.

etc., biological performance, important traits applicable to dairy, meat or dual-purpose breeds, giving indication of variation: Milk yield or off take, milk quality, live weight traits (birth, weaning, yearling) and early measures of reproduction (e.g. age at first calving).

2.3.4. Cattle breeds definitions

Either a sub specific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species or a group for which geographical and/or cultural separation from phenotypically similar groups has led to acceptance of its separate identity (FAO, 1998).

Breeds of cattle are generally defined using loose geographical criteria or through an association with a particular tribal or ethnic group. Therefore the term "breed" cannot be uniformly applied to the classification of cattle populations from different regions of the world. Instead, three alternative, but equally applicable definitions for a breed of cattle have been derived (Mackechnie and Meyn, 1991), depending on the technological and cultural milieu. The terms describe the cattle population of a certain area with varying degrees of uniformity; expresses uniformity in a few traits effected by simple gene action such as colour, colour pattern, head form, horn form, polledness, and also nebulous uniformity with regard to production traits; or result from a systematic breeding programme based on set goals with emphasis on production traits.

2.4. Origin and current classification of African cattle

The origin of indigenous cattle of Africa is still remaining uncertain despite available archaeological, anthropological and historical evidence (Epstein, 1971). It is generally accepted that the African cattle populations arose from three main phases of introduction from Asia through the Nile valley in Egypt or via the Horn of Africa. Subsequent migrations led to dense populations of cattle in the East African highlands, around the present-day Ethiopia and Kenya. Present-day African cattle can be classified into four broad categories: the humpless *Bostaurus*, widely distributed in West and Central Africa: the humped *Bos indicus* (zebu), distributed widely in eastern and the dry parts of West Africa: the sanga, found mainly in eastern and southern Africa: and sanga x zebu types (zenga.) found in eastern Africa. The taurine (humpless) type has

two groups, Longhorns *(B.taurus longifrons)* and Shorthorns (*B. taurus* brachyceros), both of which are restricted to West and Central Africa (Rege, 1999).

2.4.1. Zebu cattle breeds of eastern Africa

The zebu breed is represented by some 75 breeds in Africa; making it the largest single cattle type (Rege, 1999). Approximately 61 of these zebu breeds are found in eastern Africa and neighboring countries in southern-central Africa, while the rest are found in West Africa.

The term 'East African Zebu' is used to describe all the 'Shorthorn Zebu' of eastern and southern Africa (Rege and Tawah, 1999). Based on their body sizes, the East African zebu breeds can be divided into two subgroups, the 'Small' and the 'Large'. The term 'Small East African Zebu' was suggested to portray the small frame of these animals and to avoid confusion with other types of East African cattle (Mason and Maule 1960). The Small East African zebu breeds are the majority, being represented by 49 breeds. The Large East African zebu is represented by 13 breeds, which are restricted to the relatively drier parts of Sudan, Eritrea, Ethiopia, Somalia, Kenya, Tanzania and Uganda. The isolations imposed by tribal boundaries, whether physical and/or cultural, and those due to ecological restrictions are partially responsible for the genetic differentiation leading to the existence of different breeds and strains. However, variations in nomenclature associated with different tribes and ecologies do not, in themselves, imply genetic differences. For this reason, breeds or strains that have a common ancestry can be classified further, according to whether or not they occupy the same geographical area (e.g. a country) and/or a defined ecological zone within one or more countries. Rege and Tawah (1999) refer to these two classifications as clusters and groups, respectively.

2.5. Origin and classification of indigenous cattle breeds of Ethiopia

Major indigenous cattle breeds of Ethiopia thus far identified are Sheko, Begayit, Boran, Abigar, Afar, Horro, Fogera, Arado, Jidu, Arsi and Red Bororo. In addition very heterogeneous mixtures of Zebu sub-types (Black Zebu or Jem-Jem, short horn zebu and small zebu) have been described under the name Abyssinian Zebu. Furthermore, report by FAO (1999) indicates the presence of zebu-sub-classes (Adwa, Ambo, Bale, Goffa, Gurage, Harar, Smada, Mursi and Hammer) cattle types at different parts of the country. The study conducted by the Tigray Regional Agriculture

Development Bureau (1999), reported the presence of two breeds, namely, Medence and Abergelle in that part of the country.

The livestock population is primarily of local origin and not characterized as belonging to specific breeds. However, the local breeds are generally named after the area they occupy. Even amongst these identifiable types, there has been large inter-mixing, resulting in a dilution of breed characteristics. Thus, a large proportion of the population is nondescript. Little effort has been made to comprehensively describe the indigenous livestock populations of Ethiopia. Alberro and Haile-Mariam (1982) attempted to identify and classify some Ethiopia cattle types by compiling available literature and gathering information from field trips and Ministry of Agriculture provincial offices. Cattle were classified into four broad categories: the humpless Hametic Longhorn and Shorthorn, the Zebu, the Sanga and the intermediate Sanga/Zebu (Table 1). All of these cattle types were described as having considerable adaptability to harsh climate, poor nutrition and diseases endemic to their respective areas. Alberro and Haile-Mariam also attempted to describe some of the specific characteristics by which each of the types could be differentiated. For instance, the Boran and the Danakil can withstand prolonged droughts; the Abigar and Fogera are able to withstand periodic flooding while the Abigar has some trypanotolerant traits.

Table 1: Classification of the indigenous cattle of Ethiopia

Categories		Breed" or "Population
1	Humpless	
	Brachyceros	Sheko (Mitzan,Goda)
	Hametic	
	Longhorn	Kuri (Kouri)
		Arsi, Barka (Begait), Borana (Boran), Arab (Adeni,Berbera,Bahari), Shorthorn Zebu (Harer), Highland Zebu (Bale), Black Zebu (Jem-Jem) and
2	Zebu	Small Zebu (Jijjiga)
3	Sanga	Danakil (Adal, Raya, Keriyu, Afar), Raya Azebo and Abigar (Nilotic)
	Intermediate	
4	Sanga/Zebu	Horro, Fogera (Wagera), Arado and Jiddu
5	Other	Fellata (Red Bororo)

Source: Alberro and Haile-mariam (1982)

2.5.1. Characterization of indigenous cattle breeds of Ethiopia

Ethiopia is considered the home of some of the most important cattle breeds in eastern and southern Africa. The indigenous breeds, as described by Epstein (1957), originated from the migration of Hametic Longhorn from Egypt along the Nile Valley and the humped Zebu from India through the Horn of Africa. Interbreeding between the Hametic Longhorn and the Zebu resulted in a third breed, the Sanga, which spread to the southern part of the continent. Among some of the strains and varieties of the Sanga are the Nilotic of the Sudan, Ankole of Uganda, Tonga of Zambia and Tuli and Mashona of Zimbabwe. A second invasion of Zebu cattle is believed to have led to the displacement of the Sanga and, in some areas, interbreeding with the Sanga to form the intermediate Sanga/Zebu (ILCA, 1992).

2.6. Tigray cattle types and population

Tigray region has a considerable number of different species of livestock, which is found throughout the different ecology of the region (table 2). As a result of the different physical as well as biological factors found in the region, a diversified livestock species and livestock breeds are reared in different parts of the region. According to BoNAR (1999) cattle population of Tigray is estimated to be 2.81 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 the livestock for different purpose such as: milk production, meat, a source of dung, 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 breed of the region is categorized in to six major types: such as Afar, Arado, Begait, Fogera, Raya, and Medense. Medense is believed a cross breed of Begait and the Arado breeds. In compression to the remaining breeds of the region Begait and Medense are the potential breeds for diary purpose (kassahun, 2004).

Table 2: Livestock population and their distribution in Tigray

Breed	Agro-ecological zone	Altitude	Major vegetation	Production system	Population size
Afar	Hot to warm arid land	1400	Bush land riverine acacia	Pastoralist	680,590
Arado	tepid to cool semi Arid Mid high lands	1500 to 2500	Bush land and cultivation	Crop livestock	1,426644
Begait	hot to warm semi Arid Lowlands	500 to 1500	Bush land and grassland.	Pastoralist	76,706
Fogera	Tepid to cool moist	1500 to 2500	Bush land and cultivation	crop/livestock	336,000
Raya-Azebo	Hot to warm sub Moist low lands	500 to 1000	Bush land and cultivation	Agro-pastoralist crop/livestock	225678
Medense	Hot to warm semi Arid low lands	500 to 2000	Bush land and cultivation	Agro-pastoralist crop/livestock	63,893

Source: Merha (2006), Mitiku and Fikiru (1996), BoNAR (1999)

2.6.1. Arado cattle breed

The Arado cattle are considered to be intermediate breeds between sanga and zebu groups of cattle. This intermediate group has been termed zenga (Rege, 1999). It is found in the highlands of Eritrea and adjacent parts of Northern Ethiopia in northern Shire, Adwa and parts of Agame. The colours are mostly red with shades ranging from light to dark. Many animals are red-pied or black-pied and a few of them are black, brown, grey or white. The head is of medium size, with a short and broad face, and a straight profile. The horns vary in size and may be large, crescent shaped or even absent. Ears are of medium size often partially pendent. The hump is smaller in females, larger in males and the dewlap is relatively large. The back usually slopes to the sacrum. Average height at withers is 111 cm for cows and 122 cm for bulls (Mason and Maule 1990).The Arado cattle have thick skins as compared to Barka cattle of Western Eritrea and Northern Ethiopia and this is thought to be useful for protection against cold climate of the high plateau. It has been suggested that the breed is superior in its adaptation to cold and capacity for work to other neighboring breeds (Mason and Maule, 1990).

Rege (1999) indicated that the current population is about 510 000 and that they are not in a state of disappearance. However, there is no appropriate method followed to conserve the breed. Cattle are managed under transhumance such that from the highlands they are taken to the eastern

lowlands from November to March and returned to the highlands at the beginning of rainy season in June. Arado cattle are much valued for ploughing; they are docile and show great strength and are well adapted to the highlands. Ranges of the live weight of 210-409 and 190-340 kg were indicated for males and females, respectively (Mason and Maule 1960). The Arado cattle can yield up to 4 liters of milk a day, but normally they do not produce much more than a daily average of 1 liter. In spite of this low productivity the cows are normally milked to the detriment of the calves. Their meat is dark and tough and it does not show marbling.

2.6.2. Begait/Barka cattle breed

Begait cattle breed is mainly found in abundant along the border of Eritrea, Ethiopia and Sudan under pastoral and agro-pastoral production system. Specifically it is found in the western zone of Tigray (in Ethiopia) and the Gash Barka Region (in Eritrea). Begait cattle population ranks first in Eritrea and fifth in Tigray region (BoNAR, 1999; Natarajan, 1999). According to Mitiku and Fikiru, (1999); Zerihun. (1999) Begait in Tigray region is found in the hands of pastoralist in western zone, in a wide range of altitudes 500 m.a.s.l at Kafta-humera to 1500 m.a.s.l in Tahtay-adyabo. The population size of Begait was estimated to about 80,000 with more than 60% of the population size being found in Tahtay-adyabo, and Kafta-humera.

The Barka is a long legged black and white breed originating in the Barka region. It has been spread to many areas on account of its milking qualities: daily yields of 6 to 8 liters are reported as general. They are relatively resistant to diseases and are also known for their high feed conversion rate making them good meat producers. Mature body weight ranges from 267 to 316 Kg (Oqba-Michael, 2003). The origin of this breed is Sudan and the lowlands of Eritrea. Two distinct types of the breed have been identified. The Dohin is a tall and slender type with short ears, a straight nose, a narrow long neck and long thin legs, a long tail, a less developed dewlap and a smaller udder. Milk production is lower than in the other type. Both males and females have thin and medium horns, with black or brown coat colour. The most important traits of this type are its aggressive behavior towards intruders which is an advantage in areas where cattle rustling is a big problem, and the capacity to travel long distances and graze in the vast range lands. The Begait type is the largest and most docile with a well developed udder, long teats and a higher milk yield. Small and stumpy horns are common in both males and females of this type.

The Begait is very vulnerable to food shortage. Grey, brown and black and white coat colours are most common. Mature body weight ranges from 267 to 316 Kg (Natarajan, 1999).

2.6.3. Abergele cattle breed

Abergelle cattle breed is mainly found in the districts of Abergelle in the central zone of Tigray region. Farmers reared the breed for the production of milk, meat and drought power (Regge, 1999). This breed is a crossbreed of Afar cattle breed (one of the Senga group) and an indigenous cattle breed (before which were belonging to this area) (Merha, 2000). Similarly, according Regge (1999) this breed has categorized under the zenga cattle group; in which zenga cattle is believed to a crossbreed of hump less zebu cattle and the Senga cattle breed. The breed is one of the smallest, tolerant to heat stress and tick resistance cattle breed of the region. The breed has a fine skin, coat colour varies considerably with black, spotted, and balk, and white paid. Black and white animals are among abundant colour type. Opposed to the zebu cattle groups, Abergelle breed have a small dewlap and naval flap. In addition, it has undeveloped hump, which is a typical features of this breed. Female cattle of this breed tend to resemble more to the Senga in some phenotypic characteristics, but male resembles to zebu cattle breed (Merha, 2006).

2.6.4. Fogera cattle breed

This breed is mainly found in Amhara region of Fogera woreda and Tigray region. It is adaptive to a wide range of altitude 1500 and 1680 in Amhara region, and 1500 and 2500 m.a.s.l. in Tigray region. According Alberro and Solomon (1982) report most of the physical description of the breed is: a well developed naval flap and perpetual sheath, long legs, small humps, and narrow body shapes. According to Addisu and Prabhakar (2003), a study held in metekelle agricultural research center the mean calving interval of Fogera cows was 559 days (18.6 months) and the mean AFC for heifers was 44±0.60 months.

2.6.5. Production and reproductive performance of zebu cattle

Zebu cattle are known for their low productivity in their natural environment. Despite their low productivity, they are known for their high prolificacy. As many reports indicate that, the productive and reproductive performance of zebu cattle varies. The most important factors that

determine their performance is that; Genetic, environment and disease. The factors are directly influence the reproductive process at the ovulation, fertilization or implementation during gestation and parturition and indirectly affect the productivity of cow. The methods used to estimate reproductive performance of female *bosindicus* cattle is; fertility or calving rate, number of cervices per conception, calving interval, and age at first calving (Mukasa-Mugerwa et al, 1989).

Puberty is a gradual quantitative phenomenon rather than an acute and qualitative endocrinological event. It occurs when the gonads begin to secrete sufficient steroids to accelerate the growth of the genital organs and the development of secondary sexual characteristics. Heifers, especially *taurine* can reach puberty and breed at one year old. However, *Bos indicus* reach puberty late, as an example; the average age at puberty for the Ethiopian zebu cattle is 22.5 month. In general, the time taken zebu cattle to attain sexual maturity and puberty are highly influenced by environmental factors including feed quantity and quality (Mukasa-Mugerwa, 1989).

First calving marks the beginning of cow productivity life. Age at first calving is closely related to generation interval that influences selection. The average age at first calving of *bos indicus* cattle is variable. As an example, the average age at first calving for Kenana cattle in Sudan ranges from 23 to 58 (Alim, 1960). Accordintg to Saeed et al, (1987) cattle year of birth affect age at first calving. Further Dennis and Thiongane, (1978) found that Gobra (Sengal Fulani) heifers kept on pasture and supplemented with a balanced concentrate, calved first at 31 months years old compared to un-supplemented heifers (which is calved at an age of 40 months).The period of calving interval of a cow include: gestation, post partum anoestrus (from calving to first estrus) and the service period (first post partum estrus to conception). The length of calving interval is determine by different factors and it is possible shorten calving interval by manipulating thus factors (Mukasa-Mugerwa, 1989). Sometimes the post partum unestruses and service period called day open and to achieve a calving interval of 12 months this period must not exceed 80- 85 days (peters, 1984). According to Sada (1968) calving interval of cattle were categorized very well (<13.6 month), satisfactory (13.6-15.6 months) and unsatisfactory (>15.6 months). Although zebu cattle tend to reach sexual maturity rather late, their productive life and

their crosses tends to be longer than that of taurine cattle (Fowler, 1969). The useful lifetime of zebu cattle in the tropics varies from 4.5 to 8.5 years. During this time cows gives 3 to 5.4 calves (Mukasa-Mugerwa et al, 1983).

