COMMUNITY – BASED CHARACTERIZATION OF AFAR GOAT BREED AROUND AYSAITA DISTRICT OF AFAR REGION

M.Sc. THESIS

FEKI MISBAH

MARCH, 2013

JIMMA UNIVERSITY

COMMUNITY – BASED CHARACTERIZATION OF AFAR GOAT BREED AROUND AYSAITA DISTRICT OF AFAR REGION

M.Sc. THESIS

SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES JIMMA UNIVERSITY, COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCES IN AGRICULTURE (ANIMAL PRODUCTION)

BY
FEKI MISBAH

MARCH, 2013
JIMMA UNIVERSITY

APPROVAL SHEET OF MSc. THESIS
SCHOOL OF GRADUATE STUDIES
JIMMA UNIVERSITY

As Thesis Research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my guidance, by Feki Misbah, entitled **"Community-Based Characterization of Afar Goats Breeds ~~In~~in Aysaita District ~~Of~~of Afar Region**". I recommend that it can be submitted as fulfilling of the Thesis requirement.

Berhanu Belay (Ph-D)	_____	_____
Major Advisor	Signature	Date
Aynalem Haile (Ph-D)	_____	_____
Co-advisor	Signature	Date

As member of the *Board* of Examiners of the MSc Thesis Open Defense Examination, we Certify that we have read, evaluated the thesis prepared by Feki Misbah and examined the candidate. We recommended that the thesis is accepted as fulfilling the Thesis requirement for the Degree of Master of Science in Agriculture (Animal Production).

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Internal Examiner	Signature	Date
_____	_____	_____
External Examiner	Signature	Date

DEDICATION

I dedicate this thesis manuscript to my sister Tigist Degu and her husband Gashaw Ferede that ~~that~~ lost their life by car accident during their honeymoon. Rest in peace my good friends.

STATEMENT OF AUTHOR

I, the undersigned, declare that this thesis is my own original work and I have not previously in its entirety or part submitted to any institution for the award of any academic degree, diploma or certificate. I also believe that all sources of materials used for this thesis have been duly acknowledged.

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Name: Feki Misbah Nur

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Place: Jimma University, Jimma

Date of submission: _____

BIOGRAPHICAL SKETCH

The author was born on September 1979 in Assebe Teferi town, Ethiopia. He attended his elementary and secondary educations at Chiro Number One and Chercher comprehensive secondary schools in Assebe Teferi, respectively. He joined Haramay (formerly known as Alemaya) University in 2000 and graduated on July 2004 with the Ddegree of Bbachelor of sSciences in aAgriculture (in Animal Science) award.

In October 10, 2004, he was employed by the Ministry of Agriculture and served as an instructor in Gewane Agricultural Technical Vocational and Educational Training (ATVET) Collage for about three years. In November 2007, he joined Afar Pastoral and Agro--pastoral Research Institute (APARI) where he served as Assistant Researcher and director of Awra Pastoral and Agro--pastoral Research Center. In September 2010, he joined the School of Graduate Studies at Jimma University to pursue his graduate study in Master of Science study in Animal production

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I am very much grateful and would like to express my deepest respect to my major adviser Dr. Berhanu Belay for his profound and unreserved professional support, close supervision and guidance as well as for his intellectual inspiration. I am also thankful to my co-advisor Dr. Aynalem Haile for his nice reputation and proficient support in spite of his tight schedule.

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I would ~~finally~~ like to gratitude my colleagues and friends for their help and encouragement during my study. My particular regard goes to my exceptional friends Simon Seyoum (Info man), Ediget Ayele (the charming man), Hailye Nigusse (as strong as an axe), Simegne Kinfu (yeleje awaqi), Fuad Umer (sociable man), Getenesh Nega (Iron lady), Hassen yassin (chemitu sew),Ashenafi Atnafu (unbelievably kind guy) and Zelalem Wendimu (unpredictable man) and Nuru Ahmed (the Artist). My ~~particular~~ regard extends to ~~goes to Simon Seyoum~~Leyla Haji Suleyman, Tsedale Mola and Ahmed Ali (vet technician).

~~If I couldn't find you, I would have spent agonizing time.~~

Al last, comes my family and my brother Zuber Jemal; you are the reason why I am here!

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LIST OF ABBREVIATIONS

AnGR	Animal Genetic Resource
ANRS	Afar National Regional State
APARDB	Afar pastoral and Agricultural Rural Development Bureau
BCS	Body condition score
DA	Development Agents
FAnGR	Farm Animal Genetic Resource
FGD	Focus Group Discussion
GDP	Gross Domestic Product
HH	Household
ILRI	International Livestock Research Institute
IK	Indigenous Knowledge
LIFE	Local Livestock for Empowerment of Rural People
LPPS	Lokhit Pashu-Palak Sansthan, an Indian NGO
OADB	Oromiya Agricultural Development Bureau
PA	Peasant Association
PRA	Participatory Rural Appraisal
PPI	Pairs of Permanent Incisors;
PS	Production System
SAS	Statistical Analysis System
SPSS	Statistical Package for Social Science
SSA	Sub-Saharan Africa
WAD	West Africa Dwarf

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COMMUNITY – BASED CHARACTERIZATION OF AFAR GOAT BREED AROUND AYSAITA DISTRICT OF AFAR REGION

ABSTRACT

Characterization is the first step in any breed improvement and conservation strategy. This study was undertaken in Afar Region, Aysaita District with the aim of ~~documenting~~investigating the indigenous knowledge of the community in goat husbandry and breeding management as well as phenotypic performance of Afar goat breed in it environment. Purposive and random sampling techniques were employed to select ~~the PAs~~the PAs and households. Participatory Rural Appraisal (PRA) tools, semi-structured questionnaires, body measurements and recording morphological characters were employed to collect the data. A survey was conducted with 124 respondents (83 from two pastoral and 41 from one agropastoral PAs). A total of 891 ~~adult~~ goats above six months of age were used for physical description of the ~~goat~~ population. Descriptive and inferential statistics were employed to analyze qualitative and quantitative data. Indexes were calculated for all ranking data. The survey results showed that livestock and livestock products are the major source of income. Goats ranked first in pastoral and second in agropastoral area in their importance. Goats were mainly kept for milk production (I = 0.36), income source (I = 0.24), saving and insurance (I = 0.21) and fulfillment of social and cultural affairs (I = 0.14).The most preferred traits to be improved were milk yield (I=0.35), adaptation (I=0.14) and behavioral traits (I=0.10) for female goats, while body size and conformation (I=0.35) as well as coat color (I=0.20) were favored for males. Breed improvement is mainly undertaken through selection of male goats at juvenile age. Breeding males are mainly selected based on family history (I=0.30). Body size and conformation (I=0.27) are also important criteria in agropastoral system. The average flock size was 37.0 ± 25.0. There was significant variation ~~y~~ (P<0.01) in flock size between production systems and with flock size of 21.0 in agropastoral and 44.7 in pastoral areas. Flock structure~~s~~ ~~are~~ is dominated by breeding females which account 82.8% of the flock. The overall buck to does ratio was 1:13. Average age at sexual

maturity was 9.3 ± 3.3 months for female and 9.8 ± 2.2 months for males. Age at first kidding was 17.1 ± 2.3 months while the average kidding interval was 8.0 ± 0.97 months. The average number of kids born per breeding female is 1.4. The average daily milk yield was 1.1 ± 0.4 liter per doe for ~~an average~~an average lactation length of 2.7 months. The key identification features of the breed are their patchy (44.3%) and spotted (26.8%) coat color pattern and straight upward pointing horn (95.4%). Black coat color (46.6%), convex facial profile (49.9%), straight back profile (80.6%) and horizontal ears form (42.0%) are the dominant features. The overall mean body weight was 23.8 kg. Body measurements for males and females were (26.44 and 20.87 kg) for body weight, (64.8 and 59.5 cm) for chest girth, (63.1 and 58.9 cm)for body length, (59.6 and 55.4 cm) for height at wither, (13.3 and 12.4 cm) for pelvic width, (13.0 and 12.5 cm) for ear length and (26.44 and 20.87 cm) for horn length. In all measurements, males were significantly (P<0.01, P<0.05) ~~superior~~ heavier than females except ear length (P>0.05). Age significantly (P<0.05) influenced body measurements. Most body measurements increased consistently as age advances. Most of the linear parameters depicted positive and highly significant (P<0.01) correlation with body weight. The body weighs could be predicted with higher accuracy from heart girth, body length, wither height and body condition. About 81.5% of households practiced controlled mating through running selected buck in the flock (49.1%) and culling undesirable males and females (31.5%). The major source of breeding buck was own flock (83.1%) and inability to prevent mating among close family was higher (97%).The major threats in goat production were diseases (I=0.33), feed shortage (I=0.29), ~~extensive~~ expansion of crop, farming (I=0.21) and invasion of range land (I=0.13). It could be concluded that, goats are primarily preferred livestock species and adapted in arid environment and farmers have indigenous knowledge that favored some traits, which will suggest the introduction of community based genetic improvement coupled with improving management to benefit the households.

1. INTRODUCTION

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The livestock sector creates livelihoods for one billion of the worlds' poor. About 70% of the world's 880 million rural poor people are dependent on livestock for their livelihoods (World Bank, 2007). Livestock production in Ethiopia generates about 30-35% of the agricultural GDP, 19% of total GDP and more than 85% of farm cash income (Benin *et al*., 2006). Sheep and goats generate 40% of cash income earned by farm households and 25% of total domestic meat consumption (Hirpa and Abebe, 2008). Goats, specifically, accounts an estimated 13.9% and 10.5% of the total meat and milk production of domestic animals (FAO, 1999).

Goat populations of Africa were estimated to be about 159 million head. This estimate represents about 32% of the world's goat population. Agro-ecologically, the arid and semi-arid zones which predominantly practice pastoral-nomadic system of livestock production allocate 66% of African goat population (Kiwuwa, 1992). Ethiopia shares about 13.5% of the African goat population (FAO, 1991), the majority of these populations (about 70%) are located in the arid and semi – arid areas where they are kept in large flocks by pastoralists (FARM Africa, 1996).

The distribution trend indicate that greater part of the breeds inhabit in the intricate climatic areas. The type of goat breeds in these unfavorable environment are determined by the ability to survival under the prevailing fluctuating feed scarcity, disease challenges, low level of management and harsh climate (Laird, 2002). The uncertain climate and attacks by diseases forces the rural communities to minimize their risks rather than trying to maximize yields with high-performance breeds (Markos, 2008). Therefore, animals found in these areas are the result of many generations of human and natural selection to fit a specific set of circumstances and to fulfill certain functions (FAO, 2009)., as a result they are the best genotypes. That is why breeding strategies in these area face contradictions between adaptation and absolute productivity (Kiwuwa, 1992).

Genetic improvement is currently being centered on indigenous breeds because they have long been adapted to extreme harsh environmental conditions of nutrition, climate and disease and might be more productive in their own environment than the exotic breeds (Rege, 2003). They

can also be valuable experimental animals in fundamental research and a potential store of unique genes, which may be useful especially when environmental concerns necessitate changes in production system (Salako and Ngere, 2002).

Maintenance of livestock genetic diversity is mandated by the Convention on Biological Diversity (CBD), which calls for the conservation of agro biodiversity in the environment that have nurtured and shaped it (LPPS and Koehler, 2005). The needs for conservation of genetic resource have been understood and different conservation methods (in – situe and ex – situe) are on the way. Consequently, Ccomprehensive documentation of the breeds is considered necessary for sustainable use and conservation of domestic animal genetic resources. Attempts were so far made to document local indigenous breeds in Ethiopia and elsewhere in the tropics following the conventional methodological approaches.

The first conventional characterization of indigenous goat breeds of Ethiopia appeared in the series of surveys summarized by FARM-Africa (1996) which produced phenotypic descriptions as well as preliminary reproductive performance indicators. However, the work does not provide detail information on the production characteristics for the breed cited, breeding objective, and reproductive performance. The information should also be updated and enriched as new breeds may evolve, change in physical feature may happen and major changes develop in breeding objectives or production as well as market circumstances.

The conventional breed characterization lacks as well the information that the breeds contribution to the livelihoods of household. Especially in marginal and remote areas, cash products are often of secondary importance. In smallholder and pastoral systems, goats fulfilfulfill many functions going beyond the production of meat and milk, representing a means of saving and investment as well as a buffer against crop failure, and playing an important cultural and religious role (LPPS and Koehler, 2005; FAO, 2009). Beside, conventional breed descriptions have another critical lacuna. They fail to acknowledge and document the role of associated livestock keeping communities and their indigenous knowledge in shaping and managing the breed. Ignoring such wealth of knowledge could partly be the reason why livestock genetic improvement programmes have generally failed in many developing tropical countries (Sölkner *et al.*, 1998; Rege, 2003; Philipsson *et al.*, 2006).

In an attempt to fill these methodological gaps, the "people-centered" breed characterization method has recently emerged with a more participatory approach to documenting animal genetic resources. It recognizes indigenous animal genetic resources as results of both deliberate and non-deliberate manipulation of the gene pool by local communities for ecologically and socio-culturally determined preferences. The conceptual approach is hence to document breeds based on the knowledge, concepts and priorities of the associated communities (LPPS and Koehler, 2005). The methodology is not a fixed "recipe" merely meant to replace the conventional phenotypic characterization. It is rather a flexible approach that can be applied with phenotypic description of the animal genetic resource to augment the latter's scope with socio-cultural, indigenous knowledge and livelihood contexts.

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Applying such holistic approaches in characterization of indigenous livestock breeds in the country will be crucial in improving the success prospects of ongoing as well as future community-based breeding schemes. It has been tested with cattle, buffalo, and sheep in Asia & Africa, and mainly in pastoral contexts (Rege, 2003; LPPS and Köhler-Rollefson, 2005). Community-based breed characterization has been initiated in the country with sheep breed aiming community-based breed improvement strategy (Duguma *et al.*, 2010; Tadele, 2010). There is little evidence in community-based breed characterization for goats. Therefore, documentation of the Afar goat breed with the participation of the community is timely and the current study is designed with the objectives of:

1. Community – based characterization of Afar goat breed in its environment;
2. Participatory definition of local trait preferences and breeding objectives;
3. ~~Document~~Investigate the community's indigenous knowledge and traditional system in breeding management as well as general husbandry practices.

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~~2.~~ ~~LITERATURE~~2. LITERATURE REVIEW

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2.1 Origin and Classification of Ethiopian Indigenous Goats

Goat is believed to be the first domesticated ruminant before 7000 BC in Southwest Asia. The domestic goat belongs to the genus *Capra* and believed possibly developed from the following five wild species: *Capra hircus*, the true goat including the bezoar (C.*h. aegagrus*); *Capra ibex*, the ibexes; *Capra*~~–~~ *caucasica*, the Caucasian tur; *Capra pyrenaica*, the Spanish ibex; *Capra falconeri*, the markhor (Devendra and Mcleroy, 1982). Although not certain, based on some morphological indication, the bezoar of Western Asia is believed to be the main ancestor of most domestic goats today (Epstein 1971; Devendra and Mcleroy, 1982). In synthesizing the origin of indigenous goats of Africa, Epstein (1971) categorized goats of the continent into three classes of origin namely: the dwarf goats of central and West Africa, the Nubian goat and its relatives and the savanna goats.

Almost all of the savanna goats of Africa appear to have descended from their wild ~~ancestors~~ancestors' *C. h. aegagrus* ~~-~~and *C. h. falconeri* in an area of western Asia that extends to parts of the present day Jordan, Iraq and Iran. The original foundation stock in Asia that absorbed *C. h. falconeri* and *C. h. aegagrus* blood were thought getting into Africa ~~thru~~ through Egyptian route. Almost all the remaining indigenous goats of Ethiopia belong to this class (Epstein, 1971).

Indigenous Ethiopian goat genetic resources have been classified in to three major families and 12 breeds based on physical description using multivariate analysis (FARM-Africa, 1996). These are~~:~~: - the Somali family (Short-eared Somali, Long-eared Somali and Hararghe Highland), the smaller Rift Valley family (Abergelle, Worro~~e~~, Afar, Arsi-Bale and Woyto-Guji) and finally the more heterogeneous Small East African family (West Highland, Keffa, Central Highland and West Lowland).

However, Tesfaye (2004) using Microsatellite DNA Markers cluster them in to eight distinct genetic entities: Arsi-Bale, Woyto-Guji, Abergalle, Afar, Keffa, Gumez (West Lowland), Highland goats (previously separated as Central and North West Highland) and the goats from the previously known Hararghe, Southeastern Bale and Southern Sidamo provinces (Hararghe

Highland, Short-eared Somali and Long-eared Somali goats). Moreover, Tesfaye (2004) indicates that about 75% of the total genetic diversity of the Ethiopian goats is present in four breeds: Afar, Abergalle, Gumez and Keffa with marginal loss of diversity of 24.32%, 19.22%, 16.59% and 12.99%, respectively.

2.2 Significance of Goat in Pastoral Production System

Goat husbandry practices in Africa follow the diverse agro-ecologies (classified depending on altitude and rainfall) prevalent across the continent, and are broadly classified as pastoral, agro-pastoral, mixed and commercial systems (Peacock, 2005).

The majority of goat populations, about 66%, are located in arid and semi-arid zones of Africa where the owners pursue a pastoral - nomadic production system which is ecologically imposed but makes full exploitation of arid and semi-arid ranges possible. The arid and semi-arid lowlands are characterized by high spatial and temporal variability in rainfall distribution and pattern. In such conditions meaningful crop production cannot be attained in rain-fed agriculture and extensive livestock production appears to be a better means of exploiting the grazing and browse resources in the arid and semi-arid lowlands (Kiwuwa, 1992; Adugna and Aster, 2007).

Goats are the dominant livestock species in the most inhospitable areas including humid agro-ecologies (Table 1). In these eco-zones browsing and grazing converts the local vegetation into food and energy that can sustain people. Consequently, increases productivity of the land which otherwise be unexploited (Kiwuwa, 1992).

Table 1 Distribution of Ethiopian Goats by Agro-Ecological Zone[a]

Zone	Land area %	Goats population (%)	Human population %
Arid	44.5	38.0	5.6
Semi-arid	10.1	22.0	43.4
Sub-humid	7.7	5.0	4.9
Humid		3.0	2.5
Highland	37.7	32.0	43.6

~~aAdapted from Jahnke (1983).~~

~~In smallholder and pastoral systems, goats fulfils many functions going beyond the production of meat and milk including the provision of fertilizer, to generate income, representing a means of saving and investment as well as a buffer against crop failure, and playing an important cultural and religious role (LPPS and Koehler, 2005; FAO, 2009)~~

2.2~~3~~ Characterization of Pastoral Production System

Despite the recognized importance of smallholder and pastoral livestock production for the livelihoods of numerous poor people, there are no internationally agreed definitions of pastoralists and smallholder farmers. Smallholder production is often used interchangeably with small-scale, subsistence and family farming, resource-poor, low-income, low external input, low output or low-technology livestock farming. Furthermore, some recent definitions include pastoralists among smallholder farmers (FAO, 2009).

Pastoralists have been defined based on the contribution of livestock to agricultural income and the agro-ecological context in which they operate (FAO, 2007). Another definition groups them according to their mobility ranging from entirely mobile "exclusive pastoralists" to semi-settled "agropastoralists". "Exclusive pastoralists" are livestock producers who have no permanent settlements, grow no crops and depend on the sales of animals and livestock products to buy grain. Some communities migrate over long distances, commonly along set routes where they may have standing agreements with farmers to make use of their crop residues. Other pastoral groups may move their herds only short distances between wet and dry season pastures. "Transhumant pastoralists" have a permanent homestead, grow some crops mostly for home use, and may move only parts of their herds in search of grazing. "Agropastoralists" are semi-settled, hold land-rights and grow their own staple crops and sometimes crops for sale (Blench, 1999; FAO, 2009).

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The herds of agropastoralists are often smaller than other pastoral systems (Blench, 1999) which can be quite large, because livestock is the main asset in these systems and the pastoralists need a minimum number of livestock to resist drought cycles. In reality, the systems often overlap. Settlement politics, economic development and changing environments further reduce the differences and move the balance more and more towards agropastoralism (FAO, 2009).

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Goat husbandry practices in Africa follow the diverse agro–ecologies (classified depending on altitude and rainfall) prevalent across the continent, and are broadly classified as pastoral, agro–pastoral, mixed and commercial systems (Peacock, 2005).

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Goats are the dominant livestock species in the most inhospitable areas including humid agro – ecologies (Table 1). Arid and semi-arid zones constitute 60% of goat population (Table 1). Though the report of Jahnke (1983) seems old, FARM-Africa (1996) also stated that about 70% of Ethiopian goat population inhabiting in arid and semi-arid lowland areas. In these eco-zones browsing and grazing converts the local vegetation into food and energy that can sustain people. Consequently, increases productivity of the land which otherwise be unexploited (Kiwuwa, 1992).