Tropical cattle's are having low total milk production as well as yield per lactation than temperate cattle's as an example Alberro and Hail-mariam (1982a) indicate the total milk production per lactation of the indigenous cattle of Ethiopia is low., (1997) indicate that the average lactation length of indigenous cattle is low and range 272 days for Arsi cattle and 120 days of Boran cattle. According to Mason and Maule (1960), a local Arado cattle breed can yield up to 4 liters of milk a day, but normally they do not produce much more than a daily average of 1 liter. Begait cattle produce about 5 liter per day (Merha et al, 2006). The average milking days of lactating Begait cattle is also about 194 days (Azage and Alemu, 1997).

2.7. Status and trends in conservation of animal genetic resources (AnGR)

The status of AnGR or livestock breeds, particularly in the developing world, is poorly understood. Loss of genetic diversity through the disappearance of local livestock breeds is widely reported but difficult to quantify. FAO estimated (FAO, 2000) that about one third of all domesticated animal breeds were threatened with extinction. These have been criticized because they are based on national endangerment estimates, regardless of the total population size of the breed in question across countries and the genetic relationship between breeds across countries. After recent updates of the global Domestic Animal Diversity Information System (DAD-IS), the number of recognized domesticated animal breeds totals 7,600, consisting of 'trans boundary breeds' (regional and international) and 'local/national breeds' (Scherf *et al.*, 2006). The term 'breed' does not have a universally accepted biological or legal definition.

In developed countries breeds are characterized by clear definitions, physical characteristics and strict definitions of purity of pedigree, typically regulated by a breed society which is backed by law. In developing countries a breed is commonly defined by local tradition, identifying physical characteristics, a geographical location or ethnic group by which it was developed. We use the term as follows: a population of animals that share certain defined physical characteristics and which are not routinely bred with other populations (Gibson and Pullin, 2005). Rege & Gibson

(2003) and Hoffmann and Scherf (2005) summarized the factors that threaten diversity of AnGR. These include: Cross-breeding with and/or replacement by imported breeds in programs designed to improve animal productivity, neglect arising from shifts in social settings, production systems and/or market demand of certain animal products, urbanization and its impact on traditional animal agriculture, drought, civil strife/conflicts and famines.

The loss of breeds is only one indicator for the loss of genetic diversity in farm animal species. This diversity is large within breeds and overlapping with others. Hence, indiscriminate cross-breeding can be considered to be a threat to the survival of a breed but may not always reduce genetic diversity within the species. Very little is known about the distribution of specific genes and the genetic uniqueness of breeds, although a range of rather unique adaptation traits have been documented for local/indigenous breeds.

2.7.1. The value of animal genetic resources

The value of AnGR can be analyzed at different levels (livestock keeper, community, national, global) and should take into account a wide range of functions of livestock. For an overview of economics of AnGR, it is apparent from the typology of values that current economic decisions are largely based on only the direct use values, although the other categories of value may often be of equal or greater importance. For example, it has been estimated that approximately 80% of the value of livestock in low-input developing country systems can be attributed to non-market values, while only 20% is attributable to direct production outputs. By contrast, over 90% of the value of livestock in high-input developed country production systems is attributable to the latter (Gibson and Pullin, 2005). By focusing largely on direct use values, AnGR conservation is likely to be consistently undervalued. Note also that not all types of conservation strategies (discussed below) are capable of safeguarding all of the above values. For example, ex situ in vitro conservation cannot generate direct use values, while in situ conservation may be poor at ensuring option values in the face of drought.

The different types of values of AnGR constitute components of "Total Economic Value" (TEV), which is equal to the sum of the following: Direct Use Values (DUV) refers to the benefits resulting from, inter alia, actual uses, such as for food, fertilizer and hides, as well as

cultural/ritual uses. Indirect Use Values (IUV) is the benefits deriving from ecosystem functions, such as the maintenance of genetic stock and other important interactions between these breeds and the ecosystem. Option and Quasi-Option Values (OV) are derived from the value given to safeguarding an asset for the option of using it at a future date. It is a kind of insurance value against threats to livelihoods, the occurrence of, for example, unforeseen changes in the ecosystem, in future market demands, in supplies of external inputs, by emerging disease challenges or by a combination of these factors. Quasi-option values relate to the extra value attached to future information made available through the preservation of a resource. Bequest Values (BV) measures the benefit accruing to any individual from the knowledge that others might benefit from a resource in the future. Existence Values (XV) are derived simply from the satisfaction of knowing that a particular asset exists (Anderson, 2003; Pearce & Moran, 1994; Arrow & Fisher, 1974).

2.7.2. Risk status classification

For planning and prioritization purposes, it is useful to classify breeds into risk status categories. The numerical boundaries between the different risk status categories used by FAO are intended to be indicators of the need to take action. A paper presented at the Expert Consultation in 1992 argued that a population size between 100 and 1 000 breeding females "implies that the breed is in danger of extinction. Without action its effective population size is inadequate in most cases to prevent continuing genetic loss in future generations. An increase in the degree of inbreeding is unavoidable and threatens the vitality of animals. There is a real danger either of spontaneous loss for example by sudden disease, or due to neglect by man" (FAO 1992b). Further, a population size of less than 100 breeding females indicates that "The population is close to extinction. The first action must be to increase the population size. At this level of threat, the genetic variability is often already reduced so that the population cannot be considered the same as the ancient breed" (FAO 1992b).

As such, the following classification is used by FAO to describe the degrees of risk faced by livestock breeds:

Extinct breed: The case when it is no longer possible to recreate a population of the breed.

Extinction is absolute when there are no breeding males (semen), breeding females (oocytes), nor embryos remaining.

Critical breed is a breed where the total number of breeding females is less than 100 or the total number of breeding males is less than or equal to five; or the overall population size is close to, but slightly above 100 and decreasing, and the percentage of pure-bred females is below 80 percent. Endangered breed is a breed where the total number of breeding females is between 100 and 1000 or the total number of breeding males is less than or equal to 20 and greater than five; or the overall population size is close to, but slightly above 100 and increasing and the percentage of pure-bred females is above 80 percent; or the overall population size is close to, but slightly above 1 000 and decreasing and the percentage of pure-bred females is below 80 percent. Critical–maintained breed and endangered–maintained breed: Critical or endangered breeds that are being maintained by an active public conservation programme or within a commercial or research facility. But breed not at risk means the total number of breeding females and males is greater than 1000 and 20 respectively; or the population size approaches 1 000 and the percentage of pure-bred females are close to 100 percent, and the overall population size is increasing.

2.7.3. Threats to indigenous breeds

Yet these indigenous breeds may have carried genes that would have been of benefit to today's farmers; loss of these breeds means loss of such genes forever. We know little of the breeds that still exist, the genes they carry, the production system they could fit into and the benefit they could bring to farming communities in another place another time. Urgent efforts are needed to characterize breeds to preserve these valuable resources for future generation (ILIRI, 1998). Africa's indigenous base of biodiversity is being eroded by over harvesting of resources, destruction of habitat and replacement of indigenous genotype by newly introduced exotic animal germplasm. Genetic variation is the primary resource for future improvement and development of livestock to meet human needs. Loss of this diversity will thus restrict options available to meet unpredictable future requirements (Rege and Baker, 1994).

2.7.4. The impact of loss of farm animal genetic resources

The loss of animal genetic resources has both short-term and long-term implications. The permanent loss of rare and native breeds at risk would bring a substantial loss to national biodiversity and heritage. This might have an impact on long-term genetic progress and the country's ability population to or changing environmental or production niches. Over all, food security, social, environmental and economic arguments strongly favor maintaining adequate capacity for livestock production and AnGR management (FAO, 1999).

2.8. The determinants of success in conservation program

The determinants of success in community ownership and mobilization in natural resource management include broad-based participation, credibility and mutual thrust, willingness and readiness, perceived benefits and benefits distribution, value focused resource, familiarities with intended project's benefits, literacy level, socio-economic status and cultural affiliation (Thakadu, 2003).The role of community-based conservation has received increasing attention derives from the realization that most creative and productive activities of individuals or groups in society take place in the communities (Rege, 2003). The following factors have been identified as contributing to sustainability of a conservation program (Koller-Rollefson, 2003): The farmers are owners of the breed and benefit from it, the animal's owners have a sense of responsibility for the breed, animals are utilizing the farmers' own feed/fodder, maintenance is labor intensive not capital intensive, the breed is part of traditional culture and contributes to the keepers' identity and self-respect, breed and its requirements are well understood, implementing organization is stable and the project has government support. The project has the support of the other organization, such as NGOs.

2.8.1. Types of conservation

The in situ conservation involves all measures to maintain live animal breeding potentials including those involved in active breeding program in the agro-ecosystem, where they either developed or are normally found, together with husbandry activities that are under taken to ensure the continued contribution of these resources to sustainable food and agriculture

production, now and the future. The ex situ conservation of farm animal genetic diversity encompasses all conservation of genetic material in vivo, but out of the environment in which it developed, and in vitro including, inter alia the cryo-conservation of semen, oocytes, embryo. cells or tissues (FAO, 1999).

2.8.2. Utilization of farm animal genetic resources

According to FAO (2000), utilization of farm Animal Genetic Resources (AnGRs) incorporates the use and development of animal genetic resources for the production of food and agriculture. The use in production system of AnGRs that already possess high level of adaptive fitness to the environment concerned, and the development sound genetic principles, will facilitate sustainable development of the AnGRs and the sustainable intensification of the production systems themselves. The wise use of AnGRs is possible without depleting domestic animal diversity. Development of AnGRs includes a broad mix of activities that must be well planned and executed for success, and compounded over time, hence with high value. It requires carful definition of breeding objectives and the planning, establishment and maintenance of effective and efficient animal recording and breeding strategies.

3. MATERIAL AND METHODS

3.1. Description of the study area

The study was conducted in the area stretching from Medebay-Zana to Asgede-Tsimbla, which is the tract of Arado cattle breed in Northern Ethiopia. It is located on the Axum-Gondar high way, between 1057km and 1109 km of North West zone of Tigray. The Tigray National Regional State is situated between 12^0 15' and 14^0 57' N latitude and 36^0 27' and 39^0 59' E longitude. It is bordered to the North by Eritrea; to the West by the Sudan; to the South by Amhara and to the East by Afar Regional State. It belongs to the African dry lands, which are often called as the Sudano-Sahelian region (BoFED, 1998). According to Hailay and Zekarias (2000), Tigray region is categorized into kola, Weina-degua, Degua, and Berka. Major site selected for this study were Asgede-Tsimbla, Tahtay-koraro and Medebay-Zana (Figure 1). In the studied woredas, farmers follow extensive mixed farming system, crop and livestock production. The major crops grown in the surveyed area include sorghum, maize, teff, millet sesame and nug. Every sampled farm households cultivate all possible crops to fulfill their grain demand for consumption as well as for sales. There is one cropping season in the area, long rainy season (kiremt) from June to September.

3.1.1. Asgede-Tsimbla

Asgede-Tsimbla is a woreda in the North West Zone of Tigray. It is located between the latitudes of $14^0$19' to $14^0$11'N and longitudes of $37^0$34'to $38^0$19'E. The area is situated at 1109 km North of the capital Addis Ababa and 326 km North West of Mekelle, the regional capital city of Tigray. The topography of the woreda is plains, river valleys and plateau with an altitude ranging between 800 to 2300 masl. Average annual temperatures ranges between 15^0C and 34^0C and the annual rainfall ranges from 600 to 900 mm. The livestock populations in this study woreda are 232,224 cattle (Arado, Begait and exotic breeds), 146,209 shoats, 176,751poultry, 8,547 equines, 8,432 camels, and 3,560 bee colonies. The vegetation of the area is dominated by indigenous plants and some exotic plant species. Major cultivated crops include sorghum, teff, maize, nug and sesame (WARD, 2006).

3.1.2. Tahtay-koraro

Tahtay-Koraro woreda is found in Tigray Regional State, North West Zone and located at 1087km North of the capital Addis Ababa and 304 km North West of Mekelle. The area laid 23% lowland, 2% highland and 75% mid highland with an average altitude of 1883 m.a.s.l. The rainy season extends from the beginning of June to late-September with an annual rainfall of 700-900mm. The annual daily temperature ranges from 15 ^{0}C to 34 ^{0}C. Major crops grown around the woreda are cereals such as teff, sorghum, and maize and cash crops. Annual crops are dominant and rain-fed agriculture is mainly practiced using drought power. Total population of this area is 83,019. The total area of the woreda is 66,214 km^2, of which potential cultivable land is 18,430 ha, unproductive land is 17,303 ha, forest land is 17,223.5 ha, and grazing land is 7,068.6 ha. The livestock population of the woreda is 98,570 cattle, 58,590 shoats, 35,121 chickens and 37,241equines and 225 camels. Mixed crop-livestock production is practiced in the woreda (BoANR, 2008).

3.1.3. Medebay-Zana

Medebay-Zana is one of the administrative woreda found in North West Zone of Tigray Regional State and located at 1057km North of the capital city of Ethiopia (Addis Ababa), and 274 km North West of Mekelle. The area lies with the altitudes ranging from 1700 to 1900 (m.a.s.l). It receives an annual rainfall ranging from 650-950mm and has an annual average daily temperature of 26 ^{0}C (BoANR, 2003). Major crops grown around the area are cereals such as teff (*Eragrostis*), maize, sorghum, millet and pea. Total human population of this area is 118,272. The woreda is categorized as kola (47%) and woinadega (53%). Out of the total area of 105,536 ha crop land accounts for 25,549 ha and the rest 31,721 ha; 32,811 ha; 13,850 ha and 1,605 ha are grazing land, forest land, unproductive land and land for other purposes, respectively. The livestock populations in the woreda are 98,398 cattle, 65,609 goats, 15,074 sheep, 89,512 chickens, 7,899 donkeys, 146 horses and 181 camels (BoANR, 2003).

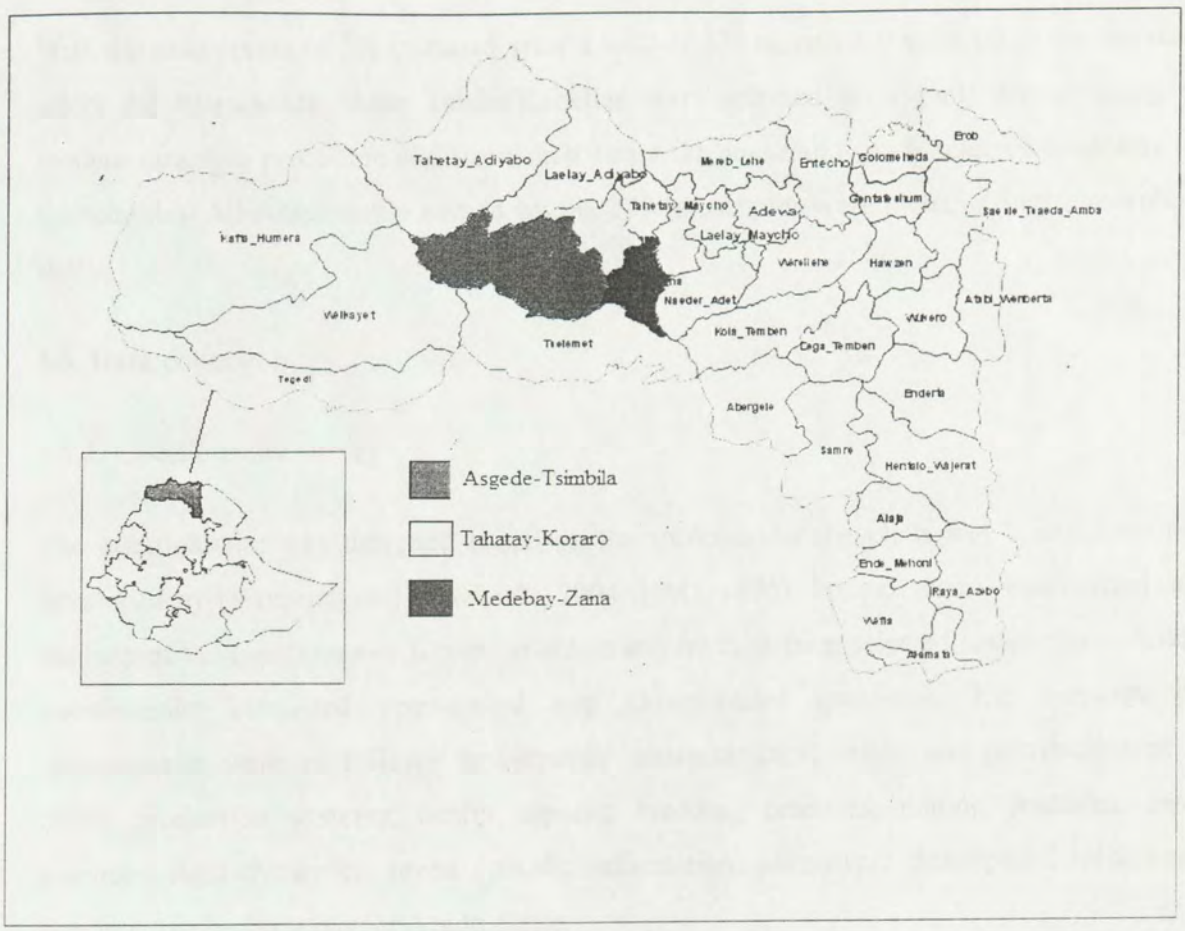

Figure 1: Map of the study area

3.2. Study population and study design

Smallholders (Arado cattle owners) and Arado cattle kept by them represented the study population. This research was basically a retrospective and cross-sectional survey focused on the selected area. Generally, data was gathered through questionnaire survey, observation, focus group discussion, and interview with key informants carried out from October 2008 to March 2009 in three woredas of North West Zone of Tigray.