Table 11 Distribution of Ethiopian goats by agro-ecological zone[a]

Zone	Land area %	Goats population (%)	Human population %
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Semi-arid	10.1	22.0	43.4

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Humid		3.0	2.5
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2.4 Farm Animal Genetic Resource (FAnGR) Conservation

FAO (2001) comprehensively defines FAnGR Conservation as: *"All human activities including strategies, plans, policies and actions undertaken to ensure that the diversity of farm animal genetic resources is being maintained to contribute to food and agricultural production and productivity, now and in the future."*

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Farm animal genetic resource can be conserved either in *in-situ* or *ex-situ* (in-vitro & in-vivo) or a combination of them. *In situ* conservation of farm animal genetic diversity refers all measures to maintain live animal breeding populations, including those involved in active breeding programmes in the agro-ecosystem where they either developed or are now normally found, together with husbandry activities that are carried out to ensure the continued contribution of these resources to sustainable food and agricultural production, currently and in the future (FAO, 2001).

Livestock are far from uniform. There is considerable variation within the main domesticated species of cattle, sheep, goats, camels and chickens. Over millennia, livestock holders have created a vast range of different breeds, each with specific characteristics, and each adapted to the conditions where it was developed. They carry genes that enable them to cope with difficult environments, thrive on thorny vegetation in drought-prone areas, walk long distances, and resist pest and disease attacks (Köhler-Rollefson, 2000; Markos, 2008). But many traditional livestock

breeds are in danger. They are dying out because of crossbreeding, the expansion of intensive agriculture and of wildlife reserves of range lands, changes in the economy, and other factors. Already, 17% of livestock mammals – over 900 of 5330 breeds – are extinct, and another 29% (1500 breeds) are thought to be endangered (Geerlings, 2001).

Modern agriculture relies on a few high-performance animal breeds. These breeds grow quickly, produce gallons of milk or crateful of eggs. But they rely on good-quality feed and a constant flow of medicines to keep them healthy. And the gene pool of high-performance breeds is becoming ever shallower: intensive selection, artificial insemination and other breeding techniques have squeezed most of the diversity from these breeds, and herds are becoming more and more uniform. That is risky: a disease outbreak could suddenly wipe out entire national herds, ruining a country's farm economy, destroying rural communities, and leaving consumers "hungry and angry." (Köhler-Rollefson and Wanyama, 2003; LPPS and Köhler-Rollefson, 2005)

Traditional breeds provide the genetic diversity that modern agriculture needs to ensure stability. They are vital building blocks for future livestock breeding. Conserving them is important, not only for the communities that keep them, but also for the future of modern agriculture. Conserving livestock breeds is possible only if (a) the breeds are first identified and adequately documented, and (b) if the communities which keep the animals participate fully in conservation efforts (Geerlings, 2001; LPPS and Köhler-Rollefson, 2005).

2.5 Breed Characterizations

A recent comprehensive definition of characterization (Rege and Okeyo, 2006) describes it as the distillation of all knowledge which contributes to the reliable prediction of genetic performance of an animal genetic resource in a defined environment and provides a basis for distinguishing between different AnGR and for assessing available diversity. Characterization thus includes a clear description of the origin, development, population size, structure, distribution, typical features and phenotypic characteristics of these resources in defined management and climatic environments (Workneh *et al.*, 2004; Rege and Okeyo, 2006). Rege and Okeyo (2006) divides the animal phenotypes of interest into three main categories: 1) physical description or measurements; 2) performance characteristics; and 3) adaptation to the environment. Phenotype

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is a result of both genotype and the environment. Phenotypic characterization is therefore complementary to the powerful biotechnological techniques for measuring genetic diversity on the genome (Cunningham, 1992). Characterization of AnGR, hence requires that data be collected on all these features (Rege and Okeyo, 2006). Besides, such baseline information is essential to establish country, Region~~region~~al and global priorities for the management of animal genetic resources (Cunningham, 1992)

Physical description can be particularly useful in the classification of populations/strains/breeds within a species. These should include both qualitative (e.g. presence or absence of horn, beard, wattles, ruff; and ear form, horn orientation, coat ~~colour~~color etc.) and quantitative (e.g. height, body length, chest girth, body weight, ear length etc.) ~~parameters~~Parameters (FAO, ~~–~~1986). Performance characteristics are the traits most familiar to animal breeders. They include reproductive (milk yield, growth and carcass quality) and reproductive traits (age at first parturition, calving interval, longevity, prolificacy etc.)

The first conventional characterization of indigenous goat population of Ethiopia appeared in the series of surveys summarized in the ILRI monograph by FARM-Africa (1996). FARM-Africa (1996) used physical measurements to classify heterogeneous, previously unclassified indigenous Ethiopian goat populations into taxonomically distinct, relatively similar entities or groups. Besides, it produced the general management as well as preliminary reproductive performance indicators. However, the work lacks a detail description of production characteristics, ~~owners~~owners' trait preference and breeding objective, reproductive performance, most of all documentation of indigenous knowledge on breeding managements.

Adaptive characteristics include such traits as disease resistance, cold tolerance, heat tolerance, ability to utilize low quality feeds, selective grazing etc. Indigenous tropical livestock have, through millennia of exposure to the rigors of the tropical environment, evolved coping mechanisms. Adaptive traits are probably the least studied in tropical livestock. Ironically, it is precisely because indigenous tropical breeds possess these characteristics that they need to be studied and conserved and genetically improved. Admittedly, studying these complex traits is an expensive enterprise. Yet, without adequate characterization of individual traits, including

estimation of relevant genetic parameters, it is impossible to incorporate them into meaningful breeding programmes (Köhler-Rollefson and Rathore, 2005; FAO, 2009)

To the extent that production environments affect the development and utility of livestock breeds over time and space, ~~characterisation~~characterization of the phenotypes also include description of the production environments with respect to relevant input-output relationships. These relationships can have biological, climatic, economic, social and cultural dimensions (FAO, 1986). Baker and Gray (2003) stressed the significances of understanding a production system and the relative importance of the different constraints prior to initiating any genetic improvement programme. For example, in a study of adoption of indigenous X exotic crossbred goats in smallholder production systems in Ethiopian highlands, Ayalew *et al.* (2003) found that the non-genetic improvement strategies – better feeding practices and greater attention to basic healthcare - were more successful than genetic strategies alone. To sum it up, greater care should be taken to better design breeding strategies for traditional low- and medium-input systems which are generally livelihood-oriented for best utilization of the breeds that would otherwise be unfairly condemned or ignored (Rege and Okeyo, 2006).

2.5.1 Community – based breed characterization

Community based breed characterization was a comprehensive term recently developed to augment the conventional method which basically neglect the indigenous knowledge of the community in characterizing their AnGR and the livelihood significances of the breed to the society. Köhler-Rollefson and Rathore (2005) stressed that improvement and conservation of livestock breeds is possible only if the breeds are first identified and adequately documented with the involvement of the community, and if the communities which keep the animals participate fully in conservation efforts.

2.5.1.1 The involvement of indigenous knowledge (IK)

Mathias (1995) ~~definition~~ defines indigenous knowledge beautifully as "The body of knowledge acquired by a community in any given area and relating to agriculture, livestock rearing, food preparation, education, institutional management, natural resource management, health care and other pertinent subjects. It is regarded as a valuable resource for development activities that may

be equal or even superior to the knowledge introduced by outsiders and should therefore be considered and applied in development projects wherever suitable."

It is not through the keeping of animals per se, but rather the combination of rural peoples' knowledge of their environment and the way that they manage their livestock that maintains domestic animal diversity. This knowledge includes the recognition and evaluation of livestock characteristics and breeds or 'types'; the management of animal and plant genetic resources and how these interact in the production system; and ethno-veterinary knowledge (Rege and Okeyo, 2006). This rather extensive and complex knowledge system has not been adequately characterized and documented. Where documentation has been done, it has not been integrative enough to be applied in selection programmes although the indigenous knowledge on livestock from livestock keepers, especially the pastoralist, can be complex and may be even more sophisticated than generally believed (Wurzinger *et al.*, 2005). This is primarily because 'experts' often do not appreciate the value of this knowledge. However, the communities know better than anyone else the special characteristics of their animals. While scientists can quantify many aspects of indigenous breeds under the controlled conditions of a research station, it is the communities who are familiar with the qualitative traits that are so important for survival and subsistence in harsh environments (Köhler-Rollefson, 2000).

Definition of comprehensive breeding objectives has been and would be impossible without inclusion of indigenous knowledge. Ignoring such wealth of knowledge could partly be the reason why livestock genetic improvement programmes that are solely based on pre-determined Western designs and structures have generally failed in many developing tropical countries (Philipsson *et al.*, 2006). But it is possible to build on indigenous knowledge and use it as a starting point for development interventions. Projects that do so have the potential to generate large benefits for the communities and for the sustainable utilization of marginal environments. Such an approach could form the basis of endogenous, bottom-up development (Köhler-Rollefson, 2000; Laird, 2002).

Domestic animal diversity is ecologically and culturally embedded. Therefore, the knowledge of local people extends beyond the breeds themselves to the complex web of interactions between

the animals and the environments in which they are kept, including the beliefs and cultures of the communities that keep them (Rege and Okeyo, 2006). This knowledge system is crucial, not only in understanding the history and nature of existing diversity in animal populations, but also as a basis for developing strategies for its continued maintenance and sustainable exploitation (e.g. niche markets) in a way that accommodates the lifestyles, aspirations and livelihoods of the keepers. This is the only way that characterization information can lead to formulation of sustainable utilization and in turn, conservation of indigenous AnGR (Wurzinger *et al.*, 2005).

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2.6 Reproductive Performances of Indigenous Goat Breeds

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Good reproductive performance is a prerequisite for any successful livestock production programme (Wilson, 1995). Reproductive parameters heavily influence genetic improvement through their impact on selection intensity. As a result, adequate knowledge on reproductive performances of the indigenous breeds is crucial for planning a feasible breeding scheme. However, information on the reproductive traits of indigenous goat breeds is scarce and whatever information available in the literatures is inconsistent (Mekasha, 2007).

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The reproductive performances (such as age at puberty, age at first parturition, parturition interval, litter size, fertility rate etc.) of an animal~~s~~ ~~can~~ varies based on many factors like genotype, nutrition, production system and the social and livelihood significances they are bred for as well as other environmental factors (Wilson, 1995; Workneh and ~~Rowlands~~Rowland, 2004). Table 2 summarizes some reproductive performances of indigenous goat breeds across different production system.

Table 2~~2~~ Reproductive p~~P~~erformances of i~~I~~ndigenous g~~G~~oats in different a~~A~~gro – e~~E~~cologies[a]

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Traits	Production systems			Total
	Agropastoral	Pastoral	Crop-livestock	
Age at sexual maturity				
Male (months)	11.3	14.0	7.8	8.3
Female (months)	10.8	13.7	7.8	8.2

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Age at 1st service (months)	15.3	19.6	13.1	13.6
Average calving interval (months)	8.9	8.4	9.1	9.0
Fertility (%)[b]	48.9	49.3	69.8	63.8

[a]Adapted from Workneh and ~~Rowlands~~Rowland (2004)
[b] Fertility = (Total goat births/t~~T~~otal ~~adult~~ mature female goats)*100%

Age at first service (AFS) of female and male goats

Age at sexual maturity or age at first service (AFS) refers the physiological stage of the goat that enables a doe to conceive and bear kid. AFS vary among and within breeds, agro-ecology and management condition. However, AFS is related more closely to ~~mature~~ adult weight than to age and usually occurs at about 60 – 70% of adult weight for that breed, which is relatively later than in males (Payne and Wilson, 1999). AFS of 7 – 8 months were reported around Awassa (Markos, 2000). However, a longer age at fist service (20 months) was indicated for pastoral production systems (Workneh and ~~Rowlands~~Rowland, 2004). Age at first service~~FS~~ of 8.2 and 9.8 months were mentioned for A~~a~~bergalle (Tesfaye, 2009) and S~~s~~idama (Endeshaw, 2007) goat types, respectively in the country. Payne and Wilson (1999) reported age at sexual maturity of 4-6 months for tropical female goats.

Age at first mating or sexual maturity for male is the age at which spermatozoa appear in the ejaculate and up on mating can cause effective fertilization. Age at sexual maturity of 132 days was reported for Tropical male goats (Payne and Wilson, 1999). A wide variation of AFS of male was reported for mixed farming and pastoral system in Ethiopia with a mean value of 8.3 months (Table 2). AFS of 12 months was reported for goats around Awassa woreda (Markos, 2000) and 7.4 months for goat type around Metema (Tesfaye, 2009).

Age at first parturition (AFP)

Where breeding males are available in the flocks, age at first parturition is a good indicator of early sexual maturity in does. It is an economically important trait as greater population turnover and more rapid genetic progress can be obtained when goats produce their first progeny at an

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earlier rather than later age. Early maturing females are also known to have a relatively long and fruitful reproductive life (Wilson, 1995; Bourdon, 2000)

Age at first parturition of 9.3 – 18.5 months was reported for Sub-Saharan Africa (SSA) goats (Wilson, 1995). Most local breeds of Ethiopia fall in the range of SSA goats with little in favor of giving the first birth at early age. AFP of 12.5 months was reported for small east African family goat in Jimma zone (Belete, 2009); 13.6 months for goat population around M~~m~~etema (Tesfaye, 2009) and 15 months for goat type in Sidama zone (Endeshaw, 2007). However, a longer AFP of about 20 months was reported for goats kept under pastoral production systems (Grum, 2010)

Fertility and parturition interval

Fertility is oftentimes used as synonym of prolificacy. However, prolificacy is different from fertility though to be prolific an animal must be highly fertile. Wilson (1995) defines fertility as the number of parturitions per female of breeding age per year. Bourdon (2000) expresses it as percent does kidding of breeding females in the herd over the period of a year. Fertility for does in SSA were reported to concentrate between 71.4 to 160 percent. On the other hand, a lower fertility rate of 63.8 percent was reported for indigenous does varying from 70 to 49 percent for crop-livestock and pastoral/agropastoral production systems, respectively (Workneh and ~~Rowlands~~Rowland, 2004).

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Parturition interval is the interval between two successive kidding. Parturition interval for does in SSA was indicated to vary from 7.6 months for West African dwarf (WAD) goats in Côte d'Ivoire to 13.6 months for Landim breed in Mozambique (Wilson, 1995). WAD goats mentioned to be among the most fertile breeds in the tropics. On a research station in Ghana where WAD goats were left free to breed and to forage, about 65 percent of does gave birth twice in 12 months with parturition intervals ranging from 175 to 183 days (Payne and Wilson, 1999). Different studies under various agro-ecology of the country ~~reviled~~ revealed parturition interval of 7.9 month in Goma district (Belete, 2009), 8.4 month in Metema (Tesfaye, 2009), 8.6 months in Sidama zone (Endeshaw, 2007). Average parturition interval of 6.1 months (Grum, 2010) and 8.1 months (Dereje, 2011) ~~months~~ were also reported for short-eared Somali and Harerghe highland goat breeds, respectively ~~(Grum, 2010; Dereje, 2011)~~.

2.7 Body Weight and Linear Body Measurements

Body measurements are quantitative parameters that are helpful to describe a breed or type jointly with the breed's morphological characteristics and the environment it inhabited. Body size appears to be a valuable criterion as it also gives clue to the performance orientation of the animals for meat or milk (Workneh, 1992; Solomon and Kassahun, 2009). Devendra and Mcleroy (19829~~2~~) take account body size to segregate goats in to three clusters: 1) Large breeds – wither height over 65 cm, weighting 20 – 63 kg and dual purpose in function; 2) Small – wither height 51 – 65 cm, weighting 19 – 37 kg and meat or milk producers; 3) Dwarf – wither height under 50 cm, weighting 18 – 25kg and used mainly for meat production.

Moreover, body measurements are considered as qualitative growth indicators which reflect the conformational changes occurring during the life span of animals. ~~Some b~~Body measurements of indigenous goat breeds were presented in Table 3. Although live body weight is an important growth and economic trait, it is not always possible to measure it due to mainly the lack of weighing scales, particularly in rural areas. However, body weight can ~~be~~ reasonably be estimated from other body measurements which show strong association (Fajemilehin and Salako, 2008; Leng *et al*., 2010)

Table 3~~3~~ Body measurements of local goat breeds[a]

Breed types	~~w~~wither height (cm)		Weight (Kg)		Chest girth (cm)		Ear length (cm)		Horn length (cm)		sources
	M	F	M	F	M	F	M	F	M	F	
Afar	64.5	60.9	31.3	23.7	74.6	67.4	12.4	12.3	29.8	17.4	Nigatu (1994)
Abergelle	71.4	65.0	33.6	28.4	79.5	71.2	13.0	12.7	37.0	19.6	Nigatu (1994)
Arsi-bale	73.2	66.1	42.1	30.4	85.0	74.9	14.1	14.0	23.7	12.5	Alemayehu (1993)
Woyto-guji	72.9	66.4	39.0	28.8	80.6	72.5	12.5	12.5	17.6	10.8	Workneh & Peacock (1993).
Hararghe highland	71.5	62.5	41.9	29.1	80.6	72.8	14.4	13.0	21.4	13.1	Alemayehu (1993)
Short-eared Somali	64.9	61.8	32.8	27.8	72.8	70.4	12.1	12.8	19.6	12.2	Alemayehu (1993)
Long-eared Somali	75.8	69.4	42.3	31.8	82.3	74.4	14.8	14.6	13.5	9.0	FARM-Africa (1994)
Central highland	76.3	67.9	43.0	30.1	84.6	74.1	13.5	13.1	23.4	13.7	Nigatu (1994)
Western highland	80.7	70.8	48.4	33.0	87.2	75.8	14.6	14.7	20.7	12.8	Nigatu (1994)
Western lowland	67.2	63.5	35.5	33.9	77.0	75.9	14.1	13.8	18.5	12.8	Nigatu (1994)
Keffa	75.6	66.7	40.5	28.2	82.7	72.2	13.3	13.0	20.1	11.6	Nigatu (1994)

[a]Adapted from FARM Africa (1996). M=male, F= female

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2.8 Participatory Definition of Breeding Goal and Breeding Objective

The breeding goal is a list of traits to be improved genetically. It should be in line with national agricultural development objectives and appropriate for the production system for which it is defined (Bourdon, 2000). Herd book breeds have a clearly defined breeding goal, and registered animals must fulfill specific criteria. In traditional societies, breeding goals are not that narrow, and diversity is often striven for (Köhler-Rollefson, 2000).

In traditional breeds, the breeding goal is often multifaceted. For instance, a goat breed kept in a pastoralist system; it may be reasonable milk yields combined with ability to survive in an unfavorable environment. Need for social currency (acting as dowry or bride price) may be another breeding goal (Kosgey, 2004). Breeding goals are also guided by aesthetic and personal preferences, religious requirements and ~~behavioural~~behavioral aspects of animals, such as complacent nature, alertness, flock leading, good mothering instincts, herdability, ability to walk long distances and loyalty to the owner (~~Köhler-Rollefson, 2000;~~ Laird, 2002; FAO, 2009; Grum, 2010).

Ouma *et al.* (2005) indicated that trait preferences of livestock keepers can vary~~ies~~ based on three major factors: 1) production system characteristics, 2) environmental conditions and 3) social and cultural practices.

Farmers in different production systems have different trait preferences and the strategies followed by them are also as diverse as the agro-environments within which they operate (FAO, 2009). ~~(Philipsson *et al.*, 2006).~~ In Suba ~~distric~~district of Kenya farmers with crop-livestock production systems, the use of manure for fertilization of agricultural plots is considered as important as milk or meat. Likewise, suitability for traction is also a very important attribute considered especially for male cattle (Ouma *et al*., 2005). Ouma *et al*. (2004) observation on trait preferences of cattle keepers in selected pastoral and agro-pastoral areas in Kenya and Ethiopia revealed that producers in pastoral system showed a high preference for hardy animals that are

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able to withstand severe environmental conditions. This is in contrast to the producers in agro-pastoral system that preferred animals which are trypanotolerant and heavy, so as to fetch favorable market prices.

~~Takele *et al.* (2010) observation on breed and trait preferences of Sheko cattle owners also revealed that Producers in pastoral systems have a high preference for hardy animals that are able to withstand severe environmental conditions. This is in contrast to the producers in agro-pastoral systems that prefer animals that are trypanotolerant and heavy, so as to fetch favorable market prices.~~

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Increased productivity of livestock by using exotic breeds in Ethiopia failed to become a sustainable option mainly because this strategy recurrently faced the problem of not being adopted widely by the rural farmers due to several socioeconomic and environmental challenges, especially avoidance of adaptive traits in the breeding objective limited the success (Philipsson *et al.*, 2006; Duguma *et al.*, 2010; Tadele, 2010). Adaptability of an animal is generally described in terms of traits enabling them to survive, reproduce, and be productive in the limits of their production environment (Bourdon, 2000). Indigenous breeds were rated to have superior merits with regard to traits such as disease tolerance, tolerance to heat, ability to produce on poor quality feeds and managements (Rege *et al.*, 2001).

Culture and tradition have an influence on the traits preferred by livestock keepers. Yet, some traits may have been preferred only for ~~ecstatic~~ aesthetic value and may not have any economical importance. For instance, farmers in Kenya prefer dark coat colored cattle, especially the dark red and other dark colors since the dark coated animals are used for slaughtering during ceremonial functions. This is despite the fact that light coat-colored cattle have a lower risk of being bitten by tsetse flies, since tsetse flies are attracted to darker colors (Ouma *et al.*, 2005). The same author stated that horn is also an important aspect to be considered in some communities of Kenya. This is because hornless cattle cannot be used for dowry payment.

Defining appropriate breeding objectives

At the *micro-level,* the definition of breeding objectives means that the relative importance of improvement of different traits of the breed for a given production environment must be determined (Sölkner *et al*., 1998). In doing so, a long term horizon of breeding should also be kept (Philipsson *et al*., 2006). To realize the benefits of a breeding program, it is essential that the breeding objectives are appropriately defined for the species/breeds, communities and environments concerned, and that the strategies laid out can be followed in practice. Breeding objectives can be set at the national, Region~~region~~al or local level but must not be by outsiders to truly reflect the real needs of the area; farmers must support the direction of change (Kosgey, 2004; Philipsson *et al.*, 2006).

So far it has been said those concern of livestock owners, environmental conditions and production systems need to be considered for sustainable breed improvement. When determining the relative importance of different traits in the breeding objectives one may, as an alternative to calculation of relative economic weights, put *restrictions* on the change in specific traits or define what the desired gain in each trait is. Whatever the choice of method of weighting traits (Philipsson *et al.*, 2006) the following additional points must be considered:

1. The short-term benefits for farmers must be considered to get good farmer participation, even though the long-term goals determine the breeding objectives and the role of each trait.
2. Special care must be taken in dealing with fitness and adaptive traits, especially if antagonistic genetic relationships exist between these and primary production traits. Generally, favorable correlations suggest that adaptability traits would not be compromised by placing major emphasis on selection for performance (Kosgey, 2004).

Therefore, one should, in most cases, try to focus selection on only the most important traits improving productivity and fitness for the environment in question (Duguma *et al.*, 2010)

2.9 Traditional Breeding Mechanism and Strategy

Indigenous knowledge about animal breeds and breeding is the knowledge that communities use to manipulate the genetic composition of their livestock. It includes knowledge and experience

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about the genetic attributes of livestock and inheritance, as well as conscious strategies and social mechanisms that influence the gene pool (Köhler-Rollefson, 2001).

2.9.1 Social breeding mechanism

Social breeding mechanisms are the socially embedded customs that influence the animal gene pool. They consolidate the population or create boundaries with other populations. Traditional pastoralist societies have strict rules about the exchange of animals. For instance, there is a rule of giving animals as gifts at certain life-cycle events, such as birth, circumcision and puberty, and as dowry or bride wealth at weddings. It is a moral and social obligation to help poorer family and clan members by giving or loaning them breeding animals. In a sense, animals often do not represent private goods, but rather are the property of the community as a whole (Köhler-Rollefson, 1997; LPPS, 2002; FAO, 2009). These rules ensure that animals are distributed within the community and remain a long-term asset over generations. They also are important forces for forming breeds.

2.9.2 Animal identification

To make breeding decisions and to avoid inbreeding, livestock keepers must know each individual animal in their herd and its relationship with other members of the herd. Traditional livestock keepers usually do know each of their animals, even if the herd is quite large and although all animals look very similar to the outsider (LPPS and Köhler-Rollefson, 2005).

The identification systems can vary from using marks on the animals to giving individual names based on the types of species, production system and flock size. Mbuku *et al*. (2006) reported ear notching, branding and coat ~~colour~~color as the major identification techniques used in pastoral goat keepers in northern Kenya. Matrilineal naming and recall system was also mentioned but with lower rate (Mbuku *et al.*, 2006). Galaty (1989) mentioned the "cognitive processes" the Maasai pastoralist in East Africa employ to describe and distinguish their many cattle. The prime identification was looking at the "status" of the animal – its sex, age (newborn, weaned, adult) and reproductive status (pregnant, lactating, castrated, etc.). The animals are further recognize via their color and pattern, the shape of their horns, and by other criteria, such as being blind, lame, or having only one ear (Galaty, 1989). The same author also reported structuring the herd

into “houses”, or female lineages. All descendants of a single cow form a “house”, and they are all called by the same name.

2.9.3 Selection of breeding animals

In traditional breeding, selecting male animals is more practical than selecting females, as one male can sire many offspring, whereas the number of offspring from a female is far more limited. Furthermore, herd sizes are often too small to mate only the best females, and as the milk from all females in a herd is needed, smallholders and pastoralists may also let inferior animals get mated (Mathias-Mundy and McCorkle, 1989).

Selection can focus on individual animals or on families. The former may further productive traits while the latter may advance adaptive traits (Hülsebusch und Kaufmann, 2002). In Kenya, Rendille pastoralists select camels by family. For them the quality of characteristics of the ancestors and the “breeding line” of a new sire to be selected are more important than the characteristics of the individual young sire. Somali and to a lesser degree ~~also~~ Gabbra, on the other hand consider the young sire’s own characteristics and give less importance to those of his ancestors. Family selection offers higher promise of success for characteristics with low heritability such as adaptation to drought or disease resistance, while individual selection has advantages in case of milk and growth which have slightly higher heritability values than adaptive traits (Hülsebusch and Kaufmann, 2002).

Similarly, selection of male goats primarily using family performance was reported for Rendille and Gabra pastorals. Big body size and milk yield were used as a selection criteria for the buck’s dam while big body size and offspring quality were considered important attributes for the buck’s sire (Mbuku *et al.*, 2006). Mbuku *et al.* (2006) added selection of breeding male at juvenile age hence less attention was paid to individual phenotypes of the buck. On the other hand, phenotypic traits of individual animals can also be used as a selection basis. Beauty traits (coat ~~colour~~color patterns and horn length and shape) were mentioned as the major selection criteria for Ankole breeders in East Africa (Ndumu *et al.*, 2006).

2.9.4 Mating control

Mating control can be temporary or long-term. The latter includes castration and the removal of potential breeders through culling or sale (FAO, 2009). Methods for temporary mating control include isolation or fencing, the use of devices to hinder mating, and manipulative practices such as tying the penis to the side (FAO, 2009). Methods like ram isolation and tying the prepuce of the ram to prevent extrusion of the penis was reported in Afar area to avoid dry season lambing (Tesfaye, 2008)

Castration and culling of inferior animals are the most commonly used methods of permanent mating control. Castration is not only a tool for mating control. Livestock owners often castrate goats for better temperament and improve fattening to fetch better price on sale (Workneh and ~~Rowlands~~Rowland, 2004; Grum, 2010; Dereje, 2011). Castration for specific functions such as the bellwether male (flock leading) in the herds of sheep was practiced by Bedouins pastorals, Syrian (FAO, 1985). The Methods of castration includes removal of the testes, severing the spermatic cord, often by biting through the cord or crushing it with some instrument. Another common method is tying off or banding the testes until they wither from lack of blood flow (FAO, 2009).

3. MATERIAL AND METHODS

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3.1 Description of the Study Area

Afar National Regional State (ANRS) is one of the nine states of the country. The Region is located between 8^0 45' to 14^0 27' latitude North and 39^o 51'to 42^0 23' longitude East and covers an area of 100,860 km^2. The R~~r~~egion has an estimated population of 1.2 million (CSA, 2007) of which 90% are pastorals while only 10% represent agropastoral. It has a common boundary with Eritrea in the north, Djibouti and Eritrea in the east, Somali and Oromiya in the south, Tigray and Amhara in the west. The ~~region is~~Region is located in the lowland of Great Rift Valley. About half of the ~~region (~~Region (51.4%) has arid agro-climate which falls with an elevation ranging from 400 to 900 meters. Even to the worst, one – third (35.5%) of the ~~region~~Region ~~–~~is categorized by desert agro-climate due to its lower altitude which is below 400 meters above sea level and small rain fall of less than ~~900mm –~~300mm (Nigatu, 1994; APARDB, 2000; Solomon, 2006).

The topography of the ~~region varies~~Region varies from hilly escarpment in the Western and Southern edges with an altitude of 1000-1500 meter above sea level to lowland plains that fall in the altitude of 0-100 meters below sea level. Around 95 percent of the Region~~region~~ has a flat landscape with altitude decreasing towards Northeastern parts. The annual temperatures vary from 18^oC in higher elevations to 45^oC in lower elevations. The rainfall is a bi-modal throughout the Region~~region~~. ~~it~~It ranges from 500mm in the semi-arid western escarpments to 150mm in the arid zones (Solomon, 2006).

The Region is divided into five Zones and 32 Woredas. Zone one (Awsi – resu) is one of the five administrative zone of the Region~~region~~ located in the Eastern part of the region. The study was conducted in Aysaita, one of the eight administrative woredas of Zone one (Appendix Fig 1). The study site is remotely located from other ethnic groups which minimize the opportunity for contacts and crossing with different breeds. As a result, the goat population in this area may best represent ~~a~~ Afar breed or unique strain/population with some desired characteristics that have to be identified and preserved. This is one of the reasons for choosing this breeding area.

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Aysaita is located at about 650 km away from Addis Ababa and 78 km from Semera, the capital city of the Regionregion. The Woreda is sub – divided in to 13 kebeles or peasant association (PA) (6 pastoral, 5 agro pastoral and 2 urban). The study site has a total population of 49,990 (CSA, 2007) and covers a total area of 138,800 hectare. Out of the total land, 14.34%, 22.995, 7.28%, 1.28% and 67.19% covered with grazing land, arable land, forest, water and sand, stone and barren land respectively. The district has an altitude ranging from 385 – 550 masl. The agro – climate of the woreda is about 85% arid and 15% semi – arid with an average annual temperature of 35^{o}C and little rainfall ranging from 200 – 300 mm per annum. Crop cultivation is only possible through small scale irrigation on Awash Rivers. Even though there is no detail study on soil type of the woreda, with available rough estimation 85% was loam and 15% sandy soil (APARDB, 2000; Solomon, 2006).

In 1999 livestock population were estimated to be 172,930 cattle, 39,986 sheep, 79,972 goats, 11,981 camels, 674 donkeys, 360 horses and 360 chickens. Cattle, camel and goats are important source of milk which is the staple diet of pastoral and agropastoral. According to, APARDB (2000) the average milk yield of a cow, she camel and a doe were estimated to be 2 liters, 4 liters and 0.5 liters per day, respectively. Invasion of range lands and crop land with *prosopis julifera* is the major problem in the area (APARDB, 2000).

3.2 Sampling Method and Sample Size

Prior to the main sampling attempt, discussions were held with regional, zonal and woreda officers and professionals to make clear the purpose of the study and ensure collaborations during the assessment. Besides, supportive information from secondary sources (APARDB, 2000; CSA, 2007) and agricultural offices was referred as well as initial diagnostic survey was undertaken to select representative PAs and to device suitable sampling techniques.

The sample size for a survey depends on funds, means of transport and ease of access. It also depends on the different types of information to be collected. If population estimation is an important objective of a survey, (Workneh and RowlandsRowland (2004) suggested a sampling fraction of 1%. In the current survey, about 27.3% of rural PAs in the woreda and 7.7% of HHs

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households per PA ~~was~~ were considered. Consequently, the sampling proportion (2.1%) used to represent the site was larger than the general recommended (1%).

Stratified sampling procedure was employed. The district was stratified into pastoral and agropastoral production systems. Afterward, two pastoral peasant associations ~~PAs~~ and one agropastoral peasant association ~~PA was~~ were selected based on security, accessibility and availability of goat flock, since in some agropastoral peasant associations~~PAs~~, only a few household~~HH~~s were found that ~~raise~~ keep goats. Fifty households were interviewed from each PA using systematic random sampling~~Fifty households that owe goat flock were interviewed at random from each PA~~. However, some questioner sheets that were not filled correctly and seem unreliable were rejected and a net 124 (83 for pastoral and 41 for agropastoral) sample unit was used for data analysis.

The samples size for physical description of a breed depends upon the precision required and the variability in the sample population. Coefficients of variation on body measurements of mature female goats were observed to range between 10 and 30% (FARM Africa, 1996). For statistical significance (5%), 100 to 300 mature females are required from representative site (Peters, 1985). Since mature females on average constitute about 40% of the flock, 400 to 600 animals are required from a given site if the whole flock is going to be observed. For breed identification animal numbers rather than flock numbers are important; the latter are more important to assess the management like flock size, structure, etc. (Workneh, 1992).

Bearing this in mind, a total of 891 ~~adult~~ individual goats above six months of age were used for qualitative and quantitative measurements. About 610 and 281 heads of goat were sampled from 32 pastoral and 22 agropastoral households, respectively. ~~–~~On average 19 and 13 goats per household were measured from pastoral and agropastoral production systems~~PS~~, respectively, for body measurement. A maximum of 30 and 20 goats were restricted from an individual household in pastoral and agropastoral system, correspondingly even if the household~~HH~~ owe large flock size.

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3.3 Data Collection

Both the survey and body measurement data were collected during February 2012 to May 2012. The dData was were collected according to four different contexts considered as pillars of community-based participatory resource, system and problem characterization. These include social and cultural context, ecological and production contexts, livelihood contexts as well as indigenous knowledge and traditional systems (LPPS and Köhler-Rollefson, 2005). Data was generated by administrating a structured questionnaire, via participatory rural appraisal (PRA) tools, employing field measurements and from secondary sources.

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3.3.1 Household survey and participatory rural appraisal (PRA)

The household survey used a set of structured questionnaires which was a slightly modified version of those designed for livestock breed survey in Oromiya Region State (Workneh and RowlandsRowland, 2004). A pretested questionnaire was administered to randomly selected household head or family members.

The PRA tools employed include focus group discussions (FGD), ranking and scoring and transect walk. The PRA tools and procedure aimed to capture the information were adopted from manual on PRA (Simon, 2000). Group discussion was held with a focal-group established at each production PS.systems. Three Focus group members GD in which each FGD consistings of 8 – 10 person was conducted, which included expertsexperts from the regional and woreda agricultural office; pastoralists known to have high quality breeding animals; elders as well as socially respected individuals who are known to have better knowledge on the present and past social and economic status of the area. Accordingly, the following data was captured using the questioner (Appendix II) and FGD (Appendix III).

- General household characteristics,
- Social and cultural context of goat breeding in the community,
- Reproductive performance, kidding pattern, milk yield and lactation length,

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- Goat husbandry practices such as: flock size and structure, feeding system, housing, watering, diseases prevalence and production constraints;
- Purpose of keeping goats and trait preference;
- Indigenous knowledge (IK) on goat breed and breeding including the origin of the breed, key and special characteristics of the breed and breeding mechanisms and strategies.

Additionally, pPhysical and resource map drawn by the community was used to obtain information on location of extensive crop land, where animals graze/browse and preferred graze/browse species, concentration and distribution of Afar goat breeds (breeding area) and place of mobility during feed shortage season. For time related data, seasonal calendar method was employed to establish regular cycles or patterns of activities and occurrences within a community over 12 months which include: feed shortage, disease prevalence, kidding patter, time of mobility, rain fall and temperature

3.3.2 Body measurements and observational data

The following body measurements: Chest Girth (CG), Body Length (BL), Height at Wither (HW), Pelvic Width (PW), Ear Length (EL), Horn Length (HL) and Scrotum Cecircumference (SC) were taken using tailors measuring tape while body weight was measured using 50 kg capacity suspended spring balance with 0.2 kg precision. The definition and way of body weight and linear measurements were described in Appendix Table 1. Qualitative traits like back profile, coat color pattern and type, presence or absence of horn, ruff, wattle and beard, horn orientation and shape, ear orientation was captured thruthrough observation. The attribute and code of morphological characters are described in Appendix Table 3. Important qualitative and quantitative traits used for physical description of the population were adopted from the standard breed description list developed by FAO (FAO, 1986) and ILRI-OADB (Workneh and RowlandsRowland, 2004).

Body condition score (BCS) was assessed subjectively and scored using the 5 point scale (1= very thin, 2=thin, 3= average, 4=fat and 5=very fat/obese) for both sexes. BCS of an animal will be scored by feeling the back bone with the thumb and the end of the short ribs with finger tips

immediately behind the last ribs (McGregor, 2007; Girma, 2009). The detail description of scoring is indicated in Appendix Table 4.

All measurements were taken in the morning before the animals were fed. Each of the animals selected for measurement was sexed and aged according to Girma and Alemu (2008) using permanent teeth eruption. Thus, goat with fully grown milk teeth that started to spread out and zero pair of permanent incisor eruption (0PPI) representing 6 to 13 months of age and goats with erupted and growing first pair of permanent incisor (1PPI) representing 14 to 17 months of age. In the same way, 2PPI, 3PPI and 4PPI represent 18 to 23 months, 24 to 36 months and above 36 months of age, respectively.

~~Each of the animals selected for measurement was sexed and aged according to Tatiana (1999) using permanent teeth eruption. Thus, adult goat with no pair of permanent incisor (0PPI) represents 6 to 13 months of age. In the same way, 1PPI, 2PPI, 3PPI and 4PPI represent 14 to 24 months, 25 to 36 months, 36 to 48 months and above 48 months of age, respectively.~~

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3.4 Methods of Data Analysis

3.4.1 Questionnaire and observational data

Data collected through questionnaire and observations on morphological characters ~~will be~~ were analyzed by descriptive statistics using Statistical Package for Social Sciences (SPSS 16.0 for windows, release 16.0, 2010). Chi - square test was employed when required to assess the statistically significant variation between/among variables at 5% probability level. Indexes were calculated for all rankings data according to a formula: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons. For pair wise ranking, all possible combination or a pair of factor were compared and a factor which got the highest score was ranked as first while the factor that have the lowest score received the last rank (Simon, 2000).

The change in inbreeding coefficient per generation was estimated~~s~~ using the formula:-

$\Delta F = 1 \div 2Ne$ (Falconer and Mackay, 1996). Where, ΔF = Rate of change in inbreeding and Ne = the effective population number. Effective population number (Ne) for a randomly mated population was obtained from: $Ne = (4NmNf) + (Nm + Nf)$. Where, Ne = effective population size, Nm = number of breeding males and Nf =number of breeding females.

3.4.2 Body measurement data

Quantitative traits (body weight and some linear body measurements) were analyzed using the Generalized Linear Model procedures (PROC GLM) of the Statistical Analysis System (SAS, release 9.2, 2010). Tukey-Kramer test was used to separate means if analysis of variance showed significance. The statistical model below (Model 1) was used to analyze ~~adult~~ body weight and linear body measurements:

$$Y_{ijkl} = \mu + A_i + S_j + D_k + (AS)ij + (AD)ik + (SD)_{jk} + (ASD)ijk + e_{ijk} \quad \text{Model 1}$$

Where: Y_{ijk} = the observed l in the i^{th} Production System (PS), j^{th} sex class and k^{th} age group; μ = Overall mean; e_{ijk} = Random error; Ai = the fixed effect of PS (i=1, 2: where 1= pastoral and 2= agropastoral); S_j = Fixed effect of sex (j = 1, 2: where, 1= male and 2= female); D_k = Fixed effect of age (k = 1, 2, 3, 4 and 5: where, 1= age group at 0PPI, 1PPI, 2PPI, 3PPI and 4PPI, respectively) and possible interactions

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Pearson's correlation coefficients between body weight and other body measurements of the population for each sex and dentition categories were estimated to select variables that have a strong correlation with body weight. Then body weight was regressed on linear measurements and BCS for each sex and age group using stepwise regression procedure of SAS version 9.2 (SAS, 2010) to ~~predict~~ identify a model~~body weight~~. Best fitted model was selected based on highest coefficient of determination R^2 and smaller Mallow's C_p (Wuensch, 2006). Model 2 and 3 were used to develop the best linear regression equation for female and male, respectively.

$$Yj = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 + \beta6X6 + e_j \quad \text{Model 2}$$

Where: Yj = the dependent variable body weight,

β0 = the intercept,

X1, X2, X3, X4, X5 and X6 are the independent variables such that body length, chest girth, height at wither, chest width, pelvic width and body condition score respectively.