3.3. Sample size determination and sampling procedures

Simple random sampling procedure was used to identify the study households and the sampling units were households keeping Arado cattle. And sample size was determined based on the formula recommended by Arsham (2007) for survey studies:

$N=0.25/SE^2$

With the assumption of 3% standard error a total of 279 households were taken for the study. To select the households, three Tabias/Kebelles were selected from each district using simple random sampling procedure and from each Tabia, 31 households were selected randomly (n=279 households). All Arado cattle owned by the 279 households were included in the morphometric study.

3.5. Data collection

3.5.1. Questionnaire survey

The questionnaire was designed based on the information checklists and breed descriptor list developed by (Workneh and Rowlands, 2004; FAO, 1986). Formal survey was carried out with the help of the questionnaire format to obtain information from selected sample households. The questionnaire consisted open-ended and closed-ended questions. The contents of the questionnaire were as follows: households' characteristics, origin and distribution of Arado cattle, production systems, health aspects, breeding practices, mating practices, castration practices, herd dynamics, breed specific information, phenotypic description, milk yield and reproductive performance of Arado cattle.

3.5.2. Additional survey materials

Additional survey materials were developed and prepared to assist the enumerators during the completion of a questionnaire. The additional survey materials consisted of Tigrigna translated version of the questionnaire format, descriptor list of phenotypic characteristics photographs of cattle adopted from ILRI (2004), color chart and measurement tape (Appendices B)

3.5.3. Participatory appraisal approach

Group discussions were held with farmer groups, development agents and the districts' livestock development desk. Group discussions were conducted in each Tabia/kebelle with 8-11 farmers and a development agent in each group. Each group was expected to identify and rank the merits

and demerits of Arado cattle and the problems associate with this breed and the production systems.

3.5.4. Morphometric measurements

A total of 40 adult males (15 intact 25 castrated) and 70 adult females (10 heifers and 60 cows) were randomly selected for phenotypic characterization. The distribution of the sampled animals by the study "Woredas" was Asgede-Tsimbla 44, Medebay-Zana 30 and Tahtay-Koraro 36 animals.

Qualitative traits examined were:

- Coat colour pattern (uniform, pied and shaded)
- Coat colour type (red, black, white, grey, brown, red and white, black and white)
- Hair length (small, medium, long)
- Facial profile, (flat, concave and convex)
- Presence of horn (present or absent)
- Horn shape (strait or curved)
- Horn orientation (upward, forward, lateral or drooping)
- Ear size (small, medium or large)
- Ear shape (rounded-edged or, strait-edged)
- Ear orientation (erect, lateral or drooping)
- Back profile (hollow or strait)
- Rump profile (flat or sloping)
- Hump presence (present or absent)
- Hump size (large, medium or small)
- Hump location (thoracic or cervico-thoracic)
- Hump orientation (bent or erect)
- Tail length:
    - Short (above the hock joint)
    - Medium (at the hock joint)
    - Long (below the hock joint),
- Udder size (large, medium or small),

- Teat size:
    - Small (hard to hold between thumb and index finger)
    - Medium (can easily be held between thumb and index finger)
    - Large (can be held between multiple fingers and thumb)
- Naval flap(large medium or small)
- Dewlap (small, medium or large)

Similarly quantitative traits were recorded in different age categories of adult animals. The measurements were taken for each traits using tape measure (meter). Heart girths were taken by using meter in the morning hours, before the animals were taken to grazing and watering areas. The reading was taken from the streak running the circumference of the animals over the back, behind the base of the hump and around the chest, just behind the front leg. The tape was held comfortably.

Quantitative traits recorded (in cm) were:

- Body length (from the hipbone to the pointing end of shoulder)
- Height at wither (from the ground to the withers of the animal)
- Heart girth (around the body just behind front legs)
- Neck length (horizontally from proximal end of cervical region to the distal end of the cranial region)
- Ear length (from the base of the ear to the pointed end of the ear)
- Face length (from the poll of the animal to the end of muzzle)
- Tail length (from the base of the tail to the pointed end of the tail) Horn length from its base to tip following its external curvature)
- Pelvic width (the width between the two pins)
- Canon bone length (the length of the bone joining the fetlock and knee joint)
- Dewlap width (measured from the widest part of the base of the neck vertically)
- Perpetual sheath (the width measured at the widest part from the base of the abdomen vertically)
- Canon bone circumference (the narrowest part of the bone joining fetlock and knee joint)
- Teat length (from the base of the teat to the end tip of the teat)

  Pictures were taken from representative cattle.

3.6. Data management and statistical analysis

The computer software Excel was used for data managing and most of the data were analyzed with SPSS (2006) version 15 software. Simple descriptive statistics such as mean, standard errors and percentiles were used to summarize the data. One way ANOVA (Analysis of variance) was used to compare the mean of different variables among the woredas.

4. RESULTS

4.1. Household and socio-economic characteristics

4.1.1. Household characteristics

Data on the household characteristics of the selected households is presented in Table 3. Out of the total interviewed households (N = 279), 69.5% were male and 30.5% were female. The same pattern of gender distribution was observed in the specific study sites. The age distribution of the household heads was 15% less than or equal to 30 years, 26.5% from 31 to 40 years, 28.7% from 41 to 50 years, 22.2% from 51 to 60 years, 6.4% from 61 to 70 years and 1.1% above 70 years. In the specific study sites, there was observable variation in the age distribution (Table 3).

Table 3: Age, sex and educational status of the respondents in the study area

Variable	Asgede-Tsimbla		Tahtay-Koraro		Medebay-Zana	
	(N=93)	%	(N=93)	%	(N=93)	%
Age						
≤ 30	16	17.2	13	14.0	13	14.0
31-40	15	16.1	34	36.6	25	26.9
41-50	26	28.0	28	30.1	26	28.0
51-60	28	30.1	14	15.1	20	21.5
61-70	8	8.6	3	3.2	7	7.5
> 70	0	0	1	1.1	2	2.2
Sex						
Female	24	25.8	30	32.3	31	33.3
Male	69	74.2	63	67.7	62	66.7
Education						
Illiterate	49	52.7	48	51.6	51	54.8
Read and write	15	16.1	18	19.4	14	15.1
Primary	20	21.5	14	15.1	10	10.8
Secondary	4	4.3	7	7.5	0	0.0
Religious school	5	5.4	6	6.5	18	19.3

N= number of respondents

Out of the total households interviewed, 53% were illiterates, 16.8% can read and write, 15.8% of them were enrolled in primary schools, 3.9% attended secondary school and 10.4% attended religious schools. The distribution of the educational status of interviewees was similar to the overall pattern except in Medebay-Zana, where there were more people with religious training than the other two sites.

4.1.2. Cropland and family size

The overall mean (± SD) cropland holding was 1.0±0.6 ha Table 4. There was a significant ($P \leq 0.05$) difference among the three "woredas" in cropland holding. Asgede-Tsimbla had more farm size (1.4 ha) than Tahatay-Koraro (0.9ha) and Medebay-Zana (0.7ha), respectively. The household survey conducted in the three study woredas showed that the mean (SD) household family size was 6.6 (2.0), 6.5 (1.9) and 6.2 (2.1) for Medebay-Zana, Asgede-Tsimbla and Tahatay-Kraro, respectively. There was no significant ($P > 0.05$) difference among the three woredas in family size. On average, there were 6.4 persons in household in the study area. The proportions of male and female members of the households were comparable in all the study areas.

Table 4: Farm and family size by the administrative woredas

Variable	Asgede-Tsimbla	Tahtay-Koraro	Medebay-Zana	Overall
	Mean(SD)	Mean(SD)	Mean(SD)	Mean
	N =93	N =93	N = 93	N = 279
Crop land size	1.4(0.7)	0.9(0.4)	0.7(0.3)	1.0(0.6)
Family size	6.5(1.9)	6.2(2.1)	6.6(2.0)	6.4(2.0)
Male	3.4(1.4)	3.2(1.5)	3.5(1.4)	3.4(1.4)
Female	3.1(1.3)	3.1(1.2)	3.1(1.1)	3.1(1.2)

N= Number of respondents, SD=standard deviation

4.1.3. Purpose of keeping cattle

The major purposes of keeping /rearing cattle in the study area are presented in Table 5. According to the respondents, cattle are kept to fulfill multipurpose functions. These include drought power, milk, income generation, reproduction, social and cultural value, dowry and hide. Most of the respondents in the three woredas reported, work power as the primary purpose for keeping cattle followed by milk, manure and breeding purposes.

Table 5: Purposes of keeping cattle in the study areas as rated by smallholder farmers

Purposes	Asgede-Tsimbla	Tahatay-Koraro	Medebay-Zana
Milk	4.3	11.8	7.5
Work/Draft	73.1	68.8	64.5
Manure	10.8	7.5	8.6
Breeding	6.5	5.4	6.5
Income	2.2	3.2	8.6
Dowry	3.2	3.2	4.3

4.1.4. Source of income

As presented in Figure 2, the major sources of household income are crop production (72.2%), livestock and products (18.6%) and others (9%) for the farmers. The farmers sold livestock and livestock products to purchase industrial products and grains during the time of crop failure.

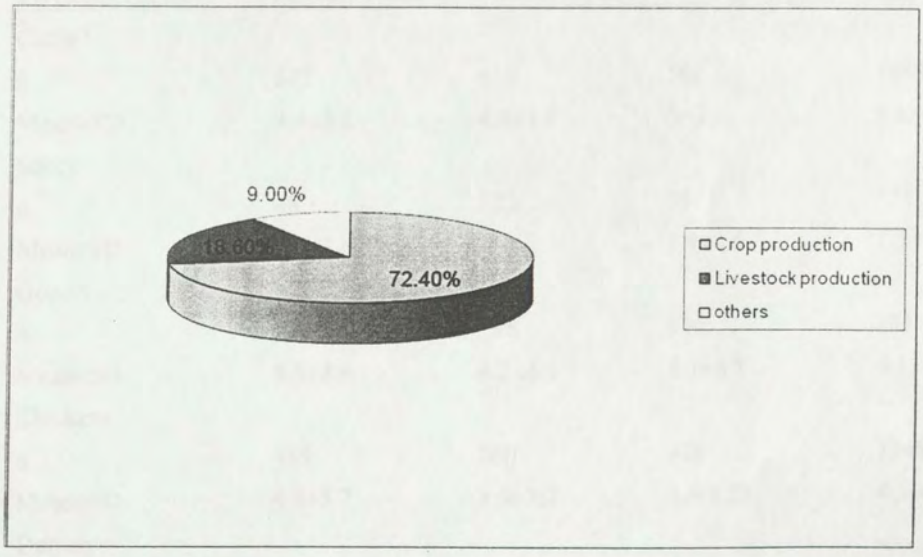

Figure 2: Sources of income for smallholder farmers

4.2. Livestock composition and herd structure

4.2.1. Livestock composition

The livestock herd in the studied households was composed of cattle (36.3%), goats (32.9%), chicken (24.0%), sheep (6.8 %) and donkeys (4.9%). Cattle and goats were more dominant in the study areas. As indicated in Tables 6, the overall mean and standard deviation of livestock holding per household were cattle 6.8 (4.1), goats 6.1 (7.1), chickens 4.5 (4.6), sheep1.3 (3.3) and donkey 0.9 (1.0) per household. Results on overall livestock ownership indicate that the average holing of cattle and goats had significant difference ($p < 0.05$) among the surveyed woredas. The higher mean cattle heads were recorded in Asgede-Tsimbla (9.4±5.2). However, the average livestock holding of sheep, chickens and donkeys were comparable ($p>0.05$) in all woredas.

Table 6: The mean livestock holding and composition by the districts

	Study locations				
Livestock species	Asgede-Tsimbla	Medebay-Zana	Tahatay-Koraro	Overall	(%)**
Cattle*					
n	872	450	562	1884	36.7
Mean±SD	9.4±5.2	4.8±1.9	6±3	6.8±4.1	
Sheep					
n	48	122	181	351	6.8
Mean±SD	0.5±2.4	1.3±2.5	1.9±4.5	1.3±3.3	
Goats*					
n	793	388	530	1711	32.9
Mean±SD	8.5±8.9	4.2±4.1	5.7±6.7	6.1±7.1	
Chickens					
n	459	360	429	1248	24.0
Mean±SD	4.9±5.7	3.9±3.7	4.6(4.2)	4.5±4.6	
Donkeys					
n	106	70	78	254	4.9
Mean±SD	1.1±1.0	0.8±0.9	0.8(1.0)	0.9±1	

*= Means show significant difference in the three woredas, ** the percent from total livestock holding, n= total livestock (for each species) owned, SD= standard deviation

4.2.2. Cattle herd structure

The mean values of cattle number in different age categories are shown in Table 7. There was no variation (P>0.05) among the woredas in the number of the different age categories of cattle in a herd. In general, the cattle herds were composed of male calves 199 (11.2%). weaned intact males184 (10.3%), intact male adults 135 (7.6%), castrated adults 432(24.2%), female calves 43 (2.4%). female weaners 204 (11.4%) and female adults 586 (32.9%).

Table 7: Cattle herd structure in the study area

Cattle herd structure	Asgede-Tsimbla	Tahatay-Koraro	Medebay-Zana	Overall
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Male calves < 1 year	1.1±0.9	0.6±0.7	0.4±0.5	0.7±0.8
Intact male weaners 1-2.5 years	1.0±1.1	0.6±0.8	0.4±0.5	0.7±0.9
Intact male adults 2.5- 4.5 years	0.8±0.9	0.3±0.5	0.4±0.6	0.5±0.7
Castrated adults > 4.5 years	1.9±1.0	1.5±0.8	1.2±0.7	1.5±0.9
Female calves < 1 year	0.8±1.0	0.4±0.5	0.3±0.5	0.5±0.7
Female weaners 1-3 years	1.1±1.2	0.6±0.7	0.5±0.6	0.7±0.9
Female adults > 3 years	2.7±1.5	1.9±1.1	1.7±0.8	2.1±1.3

4.3. Management practice

4.3.1. Labour utilization

Household members are 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 are shown in (Table 8). The selling and purchasing of cattle is mostly the responsibility of males above 15 years of age. This group is also responsible for breeding. health care and feeding activities whereas their female counterparts are responsible for milking. making and selling dairy products and feeding cattle. Males and females under 15 years

of age are given responsibilities mainly for herding and feeding. Young females are also involved in helping older women in dairying activities.