β*1*, β*2*, ..., β6 is regression coefficient of the variables *X1,X2,...,X* 6

e_j = the residual error.

$$Yj = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 + \beta6X6 + \beta7X7 + ej \quad \text{Model 3}$$

This model is similar with that of female except that scrotal circumference included in the model as independent variable

4. RESULT AND DISCUSSION

A systematic description of the goat types, management systems and the breeds association with the community should be considered as a prerequisite for planning the rational use of the national goat resources. In addition, breed characterization is the first step in the urgent task of genetic resource conservation (FAO, 2009). In this survey result, the points were discussed in sub-topics.

4.1 Socio – economic Characterization of Households

~~Socio-economic factors have an effect on livestock and farm management, decision-making and the general perception of breed and species of the farmers. These factors will therefore affect the design and implementation of a breeding program (Kosgey, 2004). Accordingly, this section presents the basic demographic and socio – economic factors of households.~~

4.1.1. Household sex, age and education level

Age of ~~households~~ the respondents varies from 22 – 70 years, the mean age being 43.2 years (Table 4). Seventy three percent of the respondents fall under 35 – 57 years of age category while about half of the respondents fall between 35 – 45 years of age class. Majority of the households were male-headed (87.9%) while only 12.1% were headed by females. This figure is similar to other studies which revealed 92.6% of male headed household for pastoral production system ~~(PS)~~ in the ~~Afar R~~region (Tesfaye, 2008).

According to the sampled house-hold, 87.1~~6.8~~% of the respondents do not have formal educated and the remaining ~~on~~ones~~ee~~ posses at least reading and writing (Table 4). Nevertheless, 44.2% of respondent mentioned having religious knowledge. Since the entire ~~100% of the~~ rural communities~~y~~ of Afar ~~society~~ people are~~is~~ Muslim, religious teaching is still given more emphasis than modern education. Despite low literacy rate, the figure is still higher than the report of Tesfaye (2008) which was 0.9% for pastoral systems in the same Region~~region which is 0.9% (Tesfaye, 2008)~~. This is less than what it should be since the area used to be the capital city of the Region~~region~~.

Although there is a primary school at each PA, they are devoid of students. The main reason behind may be the time clash between religious teaching and that of modern schooling; parents' unwillingness to send their children, owing to the time they should spend herding their flocks; the mobile nature of the pastorals and less awareness on the significance of education in the livelihood of the community.

4.1.2 Family size

The overall mean family size is 7.8 with a range of 3 to 16. The means comparison showed that pastorals have statistically higher family size than agropastoral ($p<0.01$). The overall average sex distribution of family members within the household is 3.7 and 4.1 for female and male, respectively. The average family sizes found in this ~~area~~ study was higher than the official statistics for the Region ~~regions~~ which was ~~reported as~~reported as 5.7 (CSA, 2007) and 6.2 Tesfaye (2008). This may be ascribed to the early marriage and more rate of polygamy due to relatively better economic status of this particular community.

Table 44 Demographic and socio-economic factors in pastoral and agropastoral systems

	Production system		Overall	$^{a}X^{2}$	P-value^{b}
	Pastoral (N=83)	Agropastoral (N=41)	(N=124)		
Descriptors	Mean±SD	Mean±SD	Mean±SD		
Age of respondent	43.6±10.4	42.3±9.2	43.2±10.0		0.50
Family size					
Male	4.4±1.5	3.5±1.1	4.1±1.5		0.003
Female	3.9±1.5	3.3±1.1	3.7±1.4		0.013
Total	8.2±2.6	6.8±1.8	7.8±2.5		0.002
Sex of respondents (%)				2.8	0.07
Male	73.5	58.5	68.5		
Female	26.5	41.5	31.5		
HH head (%)				1.4	0.23
Male	90.4	82.9	8768.5		
Female	9.6	17.1	12.1		
Education level (%)				2.3	0.51
Religious knowledge	42.2	29.3	37.9		
Illiterate	44.6	58.5	49.2		
Reading and writing	10.8	9.8	10.5		
Primary school	2.4	2.4	2.4		

N= Number of observation; SD = Standard Deviation; $^{a}X^{2}$ = Pearson chi-square value for categorical data; ^{b}p-value = significant level

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4.1.3 Income source

Ninety percent of the population in the Region~~region~~ is pastoral that mainly depend on livestock as means of food and income source. Agriculture such as production of maize and vegetables is also practiced along Awash River basin. Cotton and sesame production is as well common ~~is also practical to~~in the Region~~region~~, but limited to private large scale investors. Commerce, especially of salt, is another area of occupation (APRDB, 2000; Tesfaye, 2008). This implies the community tendency toward diversification of income.

In this particular site, milk forms the basis of staple diet (83.1%) followed by cereals (16.9%), predominantly maize. Nevertheless, the traditional bread made from maize floor locally referred as *"gG~~G~~a-amo"* is equally served with milk. Only *gG~~G~~a-amo* (bread) dish without milk is an indication to the poor state of a household. Small proportion of pastorals (7.2%) indicated cereals as the basis of the staple diet. The corresponding percentage of 36.6% for agropastoral was significantly higher ($P < 0.01$). Goats' contribution to the staple diet is mainly in the form of milk for pastoral and both milk and cash in agropastoral systems.

According to the respondents, the major source of incomes in both production systems were sale of live animals (I=0.51), livestock product (I=0.23) and crop and vegetables (I=0.13). About 93 and 68 percent of households ranked livestock as the first source of income in pastoral and agropastoral systems, respectively (Table 5). Livestock product particularly milk which is surplus for direct family consumption, is processed in to butter and sold to the nearby market. This indicates a tendency of the community to sell animal products such as buetter to the urban consumers which a way forwarded to improve the income of the households and introduce market oriented goat production

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Off-~~-~~farm incomes, charcoal and forest product like wood are also mentioned as source of income but with lower rate. Pastorals are not directly involved in making charcoal and selling of forest products. It is the outsider's (highlanders) that carry out the action; however, the

highlanders should involve local people who will share from the net profit, hence indirectly approving the action. Off--farm income like cross border trading between Djibouti and Aysaita, wage from guarding investors farm, remittance and petty trades were also mentioned as an alternative income sources.

The importance of livestock and their products remains the main sources of the livelihood of the community which is in agreement with Tesfaye (2008) that affirmed pastoralists in the Region~~region~~ (Afar) depending almost entirely on livestock as means of income and food source for the family. He further added that goat contribute the largest proportion for food and for income followed by cattle, sheep and camel in that order. Similarly, Kosgey (2004) stated that for the pastoralists in the lowlands of Kenya, goats are the backbone of their lives. Therefore, any development initiative without including goat improvement programs may not bring visible change to the livelihood of the community

Table ~~5~~5 List of income sources and their corresponding rating

Source	Production system								Over all[a] (N=124)			
	Pastoral[a] (N=83)				Agropastoral[a] (N=41)							
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
Livestock sell	92.8	4.8	2.4	0.54	68.3	31.7	0.0	0.47	84.7	13.7	1.6	0.51
Livestock product	3.6	62.7	3.6	0.26	2.4	31.7	29.3	0.18	3.2	52.4	12.1	0.23
Crop and vegetation	1.2	7.2	4.8	0.04	29.3	34.1	12.2	0.29	10.5	16.1	7.3	0.13
Charcoal and forest products	1.2	6.0	18.1	0.06	0.0	2.4	2.4	0.01	0.8	4.8	12.9	0.05
Off farm income	1.2	15.7	20.5	0.10	0.0	0.0	26.8	0.05	0.8	10.5	22.6	0.08

N = number of observation. I = index. [a]R1, R2 and R3 = rank 1, 2 and 3 respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons.

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This survey result revealed a number of socio-economic factors that have an effect on livestock and farm management, decision-making and the general perception of breed and species of the farmers. These factors will therefore affect the design and implementation of a breeding program (Kosgey, 2004) and should be considered seriously for success in breed improvement strategy.

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4.2 Social and Cultural Context

4.2.1 Local myths about origin of Afar goat breed

The Afar community maintains special association with the Afar goat breed and claiming a historic role in its development and custodianship. There are local myths about origin of the breed which were associated with the community ethno-history.

There are two types of story about the origin of the breed. According to FGD, the breed was believed to originate from Yemen that is directly related to the origin of the Afar people. Gamaludin (2007) who has documented the brief history of Afar people stated that majority of the clan in the Region~~region~~ were supposed to start off from Yemen. The same author further strengthened that the name itself "Afar" was derived from the word '*alme-afera*' which refers one of the clan's name that had came long time ago from Yemen. Consequently, the pastorals that had come from southern part of Yemen have brought sheep, goats and camels with them which might be the descendent of the present breeds. The other hypothesis is its origin from Saudi Arabia 1400 years ago. The focus group members explain that the current breed were the decent of the Saudi Arabian goat breeds that were brought by the disciples of the prophet Mohammed (PBUH) that came to preach Islamic religion. The disciples were thought first to arrived from the northeastern part of the Region~~region~~ and gradual expanded to other parts and the breeds they brought had also gradually replaced the previous breed.

The results from FGD were supported by the ~~indepth~~in-depth interview. Accordingly 6.5% (N=8) and 4.8% (N=6) of the respondents assumed the breed origination either from Kingdom of Saudi Arabia (KSA) or Yemen, respectively. In addition to this a few individuals 1.6% (N=2) think Egypt as the likely origin of the breed. Previous report also revealed the possible origin of Afar goat breed is from Kingdom of Saudi ~~Arebia~~Arabia and Yemen (FARM Africa, 1996). However, this information should be supported with archaeological and genetic characterization to affirm the introduction of Afar goat ~~goat~~ from Yemen or Saudi Arabia.

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4.2.2 Socio-cultural function of goats

Goats provide several functions that allow an owner to socially amalgamate within the community (Grum, 2010). These include use of goats as mediums of gift exchange in various social circumstances, means to confer social identity and status as well as ceremonial and ritual uses.

Goat gift is useful medium of negotiations and conflict resolutions between different clans/sub-clans or within members of the same clan/sub – clan. Whenever conflicts of some type arise, the local elders and clan leaders intervene by setting up traditional courts. The court then punishes the convict by ordering proportional compensation gifts in terms of goats and/or camels to the victim. If the conflict is between members of different clans and life is lost, the traditional court may order up to hundreds of goats and/or camels as compensation for the clan who lost the member. In this case, all members of clan are obliged to contribute towards the huge number of animals needed in the resolution process. This transfer of goats from the offender to the victim family/sub-clan remains the only assurance against revenge killings and associated social instability. More importantly, this ensure exchange and interbreeding among sub-population of goats developed by each clan which is a crossbreeding effort that will combine the desirable attributes of sub-population

The information from the FGD and key informants revealed that possession of goats can also be used as a means to confer social status of households. Goat ownership in terms of both flock size and quality of animals is also used as criteria of wealth status and strength. Moreover, households with large flock sizes, good breeding buck and castrated males in the flock are considered as noble and often possess high social influence and respect.

It is equally prestigious to slaughter goats in ceremonies including new births, weddings, circumcision, receiving guests as well as during funerals. There is a strict social regulation of slaughtering goat for pregnant woman during late pregnancy and immediately after the first day of birth. There is also a tradition known as '*Sedeqa*' by which better off households slaughter goats, prepare a dish and invite poorer peoples for lunch. However, sheep are preferably slaughtered during religious festival (*Arefa*) and to pay tribute to the dead. Unlike the report from

Grum (2010) and Nigatu (1994) special preference of color or type of goat were not reported in the community in this study except fulfilling of the religious requirement in *Arefa* which entail goat with no physical defect and should be healthy.

4.2.3 Social breeding mechanism

Social breeding mechanisms are the socially embedded customs that influence the animal gene pool (LPPS and Kohler, 2005). These mechanisms include exchanging animals: Lending or giving animals to poorer relatives and rules for passing on animals to the next generation through various means like dowry or bride wealth at weddings and so on.

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The marriage is accompanied by inheritance of goats for the new households. It was reported that, 70.2% of the respondents inheritance and ~~weeding~~wedding gift as the initial source of their flock and there is also contribution from relatives (16.9%) make up a considerable amount of initial flock. In the custom of groom wealth, parents of the groom are traditionally obliged to provide the new household head with an initial stock composed mainly of breeding does. This is not only practiced as a customary family gift but also considered as a means of inheriting traditional livelihood and cultural heritage to the next generation.

The Afar community also has socio – religious rule that stipulate every member to provide goat gift as help to poorer members. This religious obligation known as *Zeka*, follows a tradition of yearly flock inventory and whenever the number of goats exceeds fifty, a goat must be given to poorer relatives for every fifty goat in the flock. There is also a moral obligation whenever a relative accidentally losses higher proportions of flock, members are traditionally obliged to contribute in rehabilitating the victim with starting flock. This can be taken as a traditional institution for restocking and appears "diversity-friendly" restocking as compared to the government driven restocking projects usually involving introduction of other breeds without their home of origin (Grum, 2010).

Another tradition by which individuals that got many milking does is morally obliged to borrow to their poorer relative that is in need of milk for his family. Consequently, the poorer relative or clan member take care of the does and consume its milk. There is also social circumstance of borrowing or exchanging goats. Household that is in need of money but may not want to sell his

superior breeding goats, he can borrow or exchange goats from relatives or neighbors to be sold for the immediate cash needed rather than selling his breeding female. Then he will later replace alike ones.

These social rules and customs ensure that animals are distributed within the community and remain a long-term asset over generations. They are as well important forces for forming breeds (LPPS and Kohler, 2005). Notably, this is a traditionally accepted genetic conservation strategy through retaining of goats with desirable characteristics.

Taboo against selling female animals a social rules of Raika pastoralists in Rajasthan, India (LPPS and Kohler~~e~~, 2005) was not reported in Afar society. Nonetheless, sale of breeding does is not practiced under normal circumstances. There is no as such explicit social rule against sale of breeding does, but such act is considered as weakness and is subject to negative social judgments. Breeding bucks are also highly exchanged within the community and it is unlikely that owner of a superior buck would deny a member of the community an access. Even though there were no explicit rules reported ~~that~~ obliging an owner to share his bucks, there is a strong culture of sharing ~~characterizes~~ which characterizes ~~is a social network~~ not only in case of goats but also other resources. Goats were exchanged through the various social networks regardless of different sub-clans and castes (classes), such as wealth and religious elite and regular groups within the community. It can, thus, be concluded that the tradition of goat breeding is not caste specific. This tradition of a strong tie among community members in goat ~~breeding,~~breeding warrants to introduce community-based goat improvement programs to enhance goat production through participatory selection and improvement of management in the Region~~region~~.

This survey reveals socially embedded traditional breeding mechanism in the communities. Therefore, considering the different socio-cultural perspective of the communities is important in the adoption of any breeding programme (Kosgey, 2004). Previous improvement programmes of small ruminants ignored this fact and ended up with ~~Small ruminant production~~ unsatisfactory results~~ily~~ (Philipsson *et al.*, 2006).

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4.2.4 Sense of custodianship[1]

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In addition to livelihood and socio – economic benefits obtained from goats', the pastoral and agropastoral feels a sense of responsibility for holding and looking after the breed similar to the their ancestors. Consequently, 88.7% of the respondents did not agree to replace their breed with other breeds. The rationales mentioned were heritage (38.2%), adaptability (24.5%), quality of the breed (16.4%), unique appearance or color (5.5%) and a combination of reasons (11.8%).

The principal reason pointed out was that the breed is the valuable legacy of their ancestors and it is their responsibility to hold on and pass the breed to the next generations. Ability to survive and produce under harsh environment and poor management condition of the breed were additional reasons mentioned not to replace their breed. Moreover, some household have already tried either improved or other local breeds or have experience from neighboring households and, therefore they come to know that under same environmental condition their breed are best dairy goats. The fact that different breeds introduced previously had failed to survive and reproduce in the area can support the claim of the community.

The community believes that their ancestor played a great role on the gradual development of the current adaptive, good yielder and unique coat color breed. With such perception of roles on development by a certain defined traditional community, it is natural to follow a perception of cultural heritage and symbol of social identity. This process eventually leads to a special-association perception towards the breed, which is often expressed through giving the breed their communal name (Koehler, 2006).

The locale considers the goat population is specially associated with the Afar community which they believe share common descent. Perceptions of special associations also give rise to some sort of sense of custodianship over the breed in a sense that no matter how outperformed the breed may in the future be in any production potentials, losing the breed may well mean losing their ethno-history and ancestral cultural heritage while preserving the breed will equally mean preserving these. This has a paramount implication in conservation of the genetic diversity.

[1] Custodian refers *a protector and upholder of something seen as valuable and endangered such as traditions on the behave of their ancestors or identity(Webster 3rd ed. new International Dictionary)*

While such perception remains pervasive motive for the community to preserve the breed, the Food and Agricultural Organization (FAO) itself recognize cultural association with particular community as one of the criteria in prioritizing breeds for conservation (FAO, 2009). Hence, the FGD and empirical evidences from this study suggested that, the introduction of "improver" breeds to Afar area may not be feasible. This calls again, improving and conservation of the ~~indigenou~~indigenous~~s~~ breed through the participation of the community.

4.3 Ecological and Production Context

4.3.1 Defining the breeding area

According to inferences from focus group discussions and mapping activities, the breeding area of the Afar goat extends outside of the political binderies of Afar Region~~region~~ (Ethiopia) to south eastern part of Eritrea and towards western parts of Djibouti. It also extends to northern part of West Hararghe. The breeding tract ends in the west by the Amhara mountainous range and in the south by Somali (*Issa~~issa~~*) border. The breed in the western part of the Afar Region~~region~~ might have a chance of assimilation with highlander breeds and may be kept by those households that share common border with Afar. Besides, conflict between ethnic groups in the western border of the Region~~region~~ may result crossbreeding as a result of raiding, especially where animals obtained in this way are subsequently reared for breeding purposes (Nigatu *et al*., 2004). Otherwise, the breed is almost exclusively kept by the Afar ethnic group found in Ethiopian and Eritrean rift valley strip. The breed is concentrated in the arid north eastern part of the Region~~region~~ and decreases as one moves from south and west wards.

The breeding area of Aysaita district where this particular study was conducted is surrounded by same ethnic groups that keep identical breed except in the south with *Issa~~issa~~* pastorals. Therefore, the chances of flock mixing with different ethnic groups are rare hence the breed kept by this community may have a high probability to represent the afar goat breed. However, the breed in this area may be threatened in the future due to the rapid change in production system from pastoral to agropastoral and the random introduction of other breed type without any prior study. A recent change to agropastoral ~~production~~ system is ~~resulting~~ causing a decline in goat ~~raising~~production. For instance, in two agropastoral *kebeles (Berga and Kerebuda)* that used to be pastoral, only few households were found that kept a few goats flock.

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4.3.1.1 Farming system in the area

Before 2001, the entire rural ~~*PAs' kebeles*~~ *kebeles* in the district were pastorals that mostly depended on livestock production. Currently, however, with the introduction of sedentary farming there are five rural *kebels* regarded as agropastoral by the woreda pastoral and agricultural development office. Maize is the dominant crop cultivated in both agropastoral and transhumance pastorals systems. Sesame and cotton is also grown but only by some model agro-pastorals and private investors. Onion and tomato are also widely produced in agropastoral area although there is a market fluctuation. Majority of the community use local variety of maize. All the vegetable seeds used are improved varieties. Use of fertilizer or manure by the community was not reported.

Land holding pattern in Afar Region~~region~~ is communal. The land belongs to the clan members'. Any land holding and use is, therefore, accessed through dealing with the clan leader *"Dala"* and the community elders. Since farming is uncommon in the area, there is no land problem. Pastorals who are interested on crop cultivation can easily get as much irrigable land as he/she wants. Despite this free access to arable land, the cultivation of crop was not directly performed by the land owners except in a few agropastoral farmers rather they work in partnership with highland farmers.

The area is characterized by large plain fertile land which is facilitated by irrigation structure that passes cross most the rural *kebele*~~*PAs's*~~. There is no detail study on the soil type but with available rough estimation, 85% of the woreda soil is categorized as loam and 15% sandy soil (APARDB, 2000). Cotton, sesame and beans are the major commercial crops produced both for local as well as international market. To acquire land for crop cultivation, investors' have to deal with the clan leader. If they reach on consensus, then social agreement will be contracted between the two parties i.e. the clan to provide the land and protection while the investor to afford labor and capital afterward the clan members' share 20% of the net profit.

4.3.1.2 Local calendar systems

The year is divided into 12 months based on blend of religious (Islamic) and traditional methods which reportedly follow lunar system. According to some key informants and focus group members, neither the Ethiopian nor the western calendar systems were known in the area. The local calendar system was based on ecological seasons and traditionally delineated months.

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Generally, the year is classified in to two main seasons, *Gilal* and *Hagay*, based on temperature. *Gilal* is distinguished by its relatively low temperature and cooler weather especially in the morning. *Gilal* runs from late September to mid April lasting about seven months. The locals further indicated that the same season is a period where *acacia nilotica* ends shading all its pods, mark the ending of cold season and the ~~beg~~beginning~~ging~~ of hot and dry season. *Hagay* is characterized by its high temperature and scarcity of feed. It runs from mid April to august lasting 4 – 5 months. The hottest month also falls in this season. The pastorals argue that this season is expanding from time to time even with intense temperature and severe feed shortage. The elders pointed out that presently this hot season was extended to mid September. Similar pattern of increase in the length of dry period was also reported by Somali and Oromiya pastoralists (Adugna and Aster, 2007; Grum,2010). The climate change may be implicated for the extended period of hot season and severe feed shortage that may require a mitigation mechanism through the participation of the community.

The two major seasons, *gilal and hagay,* are further classified in to five seasons based on rainfall pattern. In these categories, there may be overlapping due to fluctuation in rain fall pattern. These seasons include:

1. *Kerma*: it is the main rainy season. Depending on the amount of rainfall, it can range 3 – 4 months starting from July/August to the end of October
2. *Deda-a*: it is characterized by a very short rainfall that lasts for a few days. It can rain during October – November.
3. *Debayba*: it runs from December to February. It is characterized by a short rainfall that lasts for a week.
4. *Sugum*: it is the second important rainy season that may last for 30 to 45 days. It is distinguished by its calm rain fall that occurs during early spring (March – April). The rain in this season is very crucial for pastoralist to survive the long dry season feed shortage.
5. *Hagay*: the dry and hottest season of the year. It can extend from mid April to June or July. Pastorals experiences sever feed shortage during this season along with mobility to a better feed resources area.

4.3.1.3 Seasonal forage calendar and preferred grazing species

The major feed source for goats in the study area is natural pastures but fallow land and crop aftermath are also important sources for agropastoral and some pastoral households (section 4.3.3.4). Large fallow lands after the harvest of cotton (September/October) are freely available during the late summer and dry seasons. When cotton cultivation starts in April/May, alternatively maize harvest begins (M~~m~~arch/April) providing fallow land during the dry season (till next planting time – October/November).

Generally, the locals have identified 12 and 13 different types of important browsing and grazing species in the area (Appendix Table 4 and 5). Pair wise ranking of most important browse feeds revealed that *Acacia nilotica, Acacia tortolis, Acacia asak and Acacia seyel* were mentioned as the most important browse species to feed goats in that order (Appendix Table 2). The leaves and pods of these browse trees and shrubs were indicated as the most favorite feed of goats. Besides, the species are abundantly available in the area both in dry and wet seasons. *Acacia senegal, Acacia oerfota* and *Acacia mellifera* were also mentioned as preferred goat feeds but they are rarely available in the area.

Pastorals in the Region~~region~~ are classified in to two based on the place they inhabited and seasonal forage availability. Majority of the pastorals that settled following the Awash River are called "*kelo*" and the other group inhabiting elsewhere referred as "*alta*". *Alta* pastorals that mostly dwell in area where there is no permanent river and availability of feed depends on rain fall.

During summer, Awash increase in volume and over flood vast areas ~~around~~ across its route. This makes the field difficult to get to for livestock feeding, particularly goats that do not like mud and swamp. Besides, the flood cause for proliferations of mosquito and waterborne diseases. So during this time the '*kelo'* moves to the upper area (*alta*) where there has been good rainfall and feeds. As the river shrinks the flooded areas flourish with vegetation, on the contrary, the amount of feed reduce in upper areas. Consequently, both the *k~~c~~il~~a~~*o and *alta* move to this area to share the resource

4.3.2 Characterization of goat husbandry practice

4.3.2.1 Flock/herd size and species composition

The percentage and mean values for livestock holding per household was presented in Table 7. It was noted that, the percent of ~~respondents~~respondents' possessio~~n~~n~~g~~ are ~~for~~ goats (100%), sheep (95.2%), cattle (86.3%), camels (58.9%) and donkeys (22.6%). The possession of goat by all (100%) of respondents is attributed to the fact that only households that owe goats ~~owners~~ were ~~purposefully sampled~~used for the interview. The mean herd size for cattle, camel and sheep reported in this survey was lower than the observation of Tesfaye (2008) for pastoral system in the Region. This may be accounted to the recurrent drought, change in farming system and declining of rangeland.

There is no statistically significant difference (P>0.05) between production systems in number of cattle, sheep and donkey holdings per household. However, pastoralists owe significantly higher (P<0.01) number of goat and camel than agropastoralists. This is expected because pastoralists preferred keeping more camels and goats than cattle and sheep, partly to avoid risk of drought loss and the feeding behavior of these species. Camels and goats are capable of eating bushes, shrubs and range vegetation which cannot be eaten by sheep or cattle (Verbeek *et al.*, 2007). Camels and goats are increasingly becoming a dominant livestock species of the pastoralists. This is in agreement with other studies (Kosgey, 2004; Nigatu *et al*., 2004). The preference of keeping goats and camel in pastoral area is one of the coping ~~mechanism~~mechanisms to ever changing situation of climate. This strategy enables pastorals to exploit patchy resources and survive climatic catastrophes such as blizzards and droughts.

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A minimum number of 8 and maximum of 155 goats were observed. During the survey, however, a household that owe a large flock size about 350 goats was noted in one of the pastoral *kebele*. The mean flock size per household for pastoral and agropastoral systems were 44.7 and 21.1, respectively with an overall mean of 37.0. The figure is closer to the report of Nigatu (1994) and Tesfaye (2008) that found mean flock size of 39.7 and 41 for the Region. On the other hand, the mean flock size in this survey was higher than the reports in pastoral and agropastoral systems around Dire-Dawa district which is ~~(~~32.8~~)~~ (Grum, 2010) and in low land area of West Harerghe which is ~~(~~34.0~~)~~ ~~((Grum, 2010 and~~ Dereje, 2011). Conversely, it is lower

compared to the mean flock size of 610.9 for goat dominated pastoral ~~production system~~area in southern Ethiopia (Workneh, 1992).

Table 66 Flock/herd size per household (Mean ± SD) and livestock possession (%)

Livestock species	Production system						Total	
	Pastoral (N=83)			Agropastoral (N=41)				
	Range	Mean±SD	%	Range	Mean±SD	%	Mean±SD	%
Goats	8-155	44.7±26.4[a]	100	5-51	21.1±10.1[b]	100	36.9±25.0	100
Camel	0-40	5.0 ±8.8 [a]	65.1	0-8	0.95±1.6 [b]	46.3	3.7±7.5	58.9
Cattle	0-25	10.1±7.7	81.9	0-20	7.7±4.3	95.1	9.3±6.8	86.3
Sheep	0-40	16.8±9.2	97.6	0-40	14.9±12.0	90.2	16.2±10.2	95.2
Donkey	0-3	0.36±0.74	22.9	0-2	0.34±0.7	22.0	0.35±0.72	22.6

[a, b] means with different superscript are significantly different (P>0.01)

Livestock species preferences

Ranking of livestock varies between production systems. In pastoral system goat was the first preferred species (I = 0.44) followed by cattle (I = 0.31) and sheep (I = 0.16). Whereas cattle (I=0.45), goats (I=0.33) and sheep (I=0.18) were rated as the first, second and third preferred species in agropastoral system, respectively (Table 7). Reported reasons for preference of goats in pastoral area were attributed to their multipurpose role, quick income source, short reproductive cycle and prolificacy, their broad feeding habits and drought tolerance. The pastoralist stressed that "unlike cattle and camel goats can give birth throughout the year, thus providing milk for the family especially in dry seasons is praised." Similar reasons which favor the keeping of goats were also mentioned in *Issa*~~*issa*~~ community and Kenya pastorals (Verbeek *et al.*, 2007; Grum, 2010). In agropastoral systems, cattle are dominant species and ranked as the first choice for their higher milk production, bigger asset and their use for ploughing as compared to goat.

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Table 7~~7~~ Household preference for livestock species across production system

Species	Pastoral[a]				Agropastoral[a]				Total			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Goat	59.0	39.8	1.2	0.437	22.0	53.7	24.4	0.331	46.8	44.4	8.9	0.401
Camel	7.2	9.6	9.6	0.086	4.9	4.9	-	0.041	6.5	8.1	6.5	0.071
Cattle	33.7	33.7	14.5	0.31	70.7	24.4	4.9	0.445	46.0	30.6	11.3	0.335
Sheep	-	15.7	65.1	0.163	2.4	17.1	68.3	0.184	0.8	16.1	66.1	0.17
Donkey	-	-	2.4	0.004	-	-	-	-	-	-	1.6	0.003

[a]R1, R2 and R3 = rank 1, 2 and respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

4.3.2.2 Goat flock structure

Flock structure across sex and age was presented in Table 8. The overall sex ratio~~n~~ of goat population was 82.8% female, 13.5% male and 2.1% castrate. There is no statistically significant (P>~~<~~ 0.05) variation between the two production systems regarding sex ratio. However, there exist statistically (P<0.01) higher flock size (both in age and sex classes) in pastoral than agropastoral systems. This ratio is closer to those reported for pastoral (79.9% female, 17.9% male and 2.2% castrate) and agropastoral (79.1% female, 18.7% male and 2.2%castrate) in southern Ethiopia with a slightly higher proportion of female (Workneh, 1992). However, smaller proportion of female than the reports of Nigatu (1994) who indicated 93.6% for the same breed. The high proportion of females maintained in the flock reflects the owners' desire for milk yield and replacement stock. Besides, smaller proportion of males post one month of age (Table 8) was due to the fact that breed improvement is manly undertaken through selection and retaining of a few breeding males based on family performance and disposing unwanted males at juvenile age - mostly before four weeks (section 4.8.3.2).

The total proportion of breeding females (i.e., with at least the first pair of permanent incisor teeth erupted) was 53.2%. These values are similar to the finding of Workneh (1992) in southern Ethiopia (53.5% for the whole population and 54.4% for pastoral), but smaller than the finding of Nigatu (1994) for the Region~~region~~ (72.9%). The overall does to buck ratio was 13:1. The ratio is similar to the inference of Workneh (1992) for pastoral production systems (11.3:1). But, the ratio shows higher breeding buck to doe ratio than the finding of Nigatu (1994) for Ethiopian and Eritrean goats (1:19) in pastoral flocks. This may be attributed to the smaller flock size in

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agropastoral system. Since the smaller the flock size, the higher male to female ratio~~n~~ (Workneh, 1992). The higher buck: doe ratio (1:3) for Ethiopian and Eritrean goats in the Highland areas which mostly possess small flock size is an evident (Nigatu, 1994).

Table ~~8~~8 Goat flock structures across sex and age categories

Flock class	Pastoral				Agropastoral				Total		
	Range	Sum	Mean±SD	%	Range	Sum	Mean±SD	%	Sum	Mean±SD	%
Female < 1 moth	1-13	317	3.8±2.5	8.0	1-8	85	2.1±1.4	9.2	402	3.2±2.3	8.2
male < 1 moth	0-13	269	3.2±2.3	6.8	0-4	59	1.45±0.9	6.4	328	2.6±2.1	7.0
Female 1-12 mths	2-30	864	10.4±5.1	21.8	2-9	195	4.8±1.8	21.0	1059	8.5±5.0	21.6
Male 1-12 moths	0-4	126	1.5±0.8	3.2	0-2	32	0.78±0.38	3.4	158	1.3±0.8	3.2
Female >1 year	6-85	2134	25.7±12.6	53.8	3-29	507	12.4±5.4	54.6	2641	21.3±12.5	53.9
Male >1 year	1-8	168	2.0±1.3	4.2	0-2	39	0.95±0.64	4.2	207	1.7±1.3	4.2
Castrate	0-4	91	1.1±0.9	2.3	0-2	15	0.37±0.61	1.7	106	0.85±0.87	2.2
Total		3969		100		932		100	4901		100

4.3.2.3 Flock acquisition and disposal

Modes' of flock entry and exit as recalled by respondents in the last 12 months prior to the survey was presented in Table 9. The major mode of entry was in the form of newly born kids on the farm (97.5%). The remaining small proportion of acquisition was contributed by gift from relatives, bought from market and loaned. Acquisition in the form of donation was relatively higher in agropastoral system.

Table ~~9~~9 Mode of flock entry and exit in the last 12 months prior to the survey (%)

	Production System						
	Pastoral			Agropastoral			Overall
Means	Male	Female	Total	Male	Female	Total	

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Entry							
Farm born	48.3	50.3	98.6	44.3	47.1	91.4	97.5
Gift	0.4	0.6	1.0	0.0	5.9	5.9	1.7
Market	0.0	0.2	0.2	0.0	2.2	2.2	0.6
Loan	0.1	0.1	0.2	0.2	0.2	0.4	0.2
Sum	48.8	51.2	100	44.5	55.4	100	100
Exit							
Sale	17.8	7.2	25.0	22.3	7.6	29.9	25.8
Slaughter	6.6	1.3	7.9	10.7	3.5	14.2	8.8
Diseases	19.9	25.9	45.8	18.2	27.1	45.3	45.7
Predator	5.1	7.0	12.1	1.7	3.5	5.1	11.1
Lost	1.2	2.8	3.9	0.4	1.4	1.8	3.6
Gift	2.9	2.4	5.3	2.1	1.5	3.6	5.0
Sum	53.5	46.6	100	55.4	44.6	100	100

The greater part of animal exits was in the form of death (45.7%). The next higher disposal was through sale (25.8%), followed by predators (11.1%) and slaughtering (8.8%). Other exits were donations (5.0%) and goats lost or stolen (3.6%). The total disposal rate was slightly higher for male in both production systems. However, males have markedly higher ($p<0.01$) proportion of exit through sale and slaughter than their counterpart female.

This finding is in agreement with Grum (2010) who reported high rate of flock entry through farm born (92%) as well as exit ~~thru~~through mortality (43.7%) and sale (24.6%) for *Issa*~~*issa*~~ pastoralists. Similarly, 95% of entry in the form of newly born kids and high rate of exit due to death (48% male and 66% female) were reported for Oromiya Region~~region~~al state (Workneh and ~~Rowlands~~Rowland, 2004).

4.3.2.4 Feeding system and response to feed shortage

Glazing land ownership in the Region~~region~~ as well as in the study area is communal (Tesfaye, 2008). The grazing system in the study area is extensive grazing system herded by family members. The feed sources during wet and dry seasons were summarized in Table 10. Natural pasture was indicated as the foremost feed source in both seasons with an overall index value of 0.44 and 0.56 during wet and dry season, in that order. This observation is in agreement with other studies (Nigatu, 1994; Workneh, 1992; Abule, 2003; Grum, 2010).

Fallow lands and crop residues were also reported as additional ~~reported~~ feed sources (Fig 1). Large fallow lands for grazing after cotton crop harvest (September/October) are freely available during the late summer and dry season. When cotton cultivation starts in April/May, alternatively maize harvest begins (M~~m~~arch/April) providing fallow land till next planting season – October or November. Maize and cotton are the sole source of crop residue. Maize thinning and stover as well as aftermath of cotton and maize are used before and immediately after harvest. Preservation of ample crop residues for dry season was not mentioned except in few model agropastorals. Small enclosure of pasture land at homestead or adjacent to cropland is also practiced to supplement kids and dams during reproductive stage.

Due to their resource sharing culture, fallow land~~s~~ grazing and~~,~~ crop residues before and immediately after harvest are accessible for everyone. Consequently, many herds from various part of the Region~~region~~ fed on a specific resource which cause poor utilization of the aftermath and last for short period of time. Moreover, herd mixing from various place cause transmission of diseases. Expansion of crop ~~Extensive~~ farming in the area can be an opportunity for crop residues if proper utilization and conservation techniques were given ~~skill was given~~ to ~~households. Therefore, this~~community. This is an important issue that should be considered especially when ~~the government policy~~ policy makers insist on ~~is~~ shifting pastoral toward agropastoral ~~farming~~system.

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Table 10~~10~~1010~~10~~ Feed sources during wet and dry seasons

Feed sources	Production system								Overall			
	Pastoral				Agropastoral							
Wet seasons	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Rangeland	80.7	13.3	6.0	0.46	61.0	29.3	9.8	0.42	74.2	18.5	7.3	0.44
Fallow land	19.3	75.9	4.8	0.36	39.0	46.3	14.6	0.37	25.8	66.1	8.1	0.36
Crop residue	-	10.8	89.2	0.18	-	24.4	75.6	0.21	-	15.3	84.7	0.19
Dry season												
Rangeland	97.6	2.4	-	0.57	92.7	7.3	-	0.56	96.0	4.0	-	0.56
Fallow land	2.4	95.2	2.4	0.38	7.3	90.2	-	0.39	4.0	93.5	1.6	0.38
Crop residue	-	2.4	21.7	0.05	-	-	9.8	0.02	-	1.6	17.7	0.04
Hay	-	-	-	-	-	-	9.8	0.02	-	-	3.2	0.01
Backyard pasture	-	-	2.4	-	-	-	7.3	0.01	-	-	4.0	0.01

R1, R2 and R3 = rank 1, 2 and respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

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Fig 1 Ff~~f~~allow ~~-~~land for grazing (left) and crop residue (right)

Supplementary feeding of goats was rare in pastoral system either in wet or dry season. The current survey also revealed that a low percentage of pastoral households (2.4%) fed supplements during dry season. Many agropastoral households (56.1%) reported supplementation of farm weeds (19.5%), palm fruit (7.3), hay (2.4) and a combination of weeds, thinning of maize, prosopis pod and palm fruits (26.9%) during dry season. Supplementation is limited to goat types at late pregnancy, lactation and kids, otherwise cattle are given priority than other types of goats due to their inability to feed shortage.

In conformity with this observation, Workneh and Rowland (2004) reported that 34.3% and 2.7% of roughage/crop residue supplementation in agropastoral and pastoral systems, correspondingly. Concentrate supplementation was not reported in the study area confirming that goats tend to be kept in low-input systems. This is in agreement with other studies (Kosgey, 2004; Workneh and Rowland, 2004) in pastoral and agropastoral systems

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Unwise utilization of resources and loss of the traditional institutions ~~in~~ for rangeland management combined decline of main rainy season, render grazing land discontinuous feed sources able to support only part of the year. The animals thrive the rest parts of the year due to their ability to utilize low quality feeds and stay in their maintenance requirements as well as the households' coping strategies.

Response to feed shortage

The households coping strategies to severe feed shortage was summarized in Table 11. The strategies include mobility, de-stocking, tree branch cut, supplementation and others unusual methods like over flooding range land/fallow land using irrigation water or Awash River. However, there exist a significance variation ($p<0.01$) between production systems regarding the type of strategy used. Mobility (81.9%) is the major coping mechanism for significantly higher ($p<0.01$) number of pastoral households, whereas considerable amount of agropastoral households (46.3%) bypass the critical feed shortage season through provision of supplementation and feeding leaves and pods from tree branch cut. Prosopis is an every green legume tree; its ~~leaves and~~ pods can be an important feed during dry season when other trees and shrubs dry out.

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Most of the respondents (88.7%) mentioned experiencing severe feed shortage during *hagay* (April – June/July) irrespective of production systems (Appendix Table 8). In the Region, sever feed shortage season mostly occur between the end of winter and the begging of main rainy season, and mobility of household is commonly observed during this dry period (APARDB, 2000).

Table 1111 Household coping strategies during severe feed shortage season (%)

Coping mechanism	Production system				Total	
	Pastoral		Agropastoral			
	Count	Percent	Count	Percent	Count	Percent
Mobility	68	81.9	10	24.4	78	62.9
Destocking	3	3.6	1	2.4	4	3.2
Supplementation	-	-	3	7.3	3	2.4
tree branch cut	1	1.2	5	12.2	6	4.8
Mobility and tree branch cut	9	10.8	4	9.8	16	10.5
Supplement and tree branch cut	-	-	11	26.8	11	8.9
Over flooding of rangeland	2	2.4	7	17.1	9	7.8

Under normal conditions, mobility in any of its forms and degrees is an applied survival strategy. Mobility being galvanized by indigenous knowledge is used to optimize and regulate the interactions among the livestock, the environment, and the human components of the system leading to pastoral livelihoods security in ecologically fragile environments (Workneh *et al.*, 2004; FAO, 2007). Therefore, forced settlements which has been initiated by the government currently would bring upsetting effect not only on the livelihood of the community but also on animal genetic resources ~~AnGR~~ and the environment

Mobility pattern

Pastorals ~~thru~~through many generations have developed a strategy of movement to cope up various problem (diseases, feed and water shortage) and efficiently utilize the patchy resources (FAO, 2007). The mobility ~~patter~~ pattern revealed in this study was that majority of pastoral households (74.4%) were transhumances that partly move their animals in search of feed and a considerable portion of them were nomadic (21.7%) pastorals. On the other hand, about 91.5% of agropastoral households are either settled or semi – settled.