Table 8: Labour distribution among family members in cattle rearing in the study area

Activity		Age and gender group				
(%)	N	Male	Female	Male	Female	labourer
		> 15 yrs	> 15 yrs	< 15yrs	< 15 yrs	
Purchasing	279	97	16	0	0	0
Selling	279	96.6	22	0	0	0
Herding	279	32	26	69.8	39	14.3
Breeding	184	96.7	10.3	0	0	8
Feeding	275	83.9	89	74.4	50.7	9.1
Making dairy products	279	0	99.3	0	2.1	0
Selling dairy products	279	0	97.8	1.8	7.9	0
Health care	274	91.6	8.8	0	0	4

N=number of respondents

4.3.2. Livestock feed resources and feeding practice

Natural pasture is 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 (Table 9). Herded and free grazing are the most common practices during dry season (December-May) in the study area. In wet season, herded grazing is the most common practice in all woredas. A few farmers in Medebay-Zana and Tahatay-Koraro tethered their animals during dry and wet season. The natural pasture dries up and becomes standing hay and animals graze up on this. Moreover, feed conservation is practiced in the form of crop residue (teff straw, millet straw, maize and sorghum stover) and hay from natural pastures (back yard). These conserved feeds were given to cattle during feed shortage (dry season) and to work oxen during the cropping season. Supplementation of high energy and

protein concentrates was practiced to some extent. However, cattle are provided salts especially in wet season (Table 10).

Table 9: Feeding practices and strategies by season and woredas

Grazing season and grazing practice	Woredas							
	Asgede-Tsimbla		Tahatay-Koraro		Medebay-Zana		Overall	
	N=93	%	N=93	%	N=93	%	N=279	%
Dry season								
Herded	37	39.8	19	20.4	38	40.9	94	33.7
Paddock	0	0	2	2.2	0	0.0	2	0.7
Tethered	0	0	13	14.0	27	29.0	40	14.3
Yard/stall	6	6.5	8	8.6	0	0.0	14	5.0
Fee grazing	37	39.8	40	43.0	15	29.0	92	33.0
Herded/tethered	0	0.0	0	0.0	4	4.3	4	1.4
Herded/yard/stall/	6	6.5	9	9.7	0	0.0	15	5.4
Herded/free grazing	7	7.5	2	2.2	4	4.3	13	4.7
Tethered/yard	0	0.0	0	0.0	5	5.4	5	1.8
Wet season								
Herded	88	94.6	68	73.1	64	68.8	220	78.9
Tethered	0	0.0	7	7.5	26	28.0	33	11.8
Yard/stall	0	0.0	8	8.6	0	0.0	8	2.9
Fee grazing	5	5.4	7	7.5	3	3.2	15	5.4
Herded/tethered	0	0.0	3	3.2	0	0.0	3	1.1

N=number of respondents,

Table 10: Feed supplemented to cattle by selected households by season and woredas

Season and feed Supplements	Asgede-Tsimbla (HH=93)	Tahatay-Koraro (HH=93)	Medebay-Zana (HH=93)
Dry season			
Crop residue	91.4	48.4	59.1
Salts	0.0	4.3	0.0
Crop residue and salts	0.0	0.0	25.8
Crop residue and concentrates	7.5	23.7	12.9
Crop residue and' attella'	1.1	23.7	2.2
Wet season			
Crop residue	28.0	2.2	11.8
Salts	37.6	52.7	10.8
Concentrates	0.0	3.2	0.0
Crop residue and salts	29.0	41.9	77.4
None	5.4	0.0	0.0

4.3.3. Watering

The main sources of water identified in the present study areas were rivers, bore wells, pipe water, dams/ponds and spring water in dry and wet seasons. Tables 11, shows sources and distance of water sources by season and woredas. During dry season, the majority (65.6%) of the households in Asgede-Tsimbla obtained water supply from rivers, while some got water (23.7%) from bore wells, springs (7.5%) and the rest from other sources. In Medebay-Zana the majority (63.4%) of the respondents obtained water from river while the rest got water from bore wells (19.4%), dam/pond (6.5%), pipe water (5.4%) and springs (5.4%).

The distances to the nearest watering points from homestead during dry and wet season is presented in Table 11. A greater proportion of households in Asgede-Tsimbla (54.8%), Medebay-

Zana (52.7%) and Tahatay-Koraro (45.2%) traveled 1-5 km to get watered for their cattle in dry season.

Table 11: Source of water and distance to watering points by seasons and woredas

Source of water	Asgede-Tsimbla	Medebay-Zana	Tahatay-Koraro
	N= 93 (%)	N= 93 (%)	N= 93 (%)
Dry season			
Dam/pond	1.1	6.5	4.3
River	65.6	63.4	50.5
Bore well	23.7	19.4	25.8
Spring	7.5	5.4	14.0
Piped	2.2	5.4	5.4
Wet season			
Dam/pond	48.4	29.0	23.7
River	35.5	58.1	54.8
Bore well	7.5	3.2	4.3
Spring	8.6	9.7	17.2
Piped	0.0	0.0	0.0
Distance to watering point			
Dry season			
At household	3.2	5.4	2.2
< 1 km	32.3	28.0	46.2
1-5 km	54.8	52.7	45.2
6-10 km	7.5	14.0	5.4
> 10 km	2.2	0.0	1.1
Wet season			
At household	17.2	4.3	6.5
< 1 km	57.0	77.4	81.7
1-5 km	25.8	18.3	11.8
6-10 km	0.0	0.0	0.0
> 10 km	0.0	0.0	0.0

Almost all the respondents allow their cattle to drink once per a day during dry season. But during wet season water is supplied freely without any restriction.

4.3.4. Cattle housing

All farmers used open fenced barn that did not have roofing to shelter cattle (except for calves) during night. Most of the sampled households (90%) in the study areas kept their cattle within

their own residence compound, and 10% used open barn around their backyard. But calves are separated from the adults and housed in the main room of the family hut or in special pens constructed inside their residence compound. The barns were constructed from different local materials: 36.7% stone+wood+bush, 33.6% wood bush only and 26.3% stone.

4.3.5. Cattle breeding/ mating system

As shown in Table 12, most common breeding system in the study areas were natural uncontrolled mating, hand mating, and only few households used AI. The sources of bull for the farmers were village bull and own bull. Selection is not practiced. However, the Arado breed owners seems to have a general selection criteria for breeding bulls, which are usually selected on the basis of own physical conformation, size, colour and performances.

Table 12: Mating methods and sources of bulls used in the study areas

Mating system and	Asgede-Tsimbla		Medebay-Zana		Tahatay-Koraro	
Source of bull	N=93	%	N=93	%	N=93	%
Mating						
Uncontrolled	75	80.6	81	87.1	77	82.8
Hand mating	15	16.1	9	9.7	14	15.1
A.I	3	3.2	3	3.2	2	2.2
Source of bull						
Own bull(bred)	41	44.1	28	30.1	35	37.6
Own bull(bought)	4	4.3	4	4.3	4	4.3
Bull donated	3	3.2	2	2.2	0	0.0
bull borrowed	3	3.2	5	5.4	2	2.2
A.I	0	0.0	3	3.2	0	0.0
Village bull	42	45.2	51	54.8	52	55.9

N=number of respondents

There was no planned mating season preferred by farmers. However, the most common months of the year with frequent births were May (10.8%), June (58.1%) and July (15.8%).

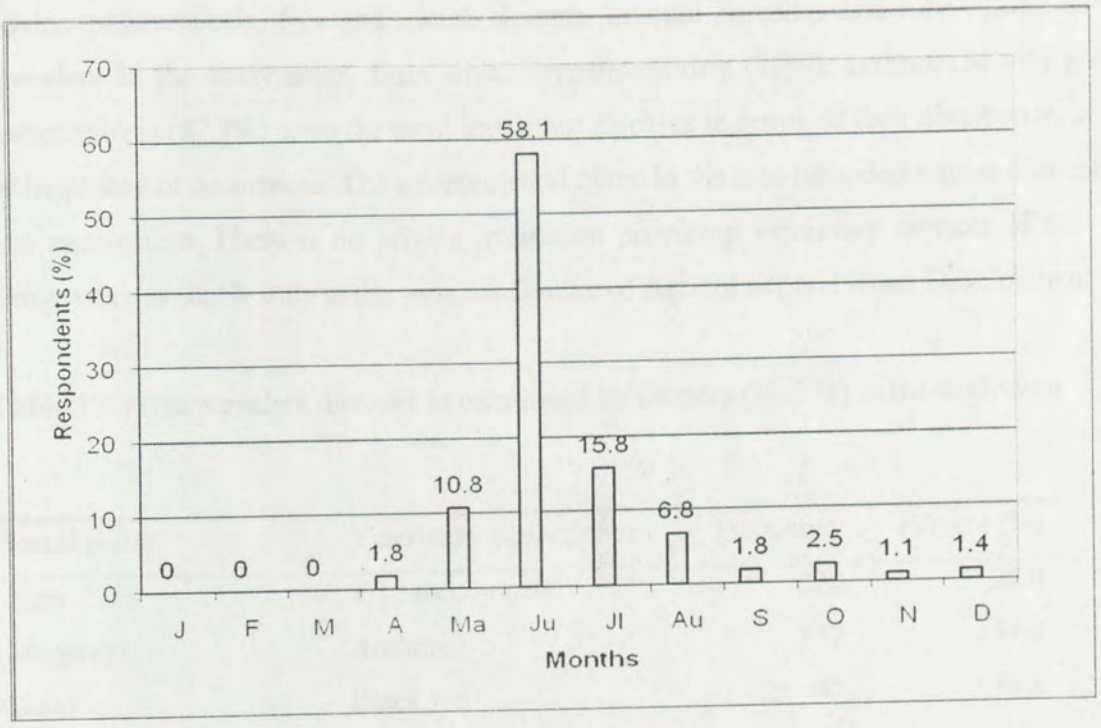

Figure 3: Calves births in the different months of the year

4.3.6. Milking and calf rearing practices

Calves were fed/grazed and housed separately from the dams except when calves are used to stimulate milk let-down. Traditional hand milking was the only type of milking practiced in the three districts. Washing of teats before milking is not practiced and they believe that during calf suckling for milk letdown, the teats get washed by the saliva of calf and, therefore, it is not as such important to wash the teats before milking. Milking was mainly done by women. Traditionally, calves are allowed to suckle their dams before (to initiate milk letdown) and after milking (to drain whatever is left in the udder). As the farmers indicated, milking frequency is mostly twice a day and this also depends on feed availability.

4.3.7. Cattle disease and control strategies

The management of animal health in the study area is a very simplified practice, characterized by very low levels of inputs. The farmers reported trypanosomosis, anthrax, liver fluke, black leg,

bovine pasteurellosis, foot and mouth disease, internal parasites and tuberculosis as diseases prevalent in the study areas, from which trypanosomosis (79%), anthrax (54.4%) and bovine pasteurellosis (52.3%) were the most important diseases in terms of their distribution and degree of frequency of occurrence. The governmental clinic in the area provided routine clinical services and vaccination. There is no private institution providing veterinary services in the woredas. Drugs were available only at the woredas Bureau of Agriculture and Rural Development.

Table 13: Most prevalent diseases as mentioned by farmers (N=279) in the study area

Local name	Veterinary equivalences	Frequency	Percent (%)
Silm	Trypanosomosis	220	79.0
Megerem	Anthrax	152	54.4
Weki	Black leg	97	34.8
E-ch lam	Foot and Mouth disease	61	21.8
Ebdet kelbi	Rabies	8	2.8
Me-ata kefti	Bovine pasteurellosis	146	52.3
TB/Himam samba	Tuberculosis	18	6.4
Tafia	Liver fluke	133	47.7
Wishtawi-tsigetegna	Internal parasites	123	44.0

4.3.8. Castration/entries/exits/culling

Castration of male animal by all farmers (100%) was practiced at an average age of 6.7 years (Table 23). Farmers also did culling. The reasons for culling of male cattle were old age (76.7%), poor performance (28.7%) and bad temperament (18.6%). Age (62.4%) was also the first reason to cull female cattle followed by poor fertility (49.1%) and income generation (36.6%).

Table 14: Reason for culling male and female cattle

Reason	HH	%	Rank
Male cattle			
Age	214	76.7	1
Performance	80	28.7	2
Temperament	52	18.6	3
Female cattle			
Age	174	62.4	1
Poor fertility	137	49.1	2
For income generation	102	36.6	3

HH= Household

Additions/entries to cattle herd in the last twelve months were mainly due to birth (70.9%), purchasing (22.3%), gift (4.5%) and exchange to some extent (2.3%). The reasons of cattle exits/culling in the last twelve months include sales (63.8%), death (25.4%) and gift (6.5%).

Table 15: Cattle entries and exits/culling in the past 12 months

Category	Number of cattle	Percent (%)
Entries		
Birth	251	70.9
Purchase	79	22.3
Gift	16	4.5
Exchange	8	2.3
Exits		
Death	59	25.4
Sales	148	63.8
Slaughter	4	1.7
Gift	15	6.5
Exchange	5	2.2
Theft	1	0.4

4.4. Cattle production constraints

The primary constraints of livestock production in the study area are summarized in Table 16. The majority of farmers (34.8%) reported were problems of grazing land as the most important constraint followed by feed shortage (33.7%), disease (11.8%), low productivity of cattle (11.5%) and shortage of veterinary service (8.2%).

Table 16: Constraints of cattle production in the study areas

Types of constraints	Frequency	Percent (%)
Feed shortage	94	33.7
Diseases	33	11.8
Shortage of grazing land	97	34.8
Shortage of veterinary service	23	8.2
Low productivity of cattle	32	11.5

4.5. Historical origin, distribution and trends of Arado cattle

Most of the interviewed of farmers (91%) did not have any idea concerning the place of origin of Arado cattle. Whereas 9% of them believed that Arado cattle was first originated from highlands of Eritrea and later spread to northern part of Ethiopia. North West Zone of Tigray is one of the major natural breeding tracts of the Arado breed. As per the respondents, Arado cattle are also found in central and Eastern Zones of Tigray and in the adjoining areas of Eretria. Agro-climatically, tepid to cool semi arid mid highlands climatic conditions were indicated as favorable environmental conditions to the breed. Of interviewed farmers 59.1% indicated that the Arado breed populations have decreased over the years (Table 17). The main reasons given were decreasing grazing land, feed shortage, drought and diseases.

Table 17: Perception of farmers on trend of the Arado cattle population

Trend	Number of HH	Percent (%)
Increasing	43	15.4
Decreasing	165	59.1
Stable	32	11.5
Unknown	39	14.0

HH= Household

4.6. Merits and demerits of Arado cattle

The merits and demerits of Arado cattle with regard to different traits are presented in Table 18. Arado cattle were rated high in all the study areas for disease tolerance, drought tolerance, and heat tolerance while they were considered as poor for milk yield, growth rate and fertility (Table 18).

Table 18: Physical and of biological characteristics Arado cattle as rated by smallholders in the study areas

"Woreda"	Cattle traits								
	Disease tolerance	Drought tolerance	Heat tolerance	Tempe rament	Work rate	Milk yield	Meat	Growth rate	Fertility
AT									
poor	-	-	-	3.2	3.2	88.2	41.9	86.0	84.9
average	25.8	24.7	24.7	23.7	34.4	11.8	11.8	14.0	15.1
good	72.0	73.1	72.0	68.8	60.2	0.0	45.2	-	-
No opinion	2.2	2.2	3.2	4.3	2.2	-	1.1	-	-
MZ									
poor	-	0.0	3.2	0.0	2.2	82.8	14.0	49.5	50.5
average	16.1	7.5	10.8	53.8	55.9	17.2	58.1	46.2	31.2
good	79.6	92.5	86.0	46.2	41.9	0.0	28.0	4.3	18.3
No pinion	4.3	-	-	-	-	-	-	-	-
TK									
poor	3.2	2.2	2.2	3.2	4.3	93.5	23.7	55.9	66.7
average	14.0	17.2	19.4	41.9	62.4	6.5	39.8	19.4	23.7
good	82.8	80.6	78.5	54.8	33.3	0.0	36.6	24.7	9.7
No opinion	-	-	-	-	-	-	-	-	-

AT=Asgede-Tsimbla, MZ= Medebay-Zana and TK= Tahatay-Koraro

4.7. Phenotypic characteristics of Arado Cattle

4.7.1. Qualitative characteristics of the cattle

Colour pattern

The present study revealed that the majority of Arado cattle have coat colours which are uniform (77.1%), pied (17.2%) and shaded (5.7%). Out of the sample female cattle red (37.5%), white (15.7%), red and white (12.9%) black (11.1%) coat colours were the most frequently observed. The hair size was dominantly short (85.7%) in all the study areas.

Table 19: Colour pattern and coat colour of the Arado female cattle in study areas

Colour pattern	Asgede-Tsimbla	Tahatay-Koraro	Medebay-Zana	Overall
Coat color pattern				
Uniform	20 (83.3%)	14 (70%)	20(76.9%)	54 (77.1%)
Shaded	2 (8.3%)	0	2 (7.7%)	4 (5.7%)
Pied	2 (8.3%)	6(30%)	4 (15.2%)	12(17.2%)
Hair length				
Medium	3(12.5%)	3(15.0%)	4(15.4%)	10(14.3%)
Short	21(87.5%)	17(85.0%)	22(84.6%)	60(85.7%)
Colour				
Black	5(20.8%)	4(20.0%)	4(15.4%)	13(18.6%)
Grey	0%	1(5.0%)	1(3.8%)	2(2.9%)
Red	8(33.3%)	4(20.0%	9(34.6%	21(30.0%)
White	5(20.8%)	3(15.0%)	3(11.5%)	11(15.7%)
Brown	2(8.3%)	2(10.0%)	3(11.5%)	7(10.0%)
Black and grey	2(8.3%)	0%	2(7.7%)	4(5.7%)
Black and white	0%	2(10.0%	1(3.8%)	3(4.3%)
Red and white	2(8.3%)	4(20.0%)	3(11.5%)	9(12.9%

Uniform= one types of colour pattern (red, white, or black), pied = white and red or white and black

The sampled male Arado cattle had uniform (65%), pied (30%) and shaded (5%) coat color pattern and short (82.5%) and medium (17.5%) hair type. The most frequent colours observed were red (40%), red and white (17.5%) and black and white (12.5%). The hair size was dominantly short (90%) in all the study areas.

Table 20: Coat colour pattern and body colour of the Arado male cattle in the study areas

Colour pattern	Asgede-Tsimbla	Tahatay-Koraro	Medebay-Zana	Overall
Coat description				
Uniform	13(65%)	6(60%)	6(60%)	25(62.5%)
Shaded	1(5%)	0	2(20%)	3(7.5%)
Pied	6(30%)	4(40%)	2(20%)	12(30%)
Hair length				
Medium	3(15%)	3(30%)	1(10%)	7(17.5%)
Short	17(85%)	7(70%)	9(90%)	33(82.5%)
Colour				
Black	1(5%)	1(10%)	1(10%)	3(7.5%)
Grey	1(5%)	0	1(10%)	2(5%)
Red	9(45%)	4(40%)	3(30%)	16(40%)
White	2(10%)	1(10%)	1(10%)	4(10%)
Black and grey	0	0	1(10%)	1(2.5%)
Black and white	2(10%	2(20%)	1(10%)	5(12.5%)
Red and white	4(20%)	2(20%)	1(10%)	7(17.5%)
Black and red	1(5%)	0	1(10%)	2(5%)

Body conformation

The present study found different types of body conformation in the female cattle. Dewlap size varied from small (45.7%) to medium (47.1%). They have predominantly straight facial profile (88.6%) and straight back profile (80%). The female cattle were horned (97.1%) with curved (41%) and straight (57.4%) horn shapes and with lateral (48.5%), forward (26.4%) and upward (22.1%) horn orientation. They have also short (47.1%), medium (33.8%) and long (19.1%) horn length. Incidence of polledness was low (2.9%). The ear size ranged from medium (74.3%) to small (25.7%) and the ears are slightly-straight (88.6%) in most of the cases and rounded-edged (11.4%) to some extent. The ear orientations were slightly dropping in the majority of the cases (68.6%) and lateral (31.4%) in some cases. The hump size is small (98.6%) in almost all cases. Regarding tail length, 45.7% have long tail length (well below the hock), 44.3% medium tail length (at the hock) and 10% short tail length (above the hock). The size of the udder varied from

small (67.5%), medium (27.5%) to large (5%). The details of qualitative characteristics of female cattle are illustrated in Table 21 and Figure 4.

Body conformations of the male cattle are presented in Table 20. Facial profile varies from flat (87.5%) to slightly concave (12.5%). All the sample male cattle were horned (100%) with curved (62.5%) and straight (37.5%) horn shape, forward (37.5%), upward (32.5%), lateral (25%) and drooping (5%) horn orientation. And the horn length varied from short (32.5%) to medium (42.5%) and long (25%). Bent (5%) and erect (95%) hump orientation. The hump location is thoracic (80%) and cervico-thoracic (20%). The details of qualitative characteristics of male cattle are illustrated in Table 21 and Figure 5.

Figure 4: Arado cow in its natural breeding tract (Medebay-Zana) Northern Ethiopia

Figure 5: Male Arado cattle in its breeding tract (Asgede-Tsimbla) Northern Ethiopia

Table 21: Body conformation of the female and male of Arado cattle in the three woredas

Variables	W 1 N =24	W2 N= 20	W 3 N =26	Overall N =70	W1 N =20	W 2 N =10	W3 N =10	Overall N= 40
	Female %				Male %			
Dewlap								
Large	2(8.3)	1(5)	2(7.7)	5(7.1)	4(20)	1(10)	3(30)	8(20)
Medium	12(50)	11(55)	10(38.5)	33(47.1)	12(60)	6(60)	6(60)	24(60)
Small	10(42)	8(40)	14(53.8)	32(45.7)	4(20)	3(30)	1(10)	8(20)
Hump size								
Large	0	0	0	0	5(25)	2(20)	4(40)	11(27.5)
Medium	0	0	0	0	9(45)	6(60)	2(20)	17(42.5)
Small	24(100)	20(100)	25 (96)	69(98.6)	6(30)	2(20)	4(40)	12(30)
Absent	0	0	1(3.8)	1(1.4)	0	0	0	0
Hump orientation								
Bent	3(12.5)	1 (5)	2(7.7)	6(8.6)	9(45)	6(60)	4(40)	19(47.5)
Erect	21(87.5)	19(95)	23(88.5)	63(90)	11(55)	4(40)	6(60)	21(52.5)
No	0	0	1(3.8)	1(1.4)	0	0	0	0
Hump location								
Cervico-thoracic	7(29.2)	7(35)	13(50.0)	27(38.6)	4(20)	2(20)	4(40)	10(25)
Thoracic	17(70.8)	13(65)	12(46.2)	42(60)	16(80)	8(80)	6(60)	30(75)
No	0	0	1(3.8)	1(1.4)	0	0	0	0
Face profile								
Flat/strait	22(91.7)	16(80)	24(92.3)	62(88.6)	18(90)	9(90)	8(80)	35(87.5)
Slightly-concave	2(8.3)	4(20)	2(7.7)	8(11.4)	2(10)	1(10)	2(20)	5(12.5)
Back profile								
Slightly-hollow	2(8.3)	5(25.0)	7(26.9)	14(20)	4(20)	0	0	4(10)
Straight	22(91.7)	15(75.0)	19(73.1)	56(80.0)	16(80)	10(100)	10(100)	36(90)
Rump profile								
Slightly flat	18(75)	14(70)	19(73.1)	51(72.9)	13(65)	8(80)	10(100)	31(77.5)
Sloping	6(25)	6(30)	7(26.9)	9(27.1)	7(35)	2(20)	0	9(22.5)
Horn presence								
Present	23(95.8)	20(100)	25(96.2)	68(97.1)	20(100)	10(100)	10(100)	40(100)
Absent	1(4.2)	0	1(3.8)	2(2.8)	0	0	0	0
Horn shape								
Curved	10(41.7)	7(35)	12(46.2)	29(41.4)	10(50)	7(70)	8(80)	25(62.5)
Straight	13(54.2)	13(65)	13(50.0)	39(55.7)	10(50)	3(30)	2(20)	15(37.5)
No	1(4.2)	0	1(3.8)	2(2.9)	0	0	0	0
Horn orientation								
No	1(4.2)	0	1(3.8)	2(2.9)	0	0	0	0
Dropping	1(4.2)	0	1(3.8)	2(2.9)	0	2(20)	0	2(5)
Forward	7(29.2)	6(30)	5(19.2)	18(25.7)	6(30)	3(30)	6(60)	15(37.5)
Lateral	12(50)	11(55)	10(38.5)	33(47.1)	7(35)	1(10)	2(20)	10(25)
Upward	3(12.5)	3(15)	9(34.6)	15(21.4)	7(35)	4(40)	2(20)	13(32.5)
Horn length								
No	1(4.2)	0	1(3.8)	2(2.9)	0	0	0	0
Long	3(12.5)	2(10)	8(30.8)	13(18.6)	5(25)	4(40)	1(10)	10(25)
Medium	11(45.8)	7(35)	5(19.2)	23(32.9)	8(40)	4(40)	5(50)	17(42.5)
Short	9(37.5)	11(55)	12(46.2)	32(45.7)	7(35)	2(20)	4(40)	13(32.5)
Naval flap								
Medium	1(4.2)	5(1)	2(7.7)	4(5.7)	-	-	-	-
Small	19(79.2)	17(85)	12(46.2)	48(68.6)	-	-	-	-
Absent	4(16.7)	2(10)	12(46.2)	18(25.7)	-	-	-	-

Table 21: Continued

Variables	W 1 N =24	W2 N= 20	W 3 N =26	Overall N =70	W1 N =20	W 2 N =10	W3 N =10	Overall N= 40
	Female %				Male %			
Ear size								
Large	0	0	0	0	3(15)	1(10)	0	4(10)
Medium	16(66.7)	15(75)	21(80.8)	52(74.3)	16(80)	9(90)	9(90)	34(85)
Small	8(33.3)	5(25)	5(19.2)	18(25.7)	1(5)	0	1(10)	2(5)
Ear shape								
Rounded-edged	3(12.5	3(15)	2(7.7)	8(11.4)	0	0	3(30)	3(7.5)
Slightly-Straight	21(87.5)	17(85)	24(92.3)	62(88.6)	20(100)	10(100)	7(70)	37(92.5)
Ear orientation								
Lateral	7(29.2)	7(35)	8(30.8)	22(31.4)	13(65)	3(30)	7(70)	23(57.5)
Slightly drooping	17(70.8)	13(65)	18(69.2)	48(68.6)	7(35)	7(70)	3(30)	17(42.5)
Tail length								
Long	11(45.8)	8(40)	13(50)	32(45.7)	15(75)	9(90)	6(60)	30(75)
Medium	10(41.7)	10(50)	11(42.3)	31(44.3)	3(15)	0	2(20)	5(12.5)
Short	3(12.5)	2(10)	2(7.7)	7(10)	2(10)	1(10)	2(20)	5(12.5)
Udder size (41)								
Large	0	1(2.4)	1(2.4)	2(4.8)	-	-	-	-
Medium	4(9.7)	6(14.6)	5(12.2)	15(36.5)	-	-	-	-
Small	9(21.9)	7(17.1)	8(19.5)	24(58.5)	-			
Teats size**								
Small	18(75)	16(80)	12(46.2)	46(65.7)	-	-	-	-
Medium	2(8.3)	2(10)	4(15.4)	8(11.4)	-	-	-	-
Large	4(16.7)	2(10)	10(38.5)	16(22.9)	-	-	-	-
Perpetual sheath								
Small	-				7(35)	4(40)	0	11(27)
Medium	-				12(60)	6(60)	4(40)	22(55)
Large	-				1(5)	0	6(60)	7(17.5)

W1= Asgede-Tsimbla, W2=Tahatay-Koraro, W3=Medebay-Zana,*= perpetual sheath shows significant ($p<0.05$) difference among the woredas. **=teat size shows significant different among the woredas, N=Cattle observation frequency

4.8. Morphological measurements of Arado cattle

The linear measurements of the different quantitative morphological parameters in female cattle are presented in Table 22. Female Arado cattle had very close values of the different quantitative parameters in the three study woredas ($p>0.05$).

Table 22: Morphometric measurement (in cm) for the female Arado cattle

Variables	Districts/woredas				
	"Woreda" 1	"Woreda" 2	"Woreda" 3	Overall	
	N=24	N=20	N=26	N=70	P-value
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	
Neck length	37.9±0.95	38.7±1.17	38.5±0.61	38.4±0.51	0.82
pelvic width	31.8±0.73	31.8±0.62	31.2±0.52	31.6±0.36	0.74
Canon bone length	19.3±0.38	18.6±0.43	19.2±0.42	19.1±0.24	0.53
Naval flap width	2.5±0.13	2.4±0.15	2.6±0.11	2.5±0.07	0.39
Height at wither	108.2±1.38	107.2±1.61	105.6±1.36	107.0±0.83	0.40
Chest girth	137.3±1.15	138.3±1.65	138.3±1.50	138.0±0.82	0.85
Body length	102.9±1.15	99.5±1.58	102.7±1.51	101.9±0.83	0.21
Ear length	18.8±0.28	18.5±0.34	18.9±0.25	18.7±0.16	0.58
Face length	39.7±0.34	38.4±0.45	38.7±0.35	39.0±0.22	0.07
Teat length**	3.0±0.16	2.7±0.16	3.2±0.10	3.0±0.09	0.08
Horn length	19.6±1.43	17.7±1.38	21.0±1.26	19.6±0.79	0.24
Tail length	71.6±0.93	70.6±1.17	71.2±0.77	71.2±0.54	0.76
Dewlap width	20.2±0.66	20.2±0.79	20.7±0.69	20.4±0.40	0.85
CBC	13.7±0.18	13.4±0.14	13.2±0.17	13.4±0.10	0.17

Woreda 1= Asgede-Tsimbla, Woreda 2=Tahatay-Koraro, woreda 3= Medebay-Zana, N= number of sampled female cattle, SE= standard error, Sig. =significance difference, **=the sampled cattle for teat length were 65, CBC= canon bone circumference

The average values of linear body measurements on quantitative morphological parameters in male cattle are displayed in Table 23. Except chest girth and horn length, male Arado cattle had very close values of the quantitative parameters in the three woredas ($p>0.05$). Chest girth was significantly larger for Arado cattle in Medebay-Zana Woreda than those in Tahatay-Koraro Woreda and comparable to those in Asgede-Tsimbla Woreda. Horn length of male Arado cattle in Medebay-Zana Woreda was longer than those in the other two Woredas.

Table 23: Morphometric measurement (in cm) for male Arado cattle

Variables	Woredas/Districts				P-value
	"Woreda" 1	"Woreda" 2	"Woreda" 3	Overall	
	N=20	N=10	N=10	N=40	
	Mean±SE	Mean±SE	Mean±SE	Mean±SE	
Neck length	40.5±1.15	38.7±1.59	40.8±0.90	40.1±0.73	0.53
Pelvic width	33.0±0.80	31.1±0.86	32.5±0.50	32.4±0.48	0.28
Canon bone length	20.9±0.57	19.2±0.53	20.9±0.72	20.5±0.37	0.16
Height at wither	115.9±1.38	115.3±1.55	114.7±1.44	115.6±0.85	0.91
Chest girth*	146.9±2.17	137.0±3.00	147.7±2.58	144.6±1.60	0.02
Body length	109.4±1.77	105.9±2.35	108.8±2.40	108.4±1.21	0.49
Ear length	20.0±0.24	19.9±0.30	20.4±0.36	20.1±0.17	0.55
Face length	40.6±0.52	39.8±0.57	41.1±0.48	40.5±0.32	0.34
Horn length*	21.0±1.34	19.2±2.06	27.9±1.86	22.2±1.08	0.01
Tail length	72.4±1.40	72.1±1.48	72.5±2.07	72.4±0.92	0.99
Perpetual sheath width	10.1±0.55	11.4±1.16	10.9±1.17	10.6±0.49	0.57
Dewlap width	21.7±1.22	21.1±1.09	22.5±1.24	21.7±0.73	0.80
CBC	14.6±0.27	13.9±0.29	14.7±0.23	14.4±0.17	0.14
Naval flap width	3.2±0.25	2.9±0.24	2.8±0.32	3.0±0.16	0.52

Woreda 1= Asgede-Tsimbla, Woreda 2=Tahatay-Koraro, woreda 3= Medebay-Zana, N= number of sampled male cattle, SE= standard error, Sig.=significance difference, CBC= canon bone circumference,*=Variables have significant difference

4.9. Production and reproduction performance of Arado cattle

4.9.1. Production performance of Arado cattle

Data on milk yield from Arado cows in Asgede-Tsimbla, Tahatay-Koraro and Medebay-Zana Woredas are presented in Table 24. The average daily milk yield per cow in Asgede-Tsimbla (1.9±0.06 liters) was significantly higher ($P<0.05$) than those in Tahatay-Koraro (1.5±0.04 liters) and Medebay-Zana (1.6±0.05 liters), while the average daily milk yield in Tahatay-Koraro and Medebay-Zana was comparable. The overall average daily milk yield from Arado cows was 1.7±0.03 liters/head/day. The estimated average lactation milk yield per cow was 372 liters over an average lactation period 7.3 months (Table 24). The overall mean life time calf crop for the Arado cows in the studied areas was 4.6±0.06 heads (Table 24), and did not vary significantly among the study areas ($p> 0.05$). The average reported lactation length of Arado cows was 7.3±0.05 months (Table 24).