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Common place of movement for pastorals include Silsa, Serdo, Abena, Awra and Gulina. About 63.9% of pastoral household~~HH~~s indicated moving to serdo, abena and silsa which are located in the north eastern part ranging 100 – 150 km from the study site. These places are the main feed resources areas for sheep and goats. Camel and cattle are commonly trekked to Awra and Gulina which are located in the western part of the Region~~region~~ where there is vast grazing land. Although most of agropastoral household~~HH~~s lead a sedentary life, in severe feed shortage condition they move to the neighboring *kebele* where there is a better feed resource.

Types of livestock and age classes that move with transhumance pastoralist include adult sheep, goat, camel and cattle leaving behind young, lactating, sick and late pregnant livestock. The duration of stay depends on the amount of water and feed supply. Sheep and goat usually stay one to three months based on availability of water. While camel and cattle can go as far away from home and can also stay longer period than sheep and goats, mostly above four months.

Mineral source and supplementation

Mineral source in the area is neither licking of salty soil nor solid salt rather it is mineralized spring water. The communities are aware of the need to supplement minerals to livestock and there are well known mineral rich spring water in the Region~~region~~ that serve as a source of mineral for all livestock species. Around Aysaita districts there are three important mineralized spring water recognized as *Dobi*, located in Dichoto; *Loma*, located in Serdo and *Alelo – beda*, located in dubti ~~woreda~~district.

Most of the ~~HHs~~ respondents (92.7%) mentioned preferring to supplement livestock from *dobi* twice or once per year. Since, *dobi* is believed to be the best one. The frequency of supplementation varies based on production system and quality of each source. Significantly ($P<0.05$) higher number of pastoral households (73.5%) supplement twice per year, whereas most agropastorals supplement once per year (73.2%). The higher frequency for pastoralists are due to their mobility along ~~these mineral source~~these mineral sources. The respondents further mentioned that these spring water also offer a good taste to ~~goats~~goat's milk and meat plus improves health of their livestock. Most of the water and soil types in the Region~~region~~ are rich

in minerals. Therefore, the quality and amount of minerals in these spring waters are a research gap that needs to be investigated.

4.3.2.5 Watering and housing

Water is a critical problem in most part of the Region,~~region~~ but not in this particular area because the community had settled following the Awash River basin. Additionally, there are many irrigation canals that pass in every village (Appendix Fig 3). Water is freely available at home yard for many household~~HH~~s. Rivers, irrigation dam and a combination of them account for 93.4% of water source both for livestock and human being (Table 12). The quality of river and dam water is not bad during dry season, however, it become muddy during summer. Most of the time watering frequency for goats is twice a day. Once in the morning when flock's leave to grazing field and in the evening when they get back home. Therefore, it can be conclude that water is not constraint for goat production.

Water source and watering frequency are not the same when pastoralist move to different areas in search of feed. During this time frequency of watering can be once or twice per day despite the local breeds which can stay for three to four days (Nigatu, 1994). Therefore, the goat population in the study site may be less tolerant to dehydration due to free accessibility.

Table 12~~12~~ Water sources for livestock and goat housing around Aysaita district

	Production system					
	Pastoral		Agropastoral		Total	
Water sources and housing type	Count	Percent	Count	Percent	Count	Percent
Water sources						
River	34	41.0	30	73.2	64	51
Irrigation canal/dam	35	42.2	4	9.8	39	31.5
Both river and canal	11	13.3	2	4.9	13	10.5
Both river and spring water	3	3.6	5	12.2	8	6.5
Goat shelter during night						
Open camp	30	36.1	4	9.8	34	27.4
Fence enclosure	53	63.9	37	90.2	90	72.6

A structured protection for goat neither at night nor at day time was observed. The only protection provided was a thorny fence enclosure (72.6%) otherwise goats are left to spend the

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night at open camp (27.4%). Nonetheless, kids have a separate stone hedge protection during night (Fig 2). Significantly (P<0.01) higher number of pastoralists ~~HHs~~ (36.1%) keeps goat at open yard while small percent of agropastoralists ~~HHs~~ (9.8%) keep at open ~~camp~~yard. Poor housing system at night can partly explain for a large number of goat losses due to predators in pastoral production system. This observation is in agreement with the report of Nigatu (1994) for the Region~~region~~ and Workneh and ~~Rowlands~~Rowland (2004) that reported use of kraal enclosures (88%) during the night for pastorals in Oromiya Region

Fig 2 Goat housing: stone hedge protection for kids (left) and fence enclosure for adults ~~goats~~ (right)

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4.3.2.6 Threats for the sustainable use of the breed

The pressure or threats for sustainable use of goats were presented in Table 13. Diseases, feed shortage, expansion of intensive farming and invasion of range land with *Prosopis juliflora* were the major constraints reported in both pastoral and agropastoral area with an overall index value of 0.33, 0.29, 0.21 and 0.13 in that order.

Although disease was ranked as the first constraint of goat production, feed scarcity is equally important. The respondents pointed out that feed shortage is the main cause of poor performance and weak immunity (consequently high velnourablity to disease attack) of livestock. Loss of

grazing and browsing opportunities due to both natural (drought and flood) and human interference like invasion of range land, expansion of intensive agriculture and deforestation are additional pressure that threatens the sustainable use of the breed and in the future even to the survival of the breed.

Prosopis juliflora is currently becoming a problematic weed in Afar Regional State. This invasive species causes loss of biodiversity and ecological service, affect livelihood of the pastoralist and agro-pastoralist, crop production and human health. It is encroaching rangeland and causing the decline and extinction of important forage species (Hailu *et.al.,* 2004; Addisu, 2009). thus impeding livestock production. Tesfaye (2008) also pointed out a decline in population and productivity of sheep in Afar pastoral system due to the invasion of this fast growing tree. *P. juliflora* is a powerful invader equipped with a number of special features that promote its rapid invasion of new areas (Hailu *et.al.,et.al.,* 2004). This anxious noxious weed is going to consume range lands threatening livestock production. Therefore, proper controlling and eradication measures should be taken without delay.

Table 1313 Pressure or threat for sustainable use and survival of the breed

Constraints	Production system										Overall	
	Pastoral[a]					Agropastoral[a]						
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	R1	Index
Feed shortage	28.9	33.7	18.1	14.5	0.287	26.8	36.6	19.5	17.1	0.289	27.9	0.288
Prosopis invasion	4.8	19.3	34.9	27.7	0.147	4.9	9.8	29.3	41.5	0.106	4.8	0.126
Extensive farming	18.1	14.5	16.9	26.5	0.167	29.3	17.1	34.1	17.1	0.260	23.7	0.213
Diseases	43.4	26.5	15.7	13.3	0.331	39.0	31.7	12.2	12.2	0.321	41.2	0.326
Market	1.2	1.2	2.4	12.0	0.014	-	4.9	2.4	2.4	0.020	0.6	0.017
Deforestation	2.4	3.6	2.4	-	0.028	-	-	-	2.4	-	1.2	0.014
Predators	-	1.2	4.8	1.2	0.010	-	-	-	-	-	-	0.006
Labor	1.2	-	1.2	3.6	0.008	-	-	2.4	2.4	0.004	0.6	0.006
Water	-	-	3.6	1.2	0.006	-	-	-	-	-	-	0.003

[a]R1, R2, R3 and R4 = Rrank 1, 2, 3 and 4 respectively. Index = sum of (4 for rank1 + 3 for rank 21 + 2 for rank 32 + 1 for rank 43) given for an individual reason (attribute) divided by the sum of (4 for rank1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4)(3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

Predators like hyena, fox, leopard and monkey are also causing trouble in goat production, principally in pastoral area. Female household heads without adult men family member are more

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victims of the problem. The community revealed that a steady decline of forest, that naturally sustain wild animals, cause the wild animals to shift their prey in to domestic animals. This statement is in harmony with high rate of flock exit through predator (section 4.3.2.3). High incidences of Predator attack in pastoral system might have also triggered behavioral trait preferences like goats standing at ~~alertness of goat at~~ night as guard or alert to predators (section 4.8.2).

~~Intensive~~ Crop farming is rapidly increasing around the study area. The area due to its plain and fertile land as well as irrigation facilities makes it an attracting site both by governments and private investors. The extensive government sugarcane plantation and some private cotton plantations can be mentioned as an example. This observation is in agreement with the report of Quinn *et.al.* (2003) who stated the expanding agricultural areas and land reformation projects have been excluding pastoralists from their traditional grazing lands.

Rangeland is the major source of feed for goat production. Extensive farming combined with prosopis invasion is causing reduction of rangeland and loss of preferred forage species worsening the feed shortage which ultimately threats the sustainable use and survival of the goat population. Therefore, if extensive farming was believed to bring more benefit to the nation, then sustainable alternative solution should be set as compensation and a good rapport with the community.

4.3.2.7 Most prevalent goat diseases

Tables 14 summarize frequently occurring goat diseases and their corresponding index values. More detail description of the reported diseases with their local name, seasons of occurrences and symptoms were presented at Appendix Table 6. Tick infestation and CCPP were the first and second most prevalent diseases reported in both production systems with an overall index value of 0.25 and 0.22 respectively. Liver fluke, respiratory diseases, anaplasmosis (blood parasite) and manage mite were also mentioned as commonly occurring in the area. This survey result is in agreement with Kosgey (2004) and Workneh (1992) that reported pneumonia, tick borne diseases and external parasites as the most commonly occurring diseases in pastoral area.

Heavy infestation of tick and mange mites was observed in epidemic (fast spreading) proportions causing severe injuries and body condition loss. Besides, ticks are the main transmitter of blood parasites which increases incidence of anaplasmosis. Contagious caprine pleuropneumonia (CCPP) together with peste des petits ruminantis (PPR), are the major disease of small ruminant in pastoral and agro pastoral areas (Feyesa *et al.*, 2010). In Afar Region~~region~~ the prevalence rate of CCPP was reported to be 22.5%, with a higher rate of prevalence (36.36%) in Aysaita woreda (Feyesa *et al.*, 2010).

Disease is the key limiting factor to productivity of sheep and goats in the Tropics (Kosgey, 2004). In Ethiopia, one of the most important constraints to the livestock development is the direct and indirect effect of diseases. Disease is a major factor responsible for poor production and productivity (Feyesa *et al*., 2010). The current survey result also revealed that poor health is the key limiting factor to productivity of goats. Therefore, healthcare is an important problem to consider before genetic programmes can be contemplated. Community-based animal health programmes may be one way forward ~~(Njoro, 2001)~~, and use of genotypes that are tolerant to disease can be another option (Baker and Gray, 2003).

Table 14~~14~~ List of major goat diseases according to prevalence rank by respondents

Diseases type	Production systems										Total index
	Pastoral[b]					Agropastoral[b]					
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	
CCPP	24.1	27.7	7.2	12	0.206	41.5	12.2	7.3	22	0.239	0.223
Liver fluke	12	10.8	3.6	25.3	0.113	2.4	12.2	22	14.6	0.105	0.109
Tick infestation	32.5	21.7	18.1	16.9	0.248	17.1	43.9	17.1	12.2	0.246	0.247
Mange	1.2	4.8	6	2.4	0.034	0	7.3	22	7.3	0.073	0.053
Endo-parasite	6	1.2	10.8	10.8	0.06	0	4.9	2.4	12.2	0.032	0.046
Anaplasmosis	13.3	4.8	9.6	18.1	0.105	2.4	2.4	2.4	4.9	0.027	0.066
PPR	2.4	2.4	20.5	3.6	0.061	0	0	2.4	7.3	0.012	0.037
Respiratory Diseases	4.8	18.1	12	1.2	0.099	31.7	7.3	12.2	7.3	0.181	0.140
Metabolic disease and disorder	3.6	2.4	4.8	0	0.031	0	2.4	0	4.9	0.012	0.022
Foot-rot	0	1.2	7.2	3.6	0.022	0	0	7.3	7.3	0.022	0.022
Shoat pox	0	0	0	1.2	0.001	4.9	7.3	4.9	0	0.051	0.026
FMD	0	4.8	0	4.8	0.019	-	-	-	-	-	0.010

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[b]R1, R2, R3 and R4 = Rrank 1, 2, 3and 4 respectively. -Index = sum of (4 for rank 1 +3 for rank 2 + 2 for rank 32 + 1 for rank 4) given for an individual reason (attribute) divided by the sum of (4 for rank 1 +3 for rank 2 + 2 for rank 32 + 1 for rank 4) for overall reasons.
CCPP= Contagious Caprine Pluero-Pneumonia; FMD=Foot and Mouth Disease, PPR = Pest des Petit Ruminants

A list of 12 goat diseases were mentioned by respondents, but it was not possible to find out a clear seasonal pattern of disease incidence based only on this interviews. Nevertheless, the seasonal pattern of CCPP and external parasite were reported to occur generally in dry season owing to the fact that flock mixing and overcrowding to share grazing land and watering point during this season.

Households sought veterinary help, mainly from government veterinary service (68.5%) and, private drug suppliers (3.2%), which may be expired. But, 7.3% of households reported not getting veterinary help. Although most of the PAs are accessible, government veterinary service is limited to provision of vaccine. Therefore, at least provision of acaricides to control tick or mange mite infestations or provision of dipping vat per village will be a small mercy for the professionals but a great relieverelief for pastoralistss.

4.3.2.8 Mortality rate

The overall mortality rate was 23% over the 12 months period prior to the survey,. Mortality rate for the different goat types range from 8.6% for female kids to 1.5% for adult males (Table 15). Mortality rate of kids was significantly (P<0.05) higher than both adult female and males. Adult female death was also higher (P<0.05) than adult male. This may be due to the smaller proportion of adult male in the flock. There is no significant (P>0.05) difference in rate of mortality between the two production systems.Thesystems. The reported causes of mortality were listed in Appendix Table 9. Diseases (I= 0.50), drought (I= 0.24) and predators (I= 0.22) were the main cause of mortality showing higher index values.

Table 1515 Mortality rates of goats across age and sex class (%)

Production systems	Mortality rate				Overall
	Kids < 4 months		Adults		
	Female	Male	Female	Male	
Pastoral	8.4	7.8	5.0	1.8	23.1

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Agropastoral	8.6	7.3	5.2	1.5	22.5
Totals	8.5	7.7	5.0	1.8	23.0

*Percent mortality = {Animals dead/(Current average stock + Animals dead) *100%}

4.3.2.9 Rangeland trend

Almost all households (98.4) in both production systems mentioned reduction of range land in the last decade. The reason for reduction of range land were extensive farming (30.1%), invasion of *prosopis juliflora* (4.9%), drought and flood (8.9%), deforestation (4.9%), loss of traditional institutions (11.4%) (Appendix Table 10). Extensive farming was the major cause for range land reduction, but its influence was higher (P<0.01) in agropastoral system.

According to the respondents and FGD, the traditional institution on rangeland management and utilization that were lost includes~~:~~ ; - lifting of the rule that prevents tending livestock on grazing lands before shading of seed to the ground; Rules that determine carrying capacity of the rangeland and limits the number of participant in ~~communities~~community's rangeland. For instances, if the grazing land is small, it is permissible to the pastoralists proximate to the range land.

4.3.2.10 Household activities in goat husbandry practice

Tables 16 summarize the patterns of division of labor in goat husbandry by sex and age of family members. Adult males carrying guns are mainly responsible for herding of cattle and camel (87.9%). Since these livestock are taken longer distances from homestead and needs more protection against neighbor rival and wild animals.

The marketing (both selling and purchasing) of goats and making breeding decision are primarily the responsibility of males and females above 15 years of age. Shoats were herded and milked by all household members but not to the same extent. About 81.5% of the respondent revealed that does can be milked by any family members when flocks are at homestead. However, higher (P<0.05) percent of females are responsible for doe milking than men.

This survey revealed that females are involved in many goat production activities and decision making which is in agreement with other studies (Verbeek *et al.*, 2007; Grum, 2010; Dereje,

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2011). Therefore, females should be encouraged to play a significant role in small ruminant breeding strategies.

Table 1616 Responsibility in goat husbandry by sex and age class of family members

Activities	Male		Female		Not specific	Adults	Kids	Only females
	< 15 years	> 15 years	< 15 years	> 15 year				
Camel and cattle keeping	11.3	87.9	-	-	-	-	-	0.8
Shoat keeping	6.5	12.1	17.7	22.6	32.3	-	4.8	4.0
Kid rearing	0.8	2.4	3.2	-	17.7	-	75.0	0.8
Selling of goats	-	4.0	-	4.8	-	90.3	-	0.8
Purchasing goats	-	26.6	-	4	-	69.4	-	
Milking does	-	-	-	1.6	81.5		-	16.9
Milk processing	-	-	-	19.4	-	-	-	80.6
Breeding decision	-	17.7	-	25.8	1.6	54	-	0.8

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4.4 Livelihood Significance

The breeding objective can be defined as the traits that are necessary for a breed to fulfill its role in the overall production system (Laird, 2002). In traditional breeds, the breeding objective is often multifaceted. People shape a breed so that it corresponds to their livelihood needs (LPPS and Kohler, 2005).

4.4.1 Breeding objective

The purpose of keeping goat was summarized in Table 17. Milk production (I = 0.36), income source (I = 0.24), saving and insurance (I = 0.21) and for social affairs (I = 0.14) were most frequently mentioned reasons for keeping goat in their decreasing order in both production system. The primary breeding objective of goat for milk production is in harmony with the basis of the staple food reported which was milk. In agreement to this ~~result~~ observation Nigatu (1994) also reported milk production as the main breeding objective of goats by Afar community. In the Afar community, not only goats even sheep are kept for milk productions (Tesfaye, 2008).

Though goats are ~~primarily~~primarily kept for milk production, they further provide multiple uses and functions. The community expressed the multifaceted use of goats with a saying *"goat and maize are similar: they got numerous uses as well as enemies"*. Goats serve as a main source of income to the households. The respondents stated that goat keeping is like having money in your pocket or saving money in banks and securing family food. The respondents articulate that goats have regular markets outlet and could be sold at any time of the year with favorable price. In the area where recurrent drought is common, unlike camel and cattle goats have short generation interval and ability to give birth at any season providing milk throughout the year that ~~made goats~~made goats a preferred species. This ~~report~~remark is in agreement with Köhler-Rollefson (2005) who stated that in rural society where there is no modern banking; goats serve as a saving and insurance company to avoid risk. Goats are also kept for social and cultural function (see section 4.2.2).

Goat production was seen not only to be important, but also to provide a variety of benefits ranging from tangible to intangible ones. This agrees with other observations (Workneh, 1992; Kosgey, 2004; Grum, 2010; Derje, 2011). This knowledge of the reasons for keeping goat is a prerequisite for deriving operational breeding goals (Jaitner *et al.*, 2001). Indeed, ignorance of this aspect has been a major constraint in the lack of success in genetic improvement programmes attempted in the tropics (Rege, 2003; Philipsson *et al.*, 2006). The importance that households attached to milk yield and the income that can be generated from goats sell, suggest that genetic improvement programs could, if carefully planned, have good chances of success.

Table 17~~17~~ Pastoral and agropastoral rating for purpose of keeping goats

	Factors or traits						
Production system	Milk	Income Source	Saving & Insurance	Social Affairs	Meat	prestige	breeding
Pastoral[a]							
R1	61.4	19.3	16.9	2.4	0.0	0.0	0.0
R2	31.3	30.1	24.1	9.6	3.6	1.2	0.0
R3	6.0	30.1	21.7	32.5	4.8	2.4	2.4
R4	1.2	16.9	20.5	25.3	16.9	6.0	1.2
Index	0.358	0.248	0.206	0.131	0.038	0.015	0.006
Agropasto~~r~~l[a]							

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R1	80.5	7.3	9.8	2.4	0.0	0.0	0.0
R2	12.2	34.1	36.6	17.1	0.0	0.0	0.0
R3	2.4	39.0	22.0	31.7	4.9	0.0	0.0
R4	4.9	12.2	24.4	22.0	24.4	4.9	7.3
Index	0.368	0.222	0.217	0.146	0.034	0.005	0.007
Overall							
R1	67.7	15.3	14.5	2.4	0.0	0.0	0.0
R2	25.0	31.5	28.2	12.1	2.4	0.8	0.0
R3	4.8	33.1	21.8	32.3	4.8	1.6	1.6
R4	2.4	15.3	21.8	30.6	19.4	5.6	3.2
Index	0.36	0.24	0.21	0.14	0.04	0.01	0.01

[a]R1, R2, R3 and R4 = R~~r~~ank 1, 2, 3and 4 respectively. Index = sum of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4) given for an individual reason (attribute) divided by the sum of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4) for overall reasons

Based on the observations made in this survey, it can be concluded that the breeding objective of is to ensure improved milk production for the household consumption and increased net income per flock through increased number of marketable animals without undermining adaptation and survival traits.

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4.4.1.1 Sale of goats

Goats, in addition to provision of food and socio – cultural function, they are the principal income generating livestock for family expenses. The reported frequency of goat sale per year and the reasons for selling was summarized in Table 17. Goats were often sold throughout the year, but most of the households mentioned selling to meet emergencies prevails (64.5%). Goats serve as a 'current account' to the household~~s~~. The respondent~~s~~ stated that "goats are like money in your pocket" so that you can use them whenever cash needed. This observation is in agreement with Kosgey (2004) report in pastoral areas.

The reported reasons for selling goats were cash, culling and mitigation against diseases and drought. Significantly (~~P< 0.01) higher number of pastoral households sell~~P < 0.01) higher numbers of pastoral households sell~~s~~ goats to dispose poor performing ones and avoid loss due to diseases and drought. In agreement with this survey Workneh and ~~Rowlands~~Rowland (2004) also indicated cash as the main reason for selling goats.

Respondents ranking for the types of goat sold to generate cash was summarized in Appendix Table 11.Young males are most frequently sold (I = 0.27) while both young (I = 0.006) and adult (I = 0.002) female are the least sold. Particularly, male kids below the age of ~~two~~ four weeks local referred as "*bekel*" are an immediate and routine source of cash to cover home expenditure like coffee, sugar, salt, fuel etc. *Bekel*s are sold in the local market and door to door selling is also common (Fig 3).

Table 18~~18~~ Reported frequency of goat sale per year and reasons for selling goats (%)

Factors	Production system		Total
	Pastoral (N= 83)	Agropastoral (N= 41)	
Frequency of selling			
Every two weeks	4.8	2.4	4.0
Every month	21.7	2.4	15.3
Every three months	7.2	4.9	6.5
Whenever cash needed	59.0	75.6	64.5
At holiday	7.2	14.6	9.7
Reasons for selling			
Cash	34.9	73.2	47.6
Culling and cash	33.7	14.6	27.4
Cash and mitigation	8.4	7.3	8.1
Cash, culling and mitigation	22.9	4.9	16.9

Fig 3 Households selling young males or "*bekel*"

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4.4.1.2 Traditional use of goat product

Afar goats are extensively milked *(hadore hana)* for food, medicine and sale. Discussion with the focus group and key informants revealed that goat milk is often used to treat constipation, as human milk substitute for orphans and babies. Goat milk also fed to babies immediately after birth believing that it will develop immunity. Sour milk, mixed with fenugreek and garlic, is used to treat measles. Occasionally excess milk is made into butter for home use and sale. Melted goat butter is used to treat sick eyes and ears and as a treatment for headaches. It is also used to massage damaged limbs.

Goat meat cooked with rice or roasted and eaten on its own *(alayseni)* is a favorite dish. Kids, less than one month old, may be sold as a delicacy known as *bekel* (male) and *bekelo* (female). Goat Skins are used for beds and made into prayer mats *(akess).* Skins are extensively used as water containers *(sar)* and as butter churns *(koda).*

The manure of goat as well as other livestock is rarely used as fertilizer or sell. Manure in pastoral areas piled up in heaps that mark settlements. Given the relatively short road distance between pastoral lowlands and adjacent agricultural highlands bordering the western part of the Region~~region~~, there is a possibility of transporting the manure to deteriorating farmlands in the highlands of Amhara and Tigrai, and even commercializing the transfer.

5.5 Reproductive Performance and Milk Yield

The reproductive performance of Afar goat breed was summarized in Table 19. According to the respondents, the average ages at sexual maturity of female and male goats were ~~was~~ 9.3 and 9.8 months, respectively. However, it can ~~varies~~vary from 5 to 24 months based on availability of feed and management provision. This finding reveals earlier sexual maturity than the report of Workneh and ~~Rowlands~~Rowland (2004) in pastoral and agropastoral goat keeping system in Oromiya Region~~region~~ and Grum (2010) for *Issa~~issa~~* goat breed. The earlier sexual maturity of Afar goat breed may be partly due to their smaller size (Nigatu, 1994). Since sexual maturity of female goat is related more closely to mature weight than to age and usually occurs at about 60-70% of adult weight, which is relatively later than in males (Payne and Wilson, 1999).

Therefore, with good nutrition and care this weight can quickly be reached for smaller breed than larger ones.

Age restriction of male for sexual maturity was not common in the area. About 85.5% of the respondents reported unrestricted mating of male before full maturity. They reasoned out that a mix of flock are herded together and the stronger or adult buck prevents the young one and even other outside bucks from mating the flock so that no need to prevent young male. The remaining 14.5% of the respondents restrict mating young male before full sexual maturity due to its less conception rate and weaker anticipated offspring.

The mean age at first kidding (AFKP) was 17.1 months. Some respondents stated that most does first kidding to occur at similar time with her dam second parturition, counted after she was born which is about 14 – 16 months. In unfavorable condition, however, first kidding of the daughter coincides with the third birth of her dam (around 24 months). AFKP reported in this survey was similar with the report of Dereje (2011) who estimated 17.2 months for lowland agro-ecology, but earlier age at first kidding than the result of Workneh and RowlandsRowland (2004) and Grum (2010) for pastoral production systems in Ethiopia who estimated 19.6 and 20 months, respectively.

The mean reproductive life time, number of kids per life time and kidding interval of doe were 10.2 years, 14 months and 8 months, respectively (Table 19). The corresponding average reproductive life time for buck was 4.4 years. Longevity, life time kids crop and kidding interval of doe revealed in this survey are similar with other studies in pastoral area (Workneh and RowlandsRowland, 2004; Grum, 2010). An earlier age at first kidding and more litter size in agropastoral system in this observation may be attributed to the differences in management practice. An improved reproductive performance of goats in crop farming and agropastoral area compared with pastoral area was also indicated in other studies (Workneh and RowlandsRowland, 2004; Dereje, 2011)

Table 1919 Mean Average values of some reproductive performances and milk yield as recalled by respondents

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Parameters	Pastoral	Agropastoral	Over all	P -

	(N=83)	(N=41)			(N=124)	value
	Mean±SD	Mean±SD	Min	Max	Mean±SD	
ASM~~Age at sexual maturity~~ of female (months)	9.0±3.0	10.1±3.6	5.0	18.0	9.3 ± 3.3	0.07
Age at first parturition (months)	16.7±2.5	17.8±3.1	12.0	25.0	17.1 ± 2.3	0.04
kidding interval (months)	8.1±1.0	7.9±1.0	6.0	11.5	8.0 ± 0.97	0.45
Reproductive life time of doe (years)	10.1±2.2	10.5±2.0	5.0	17.0	10.2 ± 2.2	0.25
Number of kids per life time	13.0±2.4	16.2±4.0	8.0	23.0	14.0 ± 3.4	0.001
ASM ~~Age at sexual maturity~~ of male (months)	9.6±2.2	10.2±2.1	5.0	15.0	9.8 ± 2.2	0.20
Reproductive life time of buck (years)	4.7±2.1	3.8±1.6	1.0	12.0	4.4 ± 2.0	0.03
Milk yield per day per doe (liter)	1.2±0.4	1.0±0.4	0.5	3.0	1.1 ± 0.4	0.01
Lactation length (months)	2.7±0.6	2.5±0.3	1.5	4.0	2.7 ± 0.5	0.05

ASM=Age at sexual maturity

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Reproductive performance is an important trait that is used to describe a breed and assume improvement based on the production and management system (Wilson, 1995). The survey result indicated that some of the reproductive measurements of the breed are similar or better than the report made for other breeds under similar production systems. This indicates the promising feature of the breed in the harsh environment condition. However, most of the economically important traits are under the control of many genes (Rege and Okeyo, 2006). An important complicating factor is that environmental effects (including seasons and management) also modify the expression of such characters and therefore contribute to the phenotypic variation among individuals. For such complex quantitative traits, the different genotypes cannot be distinguished on the basis of the phenotype of the individual (Wilson, 1991). Therefore, a detail investigation on the performance traits of the breed is needed to make sound conclusion.

The reported average daily milk yield was 1.14 liter per doe for an average lactation length of about 2.8 months (Table 19). Daily milk production of doe ranged from 0.5 to 3 liters. Some respondent and focus group members perceived that Afar goat breed is the best dairy type under good feeding and management condition along with their ability to yield even the smaller amount of milk in the worst condition that other breed fail to do so. According to a focus group discussion at Romaytu kebele, two liters of milk per day is usual for most does in the flock

unless there is poor selection and breeding management. For instance, a doe that yield below one cup or half liter per day is regarded as inferior, locally ~~refered~~referred as *'gundul'*, and culled. The focus group members also perceived that best doe can give about 34 liters of milk per day at the early stage of lactation.

The average milk production per day revealed in this survey was higher than the report in lowland and pastoral areas which was 0.50 liter (Workneh and ~~Rowlands~~Rowland, 2004; Dereje, 2011) and 0.30 liter for Afar goat breed (Wilson, 1991). In traditional goat production system, Wilson (1991) reported milk yield ranging from 24 kg (Adal in Ethiopia) to 480 kg (Alpine in Burundi) with a lactation length ranging 80 to 200 days. Wilson's (1991) report on Afar goat breed performances, which is most cited, was actually misjudging. Because the inferences for one million population of Afar goat breed (FARM Africa, 1996) was made only from 4 individual goats which is unfair and not statistically satisfactory. This survey result indicates a wide range of milk production potential of indigenous Afar goats that may necessitate improving the genetic potential of goats through community participation selection and improving management.

The frequency of milking was twice per day (91.1%) that took place in the morning and late afternoon after the kids have suckled. The maximum weaning age of kids was 3 months. About 62.1% and 37.9% of the respondents indicated kid's weaning before 2 months and between 2 to 3 months, respectively. This survey reveals earlier weaning of kids than the report of Workneh and ~~Rowlands~~Rowland (2004) who mention weaning age of goats between 3 to 6 months in about 75% of the cases. . This early weaning of Afar breed may also attribute to the early maturity of the breed compared to others.

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Kidding pattern

Kidding took place in every seasons of the year, but more frequent kidding was reported during *kerma* (August – September/October) and *sugum* (March – April) which accounts about 41.1% and 37.9% of the respondents, respectively (Table 20). However, there was significant difference ($p<0.05$) in relation to frequency of birth among seasons between the two production system. In

pastoral production system, most birth occurs during *wet season* (55.4%) and *dry season* (19.3%). The kidding is frequent during dry season (75.6%) in agropastoral system.

During *kerma* /late summer pastorals who are far away from home in search of feed they usually take 2 – 3 pack camels with the flock to carry the kids that will be born during this season. Seasonal parturition ~~patter~~ pattern accompanied by large flock size may results in many kids at similar kids at similar time, that makes caring for kids a very tedious job especially for pastorals, hence the male kids are regarded as a burden. This may account the disposal of male kids at an earlier age as well as retaining of the female kids for future replacement. The culling of male goats at early age may not allow the kid to express its genetic potential. Therefore, selection is experienced using the pedigree of the kids.

This survey result is in agreement with Workneh and ~~Rowlands~~Rowland (2004) that indicated more frequent kidding during August to November and February to April for pastoral and agropastoral production system in Oromia Region. Tesfaye (2008) also stated about 80% of lambing to be concentrated during *Sugum* and *Kerma* in same Region~~region~~.~~.~~

Table 20~~20~~ Reported kidding pattern or seasons of most birth occurrences (%)~~in percent appendix~~

Production systems	Seasons' of most birth occurrences					Total
	Kerma (Aug-Oct)	Debayba (Dec-Feb)	Sugum (March-Apr)	Deda-a (Oct-Nov)	Kerma and sugum	
Pastoral						
Count	46	5	16	7	9	83
Percent	55.4	6.0	19.3	8.4	10.8	100
Agropastoral						
Count	5	1	31	0	4	41
Percent	12.2	2.4	75.6	0.0	9.8	100
Overall (%)	41.1	4.8	37.9	5.6	10.5	100

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4.6 Live Body Weight and Linear Measurements

The body weight and linear measurements of sampled population were summarized in Table 21. Body weight and linear measurements varies among age, sex and to some extent the production systems.

Availability of few breeding male for screening was because of households' preference to keep female goats in favor of male to increase production efficiency and minimize handling problem. Most of the male animals are, therefore, preferably culled at juvenile age. The net effect of this act is availability of very few male animals. A similar limitation was faced by Fajemilehin and Salako (2008) who used smaller proportion of male (84 heads) to study the physical description of West African Dwarf (WAD) goat, Nigeria

4.6.1 Age effect:

Age ~~group~~ has significant ($P < 0.01$) effect on body weight and linear measurements and there were consistent increases in the traits considered as the animals aged (Table 21). This is expected since the size and shape of the animal increase as the animal advance in age. The variation in weight and body measurements sharply reduced at later stages (e.g. 3PPI and 4PPI). This may be attributed to the attainment of the mature weight in which growth rate is at decreasing rate. ~~This finding was in agreement with the work of~~ Jeffery and Berg (1972) also stated ~~who reported~~ that at maturity, linear body measurements are essentially a constant**,** thereby reflecting heritable size of the skeleton.

4.6.2 Sex effect

In all traits considered, males showed significantly ($P<0.001$, $P<0.05$) higher measurements than female except EL ($P>0.05$). The effect of sex in body weight and linear measurements in favor of males might be partly due to hormonal effect, androgen which is known to have growth and weight stimulating effects in male animals (Semakula *et al.*, 2010). The finding in this study was in consonance with other works (Grum, 2010; Leng *et al*., 2010; Dereje, 2011). Body weight and linear measurements revealed in this study both for mature males and females were similar to the observation of Nigatu (1994) for the same breed.

~~Body weight and linear measurements (CG, HW, BL, PW and HL) observed in this study for both males and females were lower than the report of FARM Africa (1996) for the same breed. The variation in the present and FARM Africa (1996) observation might be attributed to the selection toward adaptive traits like heat stress and feed shortage, since smaller animals need~~

~~lower maintenance requirement and energy to regulate body temperature (Kiwuwa, 1992) or it might be due to change in the management and environmental condition which could result poor performance and also change in genetic attributes (Nigatu *et al*., 2004).~~

4.6.3 Interaction effect of sex by age

The sex by age interaction has significant effect ($p<0.01$) for weight and body measurements (Table 21). The interaction effect of sex and age was ~~in goat breed is~~ also evident in other studies (Workneh, 1992; Dereje, 2011). In both sexes, body weight and measurements increased as age of the animal advances. In all parameters except BCS, females showed wider range of variation in measurements between age class 0PPI and 1PPI and a narrow variation was observed at later age groups. While male goats' shows accelerated growth through 0PPI to 2PPI years and slower growth rate was observed post age group of 2PPI. A similar growth trend was reported in other observations (Leng *et al*., 2010; Grum, 2010).

The growth trend in this study may suggest that the age between one and three years may be the age in which the animal shows the fastest growth rate. This is expected since animals, under normal conditions, grow fast when younger but grow slowly when they reach maturity (Mekasha, 2007).

The live weight of males and females at age ~~3~~2PPI were about 83.1~~92.2~~% and ~~98~~4.4~~6~~% of that at age group 4PPI, respectively. This suggests that, farmers could sell goats after age group 2~~3~~PPI, however such decision cannot be solely made on biological parameters and the availability of feed and other cost associated with their husbandry would certainly play an important role in making such decision.

Table 2121 Least square means and standard error (LSM ± SE) for main effects of dentition (PPI), sex and production system (PS) and sex by age interaction effect on body weight (kg) and linear measurements of Afar goat breed.

Effects & level	N	Body weight	CG	CW	BL	HW	PW	BCS	HL	EL	SC
Overall	891	23.8 ± 0.21	62.17 ± 0.23	7.00 ± 0.06	60.96 ± 0.25	57.5 ± 0.20	12.9 ± 0.04	2.3 ± 0.04	21.4 ± 0.28	12.7 ± 0.12	23.4 ± 0.42
R^2		0.50	0.54	0.24	0.41	0.36	0.33	0.18	0.63	0.06	0.44
C.V		14.04	5.5	14.04	6.17	5.15	9.75	33.6	20.27	11.24	12.24
Dentition		***	***	***	***	***	**	NS	***	***	***
0PPI	127	19.10 ± 0.31^{a}	56.3 ± 0.34^{a}	6.2 ± 0.10^{a}	56.1 ± 0.37^{a}	54.0 ± 0.29^{a}	11.3 ± 0.12^{a}	2.60 ± 0.07^{a}	14.8 ± 0.43^{a}	11.96 ± 0.15^{a}	19.9 ± 0.58^{a}
1PPI	87	21.43 ± 0.55^{b}	60.2 ± 0.40^{b}	6.8 ± 0.11^{b}	59.8 ± 0.44^{b}	56.2 ± 0.34^{b}	12.5 ± 0.15^{b}	2.51 ± 0.08^{a}	18.1 ± 0.50^{b}	12.91 ± 0.18^{b}	22.3 ± 0.80^{b}
2PPI	58	23.96 ± 0.45^{c}	62.7 ± 0.48^{c}	7.3 ± 0.14^{c}	60.4 ± 0.53^{c}	57.9 ± 0.41^{c}	13.1 ± 0.18^{c}	2.26 ± 0.09^{b}	21.7 ± 0.06^{c}	12.87 ± 0.22^{b}	24.0 ± 0.98^{bc}
3PPI	142	26.33 ± 0.32^{d}	65.2 ± 0.34^{d}	7.3 ± 0.10^{c}	63.3 ± 0.37^{d}	59.7 ± 0.29^{d}	13.4 ± 0.13^{c}	2.33 ± 0.04^{b}	23.6 ± 0.42^{d}	12.93 ± 0.15^{b}	25.1 ± 0.86^{c}
4 PPI	477	27.35 ± 0.25^{e}	66.5 ± 0.26^{e}	7.4 ± 0.07^{c}	64.83 ± 0.29^{e}	59.8 ± 0.23^{d}	13.9 ± 0.10^{d}	2.00 ± 0.05^{c}	25.9± 0.33^{e}	12.98 ± 0.12^{b}	26.0 ± 1.12^{c}
Sex		***	***	***	**	***	***	***	***	*	
Female	823	20.87 ± 0.15	59.5 ± 0.16	6.5 ± 0.05	58.9 ± 0.18	55.4 ± 0.14	12.4 ± 0.06	2.15 ± 0.03	15.4 ± 0.21	12.5 ± 0.07	NA
Male	68	26.44 ± 0.39	64.8 ± 0.42	7.5 ± 0.12	63.1 ± 0.46	59.6 ± 0.36	13.3 ± 0.15	2.51 ± 0.08	26.3 ± 0.52	13.0 ± 0.19	NA
PS		***	NS	***	NS	NS	NS	**	**	NS	NS
Agropastoral	281	24.12 ± 0.26	61.9 ± 0.28	6.7 ± 0.08	61.1 ± 0.31	57.5 ± 0.24	12.9 ± 0.10	2.46 ± 0.06	20.3 ± 0.29	12.7 ± 0.12	24.0 ± 0.66
Pastoral	610	23.19 ± 0.22	62.6 ± 0.24	7.3 ± 0.07	60.8 ± 0.26	57.6 ± 0.20	12.8 ± 0.09	2.21 ± 0.05	21.3 ± 0.35^{b}	12.7 ± 0.11	22.6 ± 0.46
Sex*age		***	***	NS	***	***	***	***	***	NS	
Femal 0PPI	105	16.8±0.30^{a}	54.5±0.32^{a}	5.9±0.0.10^{a}	54.6±0.36^{a}	52.4±0.28^{a}	11.0±0.12^{a}	2.46±0.07^{a}	10.7±0.38^{a}	11.7±0.14	NA
Femal 1PPI	75	19.1±0.35^{b}	58.1±0.38^{b}	6.5±0.12^{b}	58.1±0.42^{b}	54.4±0.33^{b}	12.1±0.14^{b}	2.31±0.08^{a}	13.1±0.44^{b}	12.6±0.17	NA
Femal 2PPI	50	20.5±0.43^{c}	60.4±0.47^{c}	7.1±0.14^{c}	57.9±0.52^{b}	55.7±0.41^{c}	12.6±0.17^{c}	1.96±0.09^{b}	16.2±0.54^{c}	12.7±0.21	NA
Femal 3PPI	128	23.0±0.27^{d}	62.4±0.29^{d}	6.9±0.09^{c}	61.2±0.32^{c}	57.4±0.25^{d}	12.9±0.11^{c}	2.09±0.06^{b}	17.1±0.33^{c}	12.7±0.13	NA
Femal 4PPI	465	24.3±0.14^{e}	63.9±0.15^{e}	7.0±0.05^{c}	62.6±0.17^{d}	57.6±0.13^{d}	13.4±0.06^{d}	1.72±0.03^{e}	20.0±0.18^{d}	12.8±0.07	NA
Male 0PPI	22	18.7±0.65^{bf}	55.9±0.71^{af}	6.4±0.21^{bd}	55.0±0.78^{ae}	54.1±0.61^{be}	11.0±0.26^{ae}	2.43±0.14^{abf}	14.4±0.79^{bce}	12.3±0.32	NA
Male 1PPI	12	20.7±0.89^{bcf}	60.8±0.96^{cdg}	7.4±0.29^{ce}	59.3±1.05^{bcf}	56.8±0.83^{cdf}	12.6±0.35^{bcf}	2.5±0.19^{abf}	19.4±1.07^{df}	13.6±0.45	NA
Male 2PPI	8	28.6±1.08^{g}	65.5±1.17^{eh}	7.6±0.36^{cef}	64.6±1.29^{dg}	61.0±1.02^{g}	13.5±0.43^{cdfg}	2.63±0.24^{abf}	25.8±1.32^{g}	13.0±0.71	NA
Male 3PPI	14	31.7±0.82^{h}	71.0±0.89^{i}	8.3±0.27^{f}	68.2±0.98^{h}	63.2±0.77^{gh}	13.9±0.33^{dg}	2.50±0.18^{abf}	37.1±1.03^{h}	13.0±0.38	NA
Male 4 PPI	12	34.4±0.89^{i}	73.9±0.96^{j}	8.3±0.29^{f}	70.8±1.05^{h}	65.0±0.83^{h}	16.3±0.35^{h}	2.58±0.19^{abf}	37.9±1.07^{h}	12.8±0.41	NA

^{a,b,c,d,e,f,g,h,i} means on the same column with different superscripts, within the specified class variable, are significantly different ($p < 0.05$); Ns = non-significant; *P< 0.05; ** P< 0.01; CG = Chest Girth; CW = Chest width; BL= Body length; HW = height Wither; PW = Pelvic Width; BCS = Body Condition Score; HL = Horn Length; EL = Ear Length; SC = Scrotal Circumference; 0PPI = 0 Pair of Permanent Incisors, 1PPI =1 Pair of permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors; NA = Not Applicable.