4.9.2. Reproductive performance of Arado cattle

The estimated overall mean (±SE) age at puberty of Arado cattle was reported to be 41.2±0.34 and 39.8±0.30 months, respectively, in female and male cattle. The mean age at puberty of female and male Arado cattle in the three Woredas was significantly different ($p<0.05$). The shortest age at first puberty in both female and male animals was found in Medebay- Zana Woreda. The overall mean age at first calving was 56.9±0.37 months and calving interval (CI) was 21.6±0.25 months. There were also significant variations among the woredas in age at first calving and calving intervals ($p<0.05$). The shortest values of age at first calving and calving interval were found for Arado cattle in Tahatay-Koraro Woreda.

Table 24: The estimated mean (±SE) for production and reproductive traits of Arado cattle

Traits	Asgede-Tsimbla (N=93)	Tahatay-Koraro (N=93)	Medebay-Zana (N=93)	Overall (N=279)
AP in male (mon)	42.8±0.66	41.6±0.54	39.3±0.53	41.2±0.34***
AP in female (mon)	40.7±0.53	40.3±0.52	38.4±0.46	39.8±0.30**
AFC (mon)	57.3±0.66	54.8±0.56	58.4±0.65	56.9±0.37***
CI (mon)	21.5±0.47	21.0±0.39	22.4±0.40	21.6±0.25^{NS}
LL (mon)	7.5±0.11	7.2±0.08	7.1±0.09	7.3±0.05*
CC (n)	4.7±0.10	4.6±0.08	4.6±0.11	4.6±0.06^{NS}
DMY (liter)	1.9±0.06	1.5±0.04	1.6±0.05	1.7±0.03***
CA (yrs)	6.9±0.07	6.8±0.07	6.4±0.11	6.7±0.05***

Productive and reproductive performances Arado cattle with superscript within the same rows shows significantly difference at 5 % level of significance, NS= (P> 0.05): *= (P<0.05); **= (P<0.01); *** = (P<0.001) (AP=Age at puberty in male and female, AFC=Age at first calving, CI=Calving interval, LL=Lactation length, CC=Calf crop, DMY=Daily milk yield, CA= Castration age

5. DISCUSSION

There was no a significant ($P > 0.05$) difference among the three woredas in family size. On average, there were 6.4 persons in household in the study area. This was a little larger than the report for Adwa (5.7), Kolatembein (5.35) and Western zone (4.8) (Abraham, 2009) and similar to the average family size of in Astbie Womerta, Alamata and Enderta woreda (6.5) in Tigray Region as reported by Almaz (2008). However, our finding was larger than the national average (5.2) reported by CACC (2002). Having many children was considered as an asset as this guarantees as a supply of labour for herding and farming activities and being large in number in a household has social prestige showing the strength of that family.

Land is one of the important prerequisites for any farming activity. One of the big challenges of both rural and urban livestock producers is the diminishing land size they own. Because of rapid growth of population and urbanization, farmers do not have extra land to develop improved animal feeds or do not have access to communal grazing land (Sintayehu, *et al.*, 2008). Mean (± SD) cropland holding was 1.0±0.6 ha. There was a significant ($P \leq 0.05$) difference among the three woredas in land holding. Asgede-Tsimbla had large farm size (1.4 ha) than the rest, 0.9 ha and 0.7 ha in Tahatay-Koraro and Medebay-Zana, respectively.

Most of the respondents in the three woredas reported work power as the primary purpose for keeping cattle followed by milk. 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 environment. 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.

Nine percent of interviewed farmers believed that Arado cattle was first originated from high lands of Eritrea and later spread to northern part of Ethiopia. This is in agreement with earlier report by Rege (1999), that Arado cattle are found in highlands of Eretria and adjacent parts of northern Ethiopia in Northern Shire, Adwa and parts of Agame. The Arado cattle are considered

to be intermediate between sanga and zebu groups of cattle. This intermediate group has been termed *zenga* (Rege, 1999). Most of the published documents (FAO 1999, 2000) put the 'breed' into focus and neglect cultural and other socio-economic factors. The Arado cattle have thick skins as compared to Barka cattle of Western Eritrea and Northern Ethiopia and this is thought to be useful for protection against cold climate of the high plateau. It has been suggested that the breed is superior in its adaptation to cold and capacity for work to other neighboring breeds (Mason and Maule, 1990). This perception is in sharp similar to the reality with the present study. Arado cattle's merits as perceived by the owners were drought tolerance, heat tolerance, disease tolerance, temperament and work power, heat and cold tolerance. This indicates that Arado cattle have been reared for their high adaptation traits. BoANR (1999) indicated that out of 3,415,547 cattle in Tigray, 65% (2,220,105) were Arado. On the other hand, the report of CSA (2007/08) indicated that the current cattle population in Tigray is about 3,119,407 and from this total population, Arado cattle breed constitutes 60.51% (1887553). The breed is not in a state of disappearance (not at risk). However, there is no appropriate method to conserve the breed. Cattle are reared under traditional production system.

The majority 34.8% of farmers reported problems of grazing land as the most important constraint, followed by feed shortage, which was reported by about 33.7% of the households. Disease (11.8%), low productivity of cattle (11.5%) and shortage of veterinary service (8.2%) were also problems the area. Similarly, Abraham (2009) indicated that shortage of feed, health problem and low producing animals are major problems in livestock production systems in Western and central zones of Tigray. 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 causes some of these effects and almost all have severe effects on overall production efficiency of animals (Suzuki, 2005).

The sampled Arado cattle had uniform, pied and shaded coat description, and short hair length. The most frequent colours observed were red, followed by red and white, and black and white. The present study found different types of body conformation in the Arado cattle. Dewlap size varies from small to medium. Have straight facial profile and back profile. The cattle are horned with curved and straight horn shape, with lateral, forward and upward horn orientation. Have

short medium and long horn length. Incidence of polledness was low. They have medium and small ear size, slightly-straight and rounded-edged ear shape, lateral and slightly drooping ear orientation. The hump size is small in female cattle. But medium to large hump size in male cattle. In the sampled animals have long tail (well below the hock), medium tail length (at the hock) and short tail (above the hock). This is similar with previous work of Mason and Malue (1990) who reported that the hump is smaller in females, larger in males and the dewlap is relatively large.

Regarding morphometric measurements (body length, height at withers and heart girth), in all of the animals, heart girth was highest followed by height at wither and body length giving the appearance of a small and compact body. Males had greater body measurements when compared to females. Abraham (2009) observed that the body length, height at withers and heart girth of adult female Begait cattle was 123.38±0.77cm, 127.75±0.69cm and 158.01±087cm, respectively. For adult male the values for the same parameters were 127.95±1.37cm 137.44±1.18cm, and 168.38±1.5cm, respectively. This indicates that Arado cattle breed is smaller than Begait cattle breed in body size. The average lactation length (LL) was reported as 7.3 months and significantly ($p<0.05$) varied in different woredas. The result of the present study was somewhat similar with the findings of Kedija *et al.* (2008) regarding the lactation length of the local cattle breed in the Mieso district, Oromia Regional State; the lactation length was 7.29 ±0.17 months. Takele (2005) summarized the performance of Sheko cattle for lactation length and found an average of 9.9 months, which is higher than the results of present study. Merha (2006) studied the performance of Northern Ethiopian Cattle Breeds (Arado, Begait, and Raya,) and found lactation length of 242±20, 205±32 and 210±17 days, respectively which partially agrees with the findings of the present study.

The overall average milk off-take from Arado cows was 1.7±0.03 liters/head/day with lactation milk yield per cows of 372 liters over an average lactation period 7.3 months. This result was higher than the overall average estimated lactation milk yield of Fogera cattle which was 238.35 liters (Mulugeta, 2005). Abraham (2009) found the milk yield/cow/day of Begait to be 4.5 liters which is higher than the results in the present study. 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 slightly similar to the results in the present study. The overall mean calf crop production for the Arado cow was 4.6±0.06 heads. This is less than from the mean lifetime calf crop production of cattle (7.4±0.47) heads in transhumance cattle production system in North Gondar, Amhara Region (Azage, *et al.*, 2009). As opposed to the present work, slightly lower values of overall mean lifetime calf crop (3.58) was recorded at Cheffa farm in Oromiya (Gebeyehu, 2005). The low lactation milk yield found in the current study may be due to poor genetic makeup, genetic variation, shortage of feed, shorter lactation length or poor management conditions.

The mean age at puberty (AP) for Arado cattle was 40.5months. Abraham (2009) investigated the age at puberty of Begait cattle and found it to be 30.29 and 39 months in in-situ and ex-situ, respectively, which is shorter than the result of present study. Al-Amin *et al.* (2007) reported that an Age at puberty of North Bengal Grey cattle was 28.9 months. This is also shorter than the present study. Takele (2005) reported that the age at puberty of male and female Shoko cattle was 41.6 and 42.1 months, respectively which were close to the result of present study. Fluctuations and variation in age at puberty of Arado cattle might be due to the effect of environment and management practices. The mean age at first calving (AFC) for the Arado cattle was found to be 56.9 months. Musa *et al.* (2006) reported the AFC of Butana cattle breeds to be 53 months and 51 months in central Sudan, respectively which is slightly closer to the present study. Merha (2006) found that AFC was 50±7 months for Arado cattle, which was shorter than the results of the present study.

Overall mean calving interval (CI) in this study was 21.6±0.25 months. There was also significant ($P \leq 0.05$) variation among the woredas in calving intervals. The result of the present study was slightly lower than the calving interval of Arado cattle reported by (Merha, 2006) (22±3 months). 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. Calving intervals can be improved through nutrition and early breeding. Genetic variation and management factors especially feeding systems and methods of care might have influenced these traits.

6. CONCLUSION AND RECOMMENDATIONS

Based on the facts discussed in this work, the results of this study showed that the Arado cattle can be considered the most suitable indigenous cattle breed for the low-input, high stress production system still practiced traditionally by thousands of farmers in Tigray. And these cattle constitute the highest number from the cattle population of the region.

The results of this study showed that Arado cattle are characterized mainly by their uniform red colour, small body size, and dewlap size varied from small to medium. They have predominantly straight facial profile and straight back profile. The cattle were horned with curved and straight horn shapes and with lateral, forward and upward horn orientation. They have also short, medium horn length. Incidence of polledness was low. They have medium ear size and the ears are slightly-straight in most of the cases and rounded-edged to some extent. The ear orientations were slightly dropping in the majority of the cases and lateral in some cases. The hump size of the female cattle is small in almost all cases, but medium in male. Regarding tail length, have medium to long tail length. The size of the udder is small.

The production and reproductive performance of Arado cattle is in general poor but their performance under the current environmental conditions is considered to be better than other cattle. Arado cattle are affected by diseases such as trypanosomosis, anthrax, bovine pasteurellosis and liver fluke. The most important constraints of Arado cattle production system were problems of grazing land, feed shortage, and disease, low productivity of cattle and shortage of veterinary service.

This work is a beginning in characterizing Arado cattle breed and their natural breeding tract. Thus, the following recommendations were forwarded in response to the status and performances of Arado cattle breed:

- The findings of the present study on the Arado cattle revealed that more systematic studies are needed to compare the production and reproductive performance of this breed of cattle with that of other indigenous cattle in Ethiopia.

- Further, molecular characterization of Arado cattle to determine their genetic constitution is essential.
- Work needs to be extended to include an examination of the physical characteristics of breeds in order to gain more comprehensive characterizations.
- Special attention is needed for the major constraints related with the management and husbandry practices of Arado cattle breed to improve the productivity.
- There is also a need for further work on the adaptability of these breeds, especially in terms of resistance to diseases, heat tolerance, work capacity and roughage utilization.
- Consider the possibility of selection and cross-breeding in locations where it is feasible with improved feeding and proper management systems.
- The targets of breed improvement should not be focused on few traits such as lactation yield but overall performance including adaptation traits to obtain a sustainable performance.
- The study further revealed an obvious need for more in-depth and objective information on wider samples of this type of indigenous cattle in order to assess the future need for conservation and improvement programs to be undertaken.
- Policy makers need to be concern and need to formulate enabling policies to avoid further erosion of adapted indigenous cattle.

7. REFERENCECES

Abereham, H. (2009): Phenotypic characterization of Begait cattle breed and their traditional production systems in West zone of Tigray, Northern Ethiopia. MSc thesis, School of Graduate Studies, Mekelle University, Mekelle, Ethiopia.

Addisu, B. and Prabhakar, H. B. (2003): Reproductive and growth performance of Fogera cattle and their F1 Friesian crosses at Metekel ranch, Ethiopia. In: Proceeding of the 10th Annual conference of the Ethiopian Society of Animal Production (ESAP), August 22-24, 2002, Addis Ababa, Ethiopia, Pp 407.

Al-Amin, M., Nahar, A., Bhuiyan, A. and Faruque, M. (2007): On-farm characterization and present status of North Bengal Grey cattle in Bangladesh; Department of Animal Breeding and Genetics, Bangladesh Agricultural University, and Department of Dairy Science, Bangladesh Agricultural University Mymensingh-2202, Bangladesh.

Alberro, M. and Haile-Mariam S. (1982): The indigenous cattle of Ethiopia Part I, FAO, *World Animal Review*, **41**, 2-10.

Alemayehu, M. (1987): Feed resources in Ethiopia. In: Proceedings on the second Animal feed resources for small-scale livestock producers, November 11-15 1985, Nairobi, Kenya, Pp 35-43.

Alim, K. A. (1960): Reproductive rates and milk yield of Kenana cattle in Sudan. *Journal of Agricultural Science*. ***55, 183-188.***

Anderson, S. (2003): Animal genetic resources and sustainable livelihoods. *Ecological Economics* **45**, 33-339.

Arrow, K. and Fisher, A. (1974): Environmental preservation, uncertainty, and irreversibility. *Quarterly Journal of Economics*, **98**, 85–106.

Arsham, H. (2007): Perturbed Matrix Inversion with Application to Linear Programs Simplex Method. *Applied Mathematics and Computation*, **188**, 801-807.

Ayalew, W., Rege, J.E.O., Getahun, E., Tibbo, M. and Mamo, Y. (2003): Delivering systematic information on indigenous animal genetic resources-the development and prospects. In: Proceeding of the Deutscher Tropentag Technological and Institutional, for Sustainable Rural Development, October 8-10, 2003, Gottingen, Germany, www.tropentag/ abstracts/full/28.pdf.

Ayele, S., Assegid, W., Jabbar, M., Ahmed, M. and Belachew, H., (2003): Livestock marketing in Ethiopia: A review of structure, performance and development initiatives. Socio-economic and Policy Research, *Working Paper 52*. ILRI (International Livestock Research Institute), Nairobi, Kenya, Pp 35.

Azage, T. and Alemu, G. (1997): Prospects of Peri-Urban Dairy Development in Ethiopia. In: Proceedings of the Fifth National Conference of the Ethiopian Society of *Animal Productio*n, May 15-17, 1997, Addis Ababa, Ethiopia. Pp 55-70.

Azage, T., Tesfaye, M., Tesfaye, D., Worku, T. and Eshete D. (2009): Transhumance cattle production system in North Gondar, Amhara Region, Ethiopia: Is it sustainable? IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project. *Working Paper No.14*. ILRI (International Livestock Research Institute), Nairobi, Kenya, Pp 73.

Befekadu, D. and Birhanu, N. (2000): Annual Report on the Ethiopian Economy: Volume **1**, 1999/2000. The Ethiopian Economics Association, Addis Ababa, Ethiopia, Pp 429.

Berihun, G. (2007): Domestic Animal Genetic Resources of Ethiopia, Animal Genetic Resources Department, IBC.

Beyene K. and Beruk, Y. (1992): Animal genetic resources and breed characterization work in Ethiopia. In: Proceedings of the Research Planning Workshop on African Animal Genetic Resources: their characterization, conservation and utilization, February 19 21, 1992, ILCA, Addis Ababa, Ethiopia.

BoARD, (2006): Asgede-Tsimbla woreda bureau of agriculture and rural development, Tigray Ethiopia.

BoANR, (1999): Livestock Census of Tigray Regional State, Bureau of Agriculture and Natural Resources. Mekelle, Ethiopia.

BoANR, (2003): Medebay-Zana, Bureau of Agriculture and Natural Resources. Tigray, Ethiopia.

BoANR (2007): Tahatay-Koraro, Bureau of Agriculture and Natural Resources. Tigray, Ethiopia.

CACC (Central Agricultural Census Commission) (2002): Ethiopian agricultural sample enumeration report, held 2001/02 (1994 EC). Addis Ababa, Ethiopia.

CSA (2008): Federal democratic republic of Ethiopia agricultural sample survey, volume II. Report on livestock and livestock characteristics (private peasant holdings), Addis Ababa, Pp183.

DEFRA (Department for Environment food and Rural Affairs) (2002): UK, country report on farm animal genetic resources, London, Pp 81.

Dennis, J. and Thiongane, A. (1978): Effect of intensive feeding on reproductive performance in female Gobra Zebu at the CRZ, Dehra. *Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux*, **31**, 85-90.

Duchev, Z. and Groeneveld, E. (2006): Improving the monitoring of animal genetic resources on National and International level. *Arch. Anim. Breed.* **49**, 532–544.

Ejigu, B. (2003): Opening address. In: Proceedings of the Ethiopian Dairy Master Plan Study Pre-planning Workshop, held at International Livestock Research Institute, 19 June 2003, Addis Ababa, Ethiopia, Pp 5-7.

Epstein, H. (1971): The origin of the domestic animals of Africa Volume I. Africana Publishing Corporation. New York. London, Pp 347-350.

FAO (1984): Animal genetic resource conservation by management, databanks and training. *Animal Production and Health, Paper No. 104. Rome.*

FAO (1986): Animal genetic resource data banks 2.Descriptor list for cattle, pigs, buffalo, sheep and goats. FAO, *Animal Production and Health paper* 59/2.FAO, Rome, Italy, Pp 150.

FAO (1998): Secondary guidelines for the development of national farm animal genetic resources management plans: management of small populations at risk. Rome.

FAO (1999): The global strategy for the management of farm animal genetic resources (Executive brief). Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO, (2000): World Watch List for Domestic Animal Diversity, 3rd (Ed), FAO, Rome, Italy.

Faulkner, D.E. and Epstein, H. (1957): The indigenous cattle of the British dependent territories in Africa. Colonial Advisory Council of Agriculture. *Animal Health and Forestry Publication* No 5.

Felleke, G. and Geda, G. (2001): The Ethiopian dairy development policy. In: A draft policy document. Addis Ababa, Ethiopia: Ministry of Agriculture/ AFRDRD/AFRDT Food and Agriculture Organization/SSF.

Gebeyehu G. (2005): Breeding efficiency, lifetime lactation and calving performance of Friesian-Boran crossbred cows at Cheffa farm. Livestock Research for Rural Development, Ethiopia, http://www.cipav.org.co/lrrd.

Getachew, A., Hailu, B., Workneh, N. and Gezahegn, A. (1993): A survey of the farming systems of Vertisol areas of the Ethiopian highlands. In: Improved Management of Vertisols for Sustainable Crop-livestock Production in the Ethiopian Highlands: Synthesis report. Addis Ababa, Ethiopia.

Gibson, J.P. and Pullin, S.V. (2005): Conservation of Livestock and Fish Genetic Resources. *Science Council Secretariat*, FAO.

Hailay, T. and Zekarais, G. (2000): Strategic Document on Irrigation Agronomy. The regional government of Tigray food security desk top, promotion of fruits.

Hall, S. J. G. and Ruane, J. (1993): Livestock breeds and their conservation – global review. *Conservation Biology*, 7, 815-825.

Hoffmann, I. and Scherf, B. (2005): Management of farm animal genetic diversity: opportunities and challenges. Book of the Year 2005, Pp 221-245.

IBC (2004): The State of Ethiopia's Farm Animal Genetic Resources. Country Report, a Contribution to the First Report on the State of the World's Animal Genetic Resources. Addis Ababa, Ethiopia.

Ibrahim, H. and Olaloku, E. (2002): Improving cattle for milk, meat and traction. ILRI, manual 4.ILRI (International Livestock Research Institute), Nairobi, Kenya, Pp 135.

ILCA (1992): African animal genetic resources: their characterization, conservation and utilization. In: Proceedings of the Research Planning Workshop held at ILCA, Addis Ababa, Ethiopia, Pp 73.

ILRI (International Livestock Research Institute), (1995): Livestock policy analysis. ILRI, Training Manual 2, Nairobi, Kenya, Pp 264.

ILRI (1998): (International Livestock Research Institute). ILRI 1997: Livestock people and the environment, ILRI, Nairobi, Kenya.

Jahnke, H. (1982): Livestock production systems and livestock development in tropical Africa. Kieler Wissensch. Verlag Vauk, Kiel, West Africa.

Kassahun, A. (2004): Operational policy instruments for conservation and Sustainable utilization of animal genetic resources (AnGR). In Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production (ESAP), August, 28-30, 2003. Addis Ababa, Ethiopia, 441 pp.

Kebebe, E., Tewodros, T. and Waktole, T. (2006): Sustainability of livelihoods strategies in Southern Ethiopia. In: Proceedings of the 3rd International Conference on the Ethiopian Economy. June 2-4, 2005. Addis Ababa, Ethiopia, Pp 187-212.

Kedija, H., Azage, T. Mohammed Y. and Berhanu, G. (2008): Traditional cow and camel milk production and marketing in agropastoral and mixed crop–livestock systems: The case of Mieso District, Oromia Regional State, Ethiopia. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers. *Project Working Paper* 13. ILRI (International Livestock Research Institute), Nairobi, Kenya, Pp 56.

Kurtu, M. (2003): Certain aspects of the dairy system in the Harar milk shed, eastern Ethiopia. PhD thesis, University of the Free State, Bloemfontein, Faculty of Natural and Agricultural Sciences, Department of Animal, Wildlife and Grassland Sciences, South Africa, Pp 195.

Mackechnie, J.D. and Meyn, K. (1991): Breed identification and development In: Cattle Genetics Resources. ed. C.G. Hickman. Elsevier, Amsterdam, Pp 201-219.

Mason, I. and Maule, J.P. (1960): The indigenous livestock of eastern and Southern Africa, Common wealth Agricultural Bureaux. Farnham Royal, Bucks England, Pp 76-77.

Matheron, G. and Planchenault, D. (1992): Breed characterization experience. In: Proceedings of the research Planning Workshop, February19-211992, ILCA (International Livestock Center for Africa), Addis Ababa, Ethiopia, Pp172.

Merha, Z. (2006): Genetic Diversity in Northern Ethiopian Cattle Breed: An on-Farm and Molecular Characterization, PhD Dissertation, Agricultural University, Wageningen, The Netherlands.

Milligan, K. and de Leeuw, P.N. (1983): The use of low-level aerial surveys for assessing numbers and distribution patterns of livestock and people and their relationships to environmental conditions. In: Proc. Workshop on Pastoral Systems Research in sub-Saharan Africa, ILCA, Addis Ababa, Ethiopia.

Mitiku, H. and Kebede, F. (1996): Soil and moisture conservation in the semi arid area of Ethiopia. In: Proceeding of the 3rd Conference of Ethiopian soil society, Pp 60-76.

Mukasa-Mugerwa, E. (1989): A review of a productive performance of female *Bos indicus* (zebu) cattle. ILCA, Monograph 6. ILCA, Addis Ababa, Ethiopia Pp134.

Mukasa-Mugerwa, E., Ephrem, B. and Tadese, T. (1983): Reproductive performance of indigenous cattle in the Adda district of central Ethiopia highlands. Mimeograph, International Livestock Center for Africa (ILCA). Addis Ababa, Ethiopia, Pp 90.

Musa, L., Peters K. and Ahmed, M-K. (2006): On farm characterization of Butana and Kenana cattle breed production systems in Sudan. Livestock research for rural development. Volume **18**, *Article* 177.

Natarajan, M. (1999): Strengthening the agricultural research and extension in Eritrea. Report of the consultation on Production/Farming Systems Agronomy. State of Eritrea Ministry of Agriculture, Department of Agricultural Research and Human Resources Development, Pp 48.

Niamir, F. (1999): Conflict management and mobility among pastoralists in Karamoja, Uganda. In: Niamir-Fuller M (ed), Managing mobility in African rangelands: The legitimization of transhumance. Beijer International Institute for Ecological Economics, Stockholm, Sweden.

Oqba-Michael, B. (2003): The state of Eritrea ministry of agriculture. Department of regulatory services, Plant health division.

Pamo, T. and Pieper, R. (2000): Introduction to range management in free and open access environments of sub-Saharan Africa. The Hague, the Netherlands.

Pashu-Palak, S. and Kohler-Roher-Rollefson, I. (2005): Indigenous Breeds, Local Communities Documenting Animal Breeds and Breeding from a Community Perspective. Mudra Sadri, Rajasthan, India.

Pearce, D. and Moran, D. (1994): The economic value of biodiversity. Earth scan, London.

Rege J.E.O. (1999): The state of African cattle genetic resources I. Classification framework and identification of threatened and extinct breeds. International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia.

Rege, J.E.O. and Gibson, J. (2003): Animal genetic resources and economic development: Issues in relation to economic valuation. *Ecological Economics,* **45**, 319-330.

Rege, J.E.O. (2001): Defining livestock breeds in the context of community-based management of farm animal genetic resources. In: Proceedings Workshop Community-Based Management of Animal Genetic Resources,* A Tool for Rural Development and Food

Security, organised by the GTZ and UNDP/FAO/SADC Animal Genetic Resources Project, 7_11 May, 2001, Mbabane, Swaziland.

Rege, J.E.O. and Okeyo, A.M. (2006): Improving our knowledge of tropical indigenous animal genetic resources. In: Animal Genetic Training Resource, version 2, 2006.Ojango, J. M., Malmfors, B. and Okeyo, A.M. (eds). International Livestock Research Institute, Nairobi, Kenya and Swedish University of Agricultural Sciences, Uppsala, Sweden.

Rege, J.E.O. and Tawah, C.L. (1999): The state of African cattle genetic resources II. Geographical distribution, characteristics and uses of present-day breeds and strains. FAO/UNEP *Animal Genetic Resources Information Bulletin.* **26**, 1-26.

Sada, I. (1968): The length of the gestation period, calving interval and service period in indigenous West African cattle: N'Dama, West African Shorthorn and Sokoto Gudale. *Ghana Journal of Agricultural Science, 1*, 91-97.

Saeed, A., Ward, P., Light, D., Durkin, J. and Wilson, R. (1987): Characterization of Kenana cattle at Um Banein, Sudan. ILCA Research Report 16. ILCA, Addis Ababa, Ethiopia. Pp 46.

Scarpa, R., Drucker, A.G., Anderson, S., Ferraes-Ehuan, N., and Gómez, V., Risopatrón, C.R. and Rubio-Leonel, O. (2003a): Valuing genetic resources in peasant economies: the case of 'hairless' Creole pigs in Yucatan. *Ecological Economics*, **45**, 427-443.

Scherf, B. Rischkowsky, B., Pilling, D. and Hoffmann, I. (2006): The state of the world's animal genetic resources. *World Congress of Genetics applied to Animal Production*, Belo Horizonte, Brazil.

Sintayehu Y., Fekadu B., Azage T. and Berhanu G. (2008): Dairy production, processing and marketing systems of Shashemene–Dilla area, South Ethiopia. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project, *Working Paper* 9, ILRI, Nairobi, Kenya, Pp 62.

Statistical Package for Social Sciences (SPSS) (2006): SPSS for windows. User's guide: Statistics version 15. Inc. Cary, NC.

Suzuki, K. (2005): Investigation into the Constraints to Dairy Cattle Health and Production in Northern Vietnam. A thesis submitted for the degree of Doctor of Philosophy. The Royal Veterinary College, and University of London.

Takele, T. (2005): On farm Phenotypic Characterization of Sheko Breed of Cattle and Their Habitat in Bench maji Zone, Ethiopia. MSc Thesis, Alemaya University, Ethiopia.

Thakendu, O. (2003): The concept of community ownership and mobilization: In proceeding of the Experiences from community-based natural resource management and Community-based management of animal genetic resources, May 7-11 2001, Mbabane, Swaziland, Pp121-125.

UNEP, (1995): Global Biodiversity Assessment. Cambridge University Press, England.

Workneh, A. and Rowlands, J. (2004): Design, execution and analysis of the livestock breed survey in Oromiya Regional State, Ethiopia. OADB (Oromiya Agricultural Development Bureau), Addis Ababa, Ethiopia, and ILRI (International Livestock Research Institute), Nairobi, Kenya, Pp 260.

8. APPENDICES

Appendices A: Questionnaires

Questionnaire number: _____ Date of interview ____ /____/
Enumerator name _____
Supervisor name:_____
Region name: _____
Zone name:_____
"Woreda" name: _____
Keble/Tabia/PA/ name:

1. Education level of the respondent:

A/ Illiterate _____ code no._____
B/ Read and write _____code no._____
C/ primary _____code no._____
D/ secondary _____code no._____
E/ Religious school _____code no._____

2. Household head

Position in household

1. Household head..... ☐
2. Spouse of head..... ☐
3. Brothers..... ☐
4. Sister..... ☐
5. Son..... ☐
6 /Daughters..... ☐
Other (Specify
7. ----------..... ☐

Sex of head Male..... ☐
Female..... ☐

Age (Yrs) ≤ 30 ☐
31-40 ☐
41-50 ☐
51-60 ☐
>70 ☐
Not known ☐

3.Tribe
Name----------
Code

4. Number of people residing in household
Males ☐
Females ☐
Children < 15 Yrs ☐

5. Land holding/ farm size
(enter X in box in first column if no known)

Area		Units (tick)	
Crops,,,,,,,	☐	Acres	☐
Gazing*,,,,	☐	Hectares...	☐
Forest,,,,,,,,	☐		

Total size ☐
*Other than communal

6. Land ownership
(Tick one or more)
Own..... ☐
Lease..... ☐
Other..... ☐

(Specify)----------

7. Livestock activity
Is livestock the major activity on your farm?
Yes ☐ No ☐

8. Livestock kept
(enter numbers in first column)

	Numbers	Most important species (rank up to 3: (1,2,3)
1. Cattle.....	☐	☐
2. Sheep.....	☐	☐
3. Goats.....	☐	☐
4. Chickens +...	☐	☐
5. Donkeys.....	☐	☐
Other (Specify)		
6. ----------	☐	☐

+ Adult birds only

8. Sources of income
(tick first column as appropriate, rank level of source of income in second column -1 highest.)

1. Crops ☐ ☐
2. Livestock and products* ☐ ☐
3. Home industries ☐ ☐
4. Salary/ wages ☐ ☐

Other (specify)
5. ---------- ☐ ☐

*Include the value of non-cash outputs or products e.g. manure traction etc.

10. Livestock production category
(divide numbers given in question 9. In to the following categories)

	Dairy	Meat	Dual Purpose
1. Cattle	☐	☐	☐
2. Sheep	☐	☐	☐
3. Goats	☐	☐	☐

Part 1. production System

(Tick one or more)

1. Industrial/intensive..... ☐
2. Semi-intensive..... ☐
3. Extensive/pastoral..... ☐
4. Free range/ backyard... ☐

Other (specify)
5. ---------- ☐

2. Mobility
1. Sedentary..... ☐
2. Transhumant.... ☐
3. Nomadic..... ☐

Others (specify)
4. ---------- ☐

3.Purpose of keeping cattle

Ask an open question and tick any purpose.. Then rank top three by writing

1. Meat_____
2. Milk _____
3. Work/draft_____
4. Stud breeding_____
5. Manure_____
6. Blood_____
7. Hide_____
8. Cash from sales_____
9. Investment_____
10. Dowry_____
11. Ceremonies_____
12. Cultural_____

Other (specify)

13. ---------- ☐ ☐

4. Members of household who own cattle Tick one or more)

Head..... ☐
Spouse..... ☐
Head/spouse together.... ☐
Sons..... ☐
Daughters..... ☐
Others*..... ☐

- Describe ----------

4. Members of household responsible for cattle activities

(tick as appropriate; more than one column in a row may be ticked)

	Adults Males	Adults Females	Boys (<15Y)	Girls (< 15Y)	Hreder
1. Purchasing cattle.....	☐	☐	☐	☐	☐
2. Selling/ slaughtering cattle.	☐	☐	☐	☐	☐
3. Herding.....	☐	☐	☐	☐	☐
4. Breeding decisions.....	☐	☐	☐	☐	☐
5. Feeding.....	☐	☐	☐	☐	☐
6. Milking.....	☐	☐	☐	☐	☐
7. Making dairy products.....	☐	☐	☐	☐	☐
8. Selling dairy products.....	☐	☐	☐	☐	☐
9. Animal health.....	☐	☐	☐	☐	☐
Other (specify)					
10. ----------	☐	☐	☐	☐	☐

5. Grazing/feeding

	Dry Season	Wet Season
1. Herded.....	☐	☐
2. Paddock.....	☐	☐
3. Tethered.....	☐	☐
4. Stall.....	☐	☐
5. Yard.....	☐	☐
6. Free grazing..	☐	☐

Other (specify)

7. ---------- ☐

7.Housing

	Dry season	Wet season
1. Kraal.....	☐	☐
2. Stall/shed.....	☐	☐
3. Yard.....	☐	☐
4. None.....	☐	☐

Other (specify)

1. ---------- ☐

Are calves housed together with adults?

Yes ☐ No ☐

Are calves grazed/fed together with adults?

Yes ☐ No ☐

Part 2: Cattle production system

If animals not housed go to question 10.

8. Materials used for housing
(Tick one or more)

1. Untreated wood/bush... ☐
2. Treated wood..... ☐
3. Iron sheets..... ☐
4. Stone..... ☐
5. Mud..... ☐
6. Wire..... ☐

Other (specify)

1. ---------- ☐
2. ---------- ☐

3. Form of housing
(Tick if present)

1. Roof..... ☐
2. Solid wall.... ☐
3. Floor..... ☐
   a. Concrete..... ☐
   b. Wooden..... ☐
   c. Earth..... ☐

4. Supplementation regime
(Tick as appropriate)

	Dry season	wet season
1. Roughage/crop residue	☐	☐
2. Minerals (salts) / vitamin....	☐	☐
3. Bought-in feed/ concentrates.....	☐	☐
4. None.....	☐	☐

Other (specify)

1. ---------- ☐ ☐
2. ---------- ☐ ☐

5. How cattle are watered

	Dry Season	wet Season
1. Animals go to water.....	☐	☐
2. Water if fetched/provided.....	☐	☐
3. Both.....	☐	☐

12. Source of water

	Dry season	Wet season
1. Borehole.....	☐	☐
2. Dam/pond.....	☐	☐
3. River.....	☐	☐
4. Water well.....	☐	☐
5. Spring.....	☐	☐
6. Municipal/piped.....	☐	☐

Other (specify)

6. ---------- ☐ ☐

13. Distance to watering point

	Dry season	Wet season
1. At household.....	☐	☐
2. <1km.....	☐	☐
3. 1-5km.....	☐	☐
4. 6-10 km.....	☐	☐
5. >10km.....	☐	☐

14. Frequency of watering

	Dry season	Wet season
1. Freely available.....	☐	☐
2. Once a day.....	☐	☐
3. Twice a day.....	☐	☐
4. Every other day.....	☐	☐
5. Once in 3 days.....	☐	☐
Other (specify)		
7.....	☐	☐

15. Water quality

(Tick one or more)	Dry season	Wet season
1. Good/ clear.....	☐	☐
2. Muddy.....	☐	☐
3. Salty.....	☐	☐
4. Smelly.....	☐	☐

16. Major cattle production constraints

1) _____
2) _____
3) _____
4) _____
5) _____

Part 3: Cattle health

1. Access to veterinary services

(Tick as appropriate)

1. Government vet.....	☐
2. Private vet.....	☐
3. Veterinary drug supplier	☐
4. Extension service.....	☐
5. None.....	☐
6. Other (specify)----------	☐

2. Prevalent diseases that occur on farm
(i.e. diseases that are seen by farmer in his animals)

If none tick this box ☐

Local name or symptoms of disease
(Rank. Most common first)

Code*

1. ----------
2. ----------
3. ----------
4. ----------
5. ----------
6. ----------

Are animals treated when sick?

Yes	No	Treatment given (if known)	code*
☐	☐	----------	☐
☐	☐	----------	☐
☐	☐	----------	☐
☐	☐	----------	☐
☐	☐	----------	☐
☐	☐	----------	☐

3. Vaccination/preventive treatments given

If none tick this box ☐

Local name or symptoms of disease	code *	Done Routinely (tick as appropriate)	Done when Need arises (tick as appropriate)
5. ----------	☐	☐	☐
6. ----------	☐	☐	☐
7. ----------	☐	☐	☐
8. ----------	☐	☐	☐
9. ----------	☐	☐	☐
10. ----------	☐	☐	☐

4. Ectoparasite control

Method	Done when need arises (Tick)	Done when need arises Season: dry	Done when need arises Season: wet	Done routinely Season: dry	Done routinely Season: wet
1. None	☐	☐	☐	☐	☐
2. Dip	☐	☐	☐	☐	☐
3. Spray	☐	☐	☐	☐	☐
4. Pour-on	☐	☐	☐	☐	☐
5. Hand dressing	☐	☐	☐	☐	☐
6. Inject able	☐	☐	☐	☐	☐
7. Traditional	☐	☐	☐	☐	☐

If traditional method specify ----------
Other (specify)

☐ ☐ ☐ ☐ ☐

If done routinely specify how often

	Dry season		set season	
Every	☐	weeks	every	☐ weeks
Every	☐	weeks	every	☐ weeks
Every	☐	weeks	every	☐ weeks
Every	☐	weeks	every	☐ weeks
Every	☐	weeks	every	☐ weeks
Every	☐	weeks	every	☐ weeks

Code ☐ (to be entered from list of traditional methods)

Every ☐ weeks every ☐ weeks

8. ----------

Part 4: Cattle castration/entries/exits/culling

Do you castrate? Yes ☐ No ☐

If yes, say why. (Tick one or more boxes)

1. Control breeding..... ☐
2. Improve meat quality..... ☐
3. Better price..... ☐
4. Better draft power..... ☐
5. Better temperament..... ☐

Other (specify)
6. ---------- ☐

And at what age? .....

4.Sale outlet (if sold in last 12 months)

Were animals sold? Yes ☐ No ☐

If yes tick one Or more boxes
1. Sold at auction ☐
2. Sold to butcher ☐
3.Sold privately ☐
4. Sold to abattoir ☐

Other (specify

5. ---------- ☐

1. Numbers of entries within last 12 months

For questions 2. And 3. First ask for information on calves and on others (i.e. weaners and adult's total). Then complete individual columns for weaners and adults if known. Enter X in a box if not known, 0 if answer

	Weaners and Adults				
	Adults			Total	
	Calves	Weaners	Males	Females	W + A
1. Born	☐				
2. Bought.....	☐	☐	☐	☐	☐
3. Donated/gift*...	☐	☐	☐	☐	☐
4. Exchanged/lent.	☐	☐	☐	☐	☐

*to include bride price and dowry

3. Numbers of exits within last 12 months

	Weaners and Adults				
	Adult				Total
	Calves	weaners	Males	Females	W+A
1. Died.....	☐	☐	☐	☐	☐
2. Sold	☐	☐	☐	☐	☐
3. Slaughtered....	☐	☐	☐	☐	☐
4. Donated/gift*..	☐	☐	☐	☐	☐
5. Exchanged.....	☐	☐	☐	☐	☐
6. Stolen.....	☐	☐	☐	☐	☐

*to include bride price and dowry

5. Reasons for culling/ disposal

Ask as open question and tick any answers given in first half of box, one or more boxes to be ticked. Then rank top three by writing in second half of box 1 for primary reason for culling, 2 for second and 3 for third.

	Males	Females
1. Size	☐☐	☐☐
2. Conformation/ shape	☐☐	☐☐
3. Colour	☐☐	☐☐
4. Temperament	☐☐	☐☐
5. Health	☐☐	☐☐
6. Body condition	☐☐	☐☐
7. Performance	☐☐	☐☐
8. Old age	☐☐	☐☐
9. Poor fertility	☐☐	☐☐
Other (Specify)		
10. ----------	☐☐	☐☐
11. ----------		

Part 5: Cattle breeding

1. Primary reason for keeping bull(s)
(Tick one)
   1. Breeding..... ☐
   2. Socio-cultural..... ☐
   3. Work/draft..... ☐

Other (specify)
4.---------- ☐

2. Reasons for choice of bull(s) for breeding
If breeding not done proceed to next page.

Ask an open question and tick any reason for choice considered in first half of box, one or more boxes to be ticked. Then rank to three by writing in second half of box 1 for primary reason for choice, 2 for second and 3 for third.

1. Size..... ☐☐
2. Conformation/shape..... ☐☐
3. Colour..... ☐☐
4. Horns..... ☐☐
5. Temperament..... ☐☐
6. Performance..... ☐☐
7. Availability (no choice) ... ☐☐

Other (specify)
8. ---------- ☐☐

☐☐

3.Matng

(Tick one or More boxes)
1. Uncontrolled ☐
2. Hand mating ☐
3. Group mating ☐
4. A.I. ☐

Other (specify) ☐

5.----------

4. Source and breed(s) used in the herd

Breed name(s) (specify _____

Breed type 1 (pure or cross)

Tick one or more boxes common name code*

1. Own bull (bred) ☐ ---------- ☐☐
2. Own bull (bought) ☐ ---------- ☐☐
3. Bull donated ☐ ---------- ☐☐
4. Bull borrowed ☐ ---------- ☐☐
5. A.I. ☐ ---------- ☐☐
6. Communal area bull ☐ ---------- ☐☐

Part 6: Arado cattle breed/age/sex structure

Common breed name_____

Local breed name_____

1. Trend with in herd (tick one)

Increasing ... ☐ Decreasing..... ☐

Stable..... ☐ Unknown..... ☐

2. Numbers by age and sex

(Enter X in box if not known)

	Calves	Weaners	Adults
Intact male	☐	☐	☐
Castrate	☐	☐	☐
Female	☐	☐	☐

How old is the oldest animal? ☐ Years

3. Origin/source of breed

1. Inherited..... ☐
2. Communal area form... ☐
3. Commercial farm*..... ☐
4. Market*..... ☐

*Specify location if known

---

5. Quality of traits perceived by owner

(Ask each question and for each trait tick one box, poor, average, good, no opinion)

	Poor	Average	Good	No opinion
1. Size	☐	☐	☐	☐
2. Conformation shape	☐	☐	☐	☐
3. Colour	☐	☐	☐	☐
4. Horns	☐	☐	☐	☐
5. Disease tolerance	☐	☐	☐	☐
6. Drought tolerance	☐	☐	☐	☐
7. Heat tolerance	☐	☐	☐	☐
8. Temperament	☐	☐	☐	☐
9. Work rate/drat power	☐	☐	☐	☐
10. Milk yield	☐	☐	☐	☐
11. Meat	☐	☐	☐	☐
12. Growth rate	☐	☐	☐	☐
13. Fertility	☐	☐	☐	☐
14.....Other (specify)	☐	☐	☐	☐

Part 6: Production characteristics of Arado cattle breed

1. Average age at sexual maturity

Male animals ☐ Months

Female animals ☐ Months

2. Age at first calving

Average ☐ months

Maximum ☐ months

Minimum ☐ months

3. Calving interval

Average ☐ months

Maximum ☐ months

Minimum ☐ months

4. Calving pattern, occurrence of most births

(Tick one or more boxes then rank top three in second half of box)

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

6. Is the breed milked?

Yes ☐ (Tick one box)

No ☐

7. Milk production per Animal per day

Average ☐ Liters*

Maximum ☐ Liters

Minimum ☐ Liters

*Assume 1 liter = 1 kg

8. Lactation length

Average ☐ Month

Maximum ☐ Months

Minimum ☐ Months

9. Frequency of milking
(Tick one box)

1. Ones a day
2. Twice a day
3. Three times a day

10. Average weaning age of calves

1. < 3 Months
2. 3-4 Months
3. 5-6 Months
4. > 6 Months

11. Milk feeding up to weaning
(Tick one box)

1. Unrestricted suckling
2. Restricted suckling
3. Bucket feeding

Other (specify)
4.----------

Appendices B: Check list for qualitative traits and morphometric measurements of Arado cattle

Part 1: Morphometric measurements of the cattle breed (cm)

Characteristic (Traits)	**Female**	**Male**
Neck length		
Pelvic width		
Canon bone length		
Canon bone circumferences		
Naval flap width		
Height at wither		
Chest girth		
Body length		
Ear length		
Head (face) length		
Tail length		
Horn length		
Teat length		
Perpetual sheath width		
Dewlap width		

Part 2: Qualitative traits of the Breed

Variables	Female	Male	Variables	Female	Male
Coat color pattern			**Ear shape**		
Uniform			Rounded		
Pied			Straight-edged		
Shaded			**Ear orientation**		
Coat color type			Upright		
White			horizontal		
Black			Dropping		
Fawn			**Rump shape**		
Gray			straight		
Red			sloppy		
Roan			**Hump size**		
Red drum			Absent		
Light Yellow			Small		
Red & white			Medium		
Black &white			Large		
white & brown			**Hump shape**		
Facial profile			Erect		
Slightly convex			Dropping		
Slightly concave			**Hump position**		
Strait			Thoracic		
Convex			Cervico- thoracic		
Concave			**Tail length**		
Dewlap			Short		
Absent			Medium		
Small			Long		
Medium			**Udder size**		
Large			Small		

Horn presence			Medium		
present			Large		
absent			**Teats size**		
Horn shape			Small		
straight			Medium		
Curved			Large		
Lyre- shaped			**Naval flap**		
Spiral			Absent		
Horn orientation			Small		
Forward			Medium		
Lateral			**Perpetual sheath**		
Upright			Small		
Dropping			Medium		
other (specify)			Large		
Back profile					
Slightly-hollow					
Straight					

Appendices C: Check list for group discussions

- What is the status of Arado 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

DECLARATION

I, the under signed, declare that this thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Name: Dessalegn Genzebu Weldegebriel

Signature _____

Academic Advisors	Signature
1. Dr. Mekonnen Hailemariam (DVM, MVSc, Associate professor)	_____
2. Dr. Kelay Belihu (DVM, PhD, Associate Professor)	_____

CURRICULUM VITAE

PERSONAL INFORMATION

Full Name	Dessalegn Genzebu Weldegebriel
Sex	Male
Place of birth	North West Zone of Tigray
Date of birth	19th March, 1984 G.C
Martial status	Single
Nationality	Ethiopian
Address	Tigray 0911007313
	0913144276

QUALIFICATION

- Bachelor of Science (BSc) in Animal Range and Wild life Science (ARWS)

EDUCATION

- 1993-1999 Elementary School Endabaguna, Asgede-Tsimbla.
- 2000 -2003 High school Shire secondary school, Tigray
- 2004-2006 Higher Institution Mekelle University, Mekelle, Tigray

WORK EXPERIENCE

2006-2007 Woreda livestock expert in Asgede-Tsimbla Woreda Bureau of Agriculture and Rural Development, Tigray, Ethiopia