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4.6.4 Correlation between live body weight and linear measurements

The correlation between body weight with body measurements in the pooled data ~~was positive~~was positive and significant (P< 0.01). The relationship of body weight over other variables with respect to sex and age category was presented in Table 22. Within females, body weight shows a positive and significant (P < 0.01, P < 0.05) relationship with body measurements across all age group. Chest girth (r=0.84) and body length (r=0.70) showed positive and strong association (P< 0.01) with body weight.

In the pooled data (0-4PPI) set of males, CG, BL, HW, PW, SC and HL show strong and positive correlation (r<0.01) with body weight. Negative and non-significant association of EL and body weight was found for the pooled data~~e~~ of 3PPI – 4PPI. In this study, scrotal circumference showed ~~highly~~ significant association (P<0.01) with live body weight in all age categories. Therefore, selection for scrotal circumference would lead to males with high potential for sperm production while indirectly improving body weight.

The pooled data of males showed higher 'r' value than pooled data of female for all variables except EL (r=0.07). This signifies the stronger association of body weight with linear measurements in male than female. Therefore, a separate regression equation for each sex would be preferable to estimation body weight from independent variables.

The higher association between body weight and measurements demonstrated the possibility of using simple body measurements that can be carried out in the field to predict body weight. For both males and females in all age categories, chest girth consistently gave higher correlation with body weight as compared with other body measurements. This is also evident in several studies (Fajemilehin and Salako, 2008; Leng *et al*., 2010; Grum, 2010; Dereje, 2011)

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Table 2222 Coefficients of correlation between body weight and body measurements within age and sex groups

		Age group									
		Male			Female						Overall
Trait		0-1PPI	2-4 PPI	0-4PPI	0PPI	1PPI	2PPI	3PPI	4PPI	0-4PPI	
CG	R	0.69**	0.81**	0.94**	0.75**	0.76**	0.66**	0.67**	0.71**	0.84**	0.86**
	N	34	34	68	105	75	50	128	465	823	891
CW	R	0.48**	0.16Ns	0.58**	0.46**	0.22NS	0.09NS	0.10NS	0.23**	0.37**	0.42**
	N	34	34	68	105	75	50	128	465	823	891
BL	R	0.59**	0.62**	0.88**	0.66**	0.42**	0.50**	0.56**	0.47**	0.70**	0.73**
	N	34	34	68	105	75	50	128	465	823	891
HW	R	0.66**	0.51**	0.87**	0.52**	0.49**	0.57**	0.48**	0.34**	0.61**	0.67**
	N	34	34	68	105	75	50	128	465	823	891
PW	R	0.57**	0.61**	0.83**	0.45**	0.53**	0.47**	0.34**	0.43**	0.62**	0.65**
	N	34	34	68	105	75	50	128	465	823	891
BCS	R	0.33NS	0.45**	0.27*	0.30**	0.57**	0.27NS	0.36**	0.40**	0.04Ns	0.04**
	N	34	34	68	105	75	50	128	465	823	891
HL	R	0.73Ns	0.61NS	0.91**	0.72**	0.33**	0.47**	0.52**	0.29**	0.64**	0.72**
	N	34	33	67	96	73	48	127	439	783	850
EL	R	0.40*	-0.3Ns	0.07NS	0.27**	0.09NS	0.31*	0.20*	0.02Ns	0.21**	0.20**
	N	32	32	64	102	72	47	123	443	787	851
SC	R	0.66**	0.53**	0.73**	NA	NA	NA	NA	NA	NA	0.73**
	N	34	27	61	NA	NA	NA	NA	NA	NA	61

R= coefficient of correlation; N= Number of observation; NS = non-significant; *P< 0.05; ** P< 0.01; CG = Chest Girth; CW = Chest width; BL= Body length; HW = height Wither; PW = Pelvic Width; BCS = Body Condition Score; HL = Horn Length; EL = Ear Length; SC = Scrotal Circumference; 0PPI = 0 Pair of Permanent Incisors, 1PPI =1 Pair of Permanent Incisors; 2PPI = 2 Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors, NA = Non-applicable.

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4.6.5 Multiple r~~R~~egression analysis

A stepwise regression was employed in the current study to develop the best fit regression equation for male and female. Each of the available predictors is evaluated with respect to how much R^2 would be increased by adding it to the model. The best model, the one with highest R^2 and smaller Mallow's C_p which is close to p (the number of parameters in the model, including the intercept) will be selected (Wuensch, 2006~~)~~).

Summary of multiple linear regression analysis and generated models for predicting body weight from body measurements for each sex ~~categories~~ at different age categories were~~is~~ presented in Table 23. In the entire model, chest girth was the single most important variable to produce the largest R2. For the pooled data of females, chest girth (CG), body length (BL), height at wither (HW), pelvic width (PW) and body condition score (BCS) are the best multiple regressor (R2=0.78 and Cp=5.9) to estimate body weight. For the pooled data of male, four alternative model was identified with a slightly varied R2 (0.89 – 0.92) and Mallow's Cp ranging from 22.2–4.8. Chest girth, BL, HW and BCS are the best regressor variables to predict body weight of male. Nevertheless, the remaining equations can also be used with lesser precision under different circumstance (time, cost and ease of application).

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The pooled data of male ~~have~~ shows higher coefficient of determination than the pooled data of female. A similar situation was also reported in other studies (Grum, 2010; Dereje, 2011). Therefore, using a separate equation for each sex is feasible and can substantially increase precision to estimation ~~of~~ body weight

Table 2323 Prediction equations for body weight at different sex and age groups

Dentition	Equations	Intercept	β1	β2	β3	β4	β5	β6	R^2	Δ R^2	Cp
Female	CG	-19.2	0.66						0.56	0	38.7
0PPI	CG+BL	-23.7	0.49	0.25					0.64	0.07	16.9
	CG+BL+BCS	-25.3	0.49	0.23	1.10				0.69	0.05	3.04
1PPI	CG	-24.05	0.74						0.58	0	45.4
	CG+BCS	-21.50	0.64	1.5					0.73	0.14	7.4
	CG+BL+BCS	-25.0	0.58	0.12	1.5				0.74	0.02	5.0
2PPI	CG	-19.1	0.66						0.44	0	25.4
	CG+HW	-35.7	0.53	0.44					0.58	0.14	9.7
	CG+BL+HW	-42.3	0.42	0.23	0.43				0.62	0.05	5.8
	CG+BL+HW+PW	-43.2	0.34	0.23	0.42	0.53			0.64	0.03	3.5
3PPI	CG	-19.7	0.68						0.45	0	46.0

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	CG+BCS	-19.6	0.64	1.2					0.52	0.07	26
	CG+BL+BCS	-25.1	0.49	0.25	1.2				0.58	0.06	9.1
	CG+BL+HW+BCS	-29.8	0.40	0.23	0.19	1.3			0.60	0.02	4.2
4PPI	CG	-16.5	0.64						0.51	0.0	159.7
	CG+BL	-15.9	0.59	1.4					0.59	0.08	59.6
	CG+BL+BCS	-22.6	0.53	0.18	1.3				0.625	0.04	16.2
	CG+BL+PW+BCS	-23.1	0.50	0.16	0.26	1.3			0.632	0.008	8.5
	CG+BL+HW+PW+BCS	-25.7	0.48	0.15	0.08	0.25	1.3		0.636	0.004	5.4
0-4PPI	CG	-22.9	0.73						0.71	0	262.7
	CG+BL	-27.4	0.59	0.22					0.74	0.03	135.6
	CG+BL+BCS	-30.7	0.60	0.23	0.93				0.769	0.03	36.0
	CG+BL+HW+BCS	-24.34	0.36	0.22	0.14	0.37			0.776	0.003	13.8
	CG+BL+HW+PW+BCS	-33.5	0.53	0.20	0.12	0.20	0.96		0.778	0.002	5.9
Male	CG	-30.2	0.87						0.89	0	22.2
(0- 4PPI)	CG+BCS	-33.3	0.85	1.71					0.907	0.02	11.8
	CG+ HW + BCS	-38.4	0.72	0.24	1.6				0.914	0.008	7.8
	CG+BL+HW+BCS	-39.8	0.56	0.18	0.23	1.7			0.921	0.006	4.8

BL= Body length; CG = Chest Girth; CW = Chest width WH = Wither height; PW = Pelvic Width; SC = Scrotal circumference; SL = Scrotal Length; BC = Body Condition Score; 0PPI = 0 Pair of Permanent Incisors, 1PPI =1 Pair of Permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors

4.7 Morphological Characteristics of Goat Population

The major morphological traits of the breed were presented in Table 24. The observation in this study revealed that 44.3% of the sample population were patchy, 28.2% spotted and 26.8% plain coat color pattern. The dominant coat color types were black (46.6%) and white (43.8%). About 40.7%, 36.9% and 21.7% of black colored goats are patchy, plain and spotted pattern, respectively. Similarly, 48.1%, 16.9% and 34.8% of white coat color goats are patchy, plain and spotted form, respectively (Fig 4).

Almost all males (98.5%) and females (95.1%) possess horn. The mean horn length of males and females were 26.3 and 15.4 cm, respectively. From a total of horned goats 86.3% (N=770) had straight horn shape which is oriented either lateral (14.0%), upward (76.6%) or backward (9.4%). Most males have beard (67.6%) and ruff (82.4%) whereas small proportion of females have beard (2.3%) and ruff (1.5%). wattles appear in 13.5% of females. Majority of the sample population have a convex facial profile (49.9%), straight back profile (80.6%) and horizontal ear form (42.0%). The head profile rang from markedly concave through straight to convex with variation between sexes. Markedly convex head profile is relatively higher in males (25.0%) than females (2.9%).

Most of the morphological traits were in consonance with the report of Nigatu (1994) except higher frequency of black coat color and convex head profile in this observation. Similar to this observation Workneh (1992) reported ~~Change in head profile may be due to alteration of the word convex with concave otherwise it was mentioned that the~~ convex head profile predominantly occurring ~~ed~~ in the lowland areas ~~(Werkneh, 1992)~~. This is to be expected in view of the role of a larger space in the nasal cavity for thermoregulation (Bonsma, 1983).

Further investigations of goat types at the same sample sites after some time can be done to try to assess gradual morphological changes, which could give clue to the extent of genetic erosion (~~Lauvergne~~ Rege and Okeyo, 2006~~*et al*., 1987~~). Some respondents in this study associated goats with presence of horn and black coat color with hardiness and high milk yield. Therefore, the presence of high incidence of horn and black color goats might be due to selection pressure for these traits.

Table 2424 Description of physical features of the breed

Character	Attribute	Sex				Overall %
		Female		Male		
		No.	%	No.	%	
Coat colour pattern	Plain	234	28.4	5	7.4	26.8
	Patchy	357	43.4	38	55.9	44.3
	Spotted	226	27.5	25	36.8	28.2
	Streak	6	0.7	0	0	0.7
	Overall	823	100.0	68	100	
Coat colour type	White	357	43.4	33	48.5	43.8
	Creamy white	4	0.5	1	1.5	0.6
	Black	384	46.7	31	45.6	46.6
	Red	24	2.9	1	1.5	2.8
	Brown	11	1.3	2	2.9	1.5
	Grey	43	5.2	0	0	4.8
	Overall	823	100	68	100	
Horn shape	Polled	31	3.8	1	1.5	3.6
	Rudimentary	9	1.1	0	0	1
	Straight	723	87.7	47	69.1	86.3
	Curved	59	7.2	20	29.4	8.9
	Spiral	2	0.2	0	0	0.2
	Overall	823	100	68	100	
Horn orientation	Lateral	131	16.7	23	34.3	18.1
	Upward	565	72.1	40	59.7	71.1
	Back ward	88	11.2	4	6.0	10.8
	Overall	784	100	67	100	
Horn length	Short	718	91.6	36	53.7	88.6
	Medium	66	8.4	20	29.9	10.1
	Long	0	0	11	6.4	1.3
	Overall	784	100	67	100	
Ear form	Erect	322	39.1	20	29.4	38.4
	Carried horizontally	337	40.9	37	54.4	42.0
	Semi pendulous	128	15.6	7	10.3	15.2
	Rudimentary	36	4.4	4	5.9	4.5
	Overall	823	100	68	100	
Beard	Absent	804	97.7	22	32.4	92.7
	Present	19	2.3	46	67.6	7.3
	Overall	823	100	68	100.0	
Wattle	Absent	715	86.9	68	100	87.9
	Present	108	13.1	0	0.0	12.1
	Overall	823	100	68	100.0	
Ruff	Absent	811	98.5	12	17.6	92.4
	Present	12	1.5	56	82.4	7.6

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Character	Attribute	Sex				Overall %
		Female		Male		
		No.	%	No.	%	
	Overall	719	100	162	100	
Back profile	Straight	663	80.6	55	80.9	80.6
	Slightly bent down	158	19.2	13	19.1	19.2
	Bent down	2	0.2	0	0	0.2
	Overall	823	100	68	100	
Head profile	Straight	409	49.7	22	32.4	48.4
	Slightly convex	384	46.7	20	29.4	45.3
	Markedly convex	24	2.9	17	25.0	4.6
	Slightly concave	6	0.7	8	11.8	1.6
	Markedly concave	0	0	1	1.5	0.1
	Overall	823	100	68	100	

~~**sample goat population**~~

~~Table 24 (continued)~~

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Fig 4 The dominant coat color type and pattern of Afar goat population

4.8 Indigenous Knowledge (IK) on Goat Breed and Breeding

4.8.1 Local concept about key and special characteristics of the breed

The communities inference about the "Key and special characteristics" of Afar goat breed were relative to other goat breeds or types found within their migratory reach or previously introduced in the area. The locales are familiar with central highland, Abergelle and *Issa~~issa~~* (short-eared Somali) breeds or types that can be found in the breeding tract of the Region~~region~~.

Key characteristics refers unique feature that differentiate the breed from other adjoining breeds or type. Accordingly, 100% of the respondents believe that they raise a unique breed. And the key identifying features stated were listed in Table 25.

The dominant spotted and patchy coat color pattern (34%), long upward pointing horn (3.2%) and fine hair coat (2.4%) and a combination of features (75.8%) were mentioned as the unique feature that distinguish the Afar breed from other neighboring breeds. The respondent also mentioned that their breed got unique behavior (6.5%). Behaviors like returning home for milking, begging to be milked, and alertness to predator during night time and staying at homestead ~~lying outdoor~~ quietly until the herder moves them. These traits were also mentioned during participatory rating of preferred trait. The communities inference was in consonances with the report of FARM Africa (1996) ~~Nigatu, (1994)~~ who stated ~~has also reported the~~ patchy coat color, long thin upward-pointing horns, concave facial profile, narrow face, long-limb and prick-eared as Key identifying features of Afar goat breed. This indicates the implicit knowledge of the community ~~pastoral~~ in identifying different breeds, strains or population that greatly facilities community-based genetic improvement programs.

Table 25~~25~~ Key identifying features of Afar goat breed mentioned by respondents (%)

Production Systems	Key characteristics (%)							
	Color	Horn	Fine hair	Udder size	Color & fine hair	Color, horn & fine hair	Behavior	All features
Pastoral (N=83)	32.5	3.6	3.6	1.2	6	47	3.6	2.4
Agropastoral (N=41)	36.6	2.4	0	0	31.7	12.2	12.2	4.9
Total (N=124)	33.9	3.2	2.4	0.8	14.5	35.5	6.5	3.2

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The local concept also extended to perceptions about special attributes of the goat population. According to the FGD members and individual interviewees, tolerance to ecto-parasite, ability to walk long distances, drought and heat stress tolerance were mentioned as special attributes of Afar goats.

The area is very much infected with external parasites due to mixing and overcrowding of flock. Tick and mange mite infestation is lethal to other goat breeds, types or populations~~flocks that come from other area in search of feed (I witnessed to this incidence)~~ , but not for the local breeds (I observed external parasite infestation causing death to different goat population that come from other localities in search of feed). The fact that goats were usually taken in cross border migration to Djibouti and the far north east and western part of the Region~~region~~ without major losses was referred to support claim of extra ordinary ability of the Afar goat to walk long distances.

Respondents also appreciated the ability of the breed to tolerate feed and water shortages during ~~the~~ dry seasons. The locals associate feed shortage tolerance of the Afar goat, as evidence for the ability to utilize low quality feeds such as branches of large thorny shrub trees which are cut and fed to goats during the dry season. The locals also mentioned that they can even eat paper, carton and barks. They also mentioned that their goats have the tendency to remain active and grazing despite peak temperatures in the afternoon~~.~~ ~~According to them this is~~as ~~-~~an evidence of heat tolerance of their goats which in turn contributes to their ability to stay less affected by the dry seasons.

The special attributes mentioned in this observation were in harmony with the report of FARM-Africa (1996) which stated that ~~Generally, a~~Afar goats are well adapted to arid environments where they are watered every three to four days. They ~~se goats~~ are also hardy and used to long distance trekking in search of feed and water ~~(FARM-Africa, 1996)~~. However, the goats in this area are not dehydration tolerance more than two days when they migrate during dry seasons. This may be due to the free availability of water throughout the year in the study area.

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Some of the respondents and FGD members also recalled a historic event in which the local administration introduced twine birth giving large sized ~~Zumbabe~~Zimbabwe cross breed and local ~~b~~Borena and ~~a~~Abergalle breeds (recently, before five years). According to the informants, all the breeds were unable to survive the feed shortage and heat stress. This indicates the ability of the breed to survive and produce under the harshest environmental condition of the country. Rege and Okeyo (2006) stated that populations with different adaptive characteristics or possessing unique physiological characteristics should be recognized as different breeds. This distinction should be drawn even if the populations are shown to be relatively closely related based upon measures of genetic distance. Therefore, the goat population in this area can be at least regarded as a unique strain and should be conserved for its adaptive traits which will be ~~vital~~ needed in predictive incidence of climatic change. ~~Besides, consultation with the community prior to introduction of any breed will save resource wastage.~~ Failure in the introduction of the other breeds should be taken as a lesson that without the participation of the community, failure in breed improvement is inevitable. Besides, consultation with the community prior to introduction of any breed will save resource wastage.

The locals also claim superior milk and meat flavor as special attributes of the Afar goat. They associate the meat flavor quality with the mineralized spring water, salty soil type and quality of diverse browse species in the area. “This is the main reason why the breed gets more preference in the local as well as international market”. However, they admitted that when compared with ~~i~~*Issa* (short – eared Somali) goat, afar breed are inferior in meat yield & flavor (quality) for the reason that *Issa* ~~issa~~ goats have more access to a diverse browse species, mineralized spring water supply, abundance salty soil and less tick problems.

4.8.2 Participatory definition of trait preferences

Goat flock owners were asked to choose their first, second and third best male and female goat among the flocks and then to mention the reasons for their preferences. Subsequently, only the first three reasons from the first, second and thirdly chosen animal were used for ranking. This participatory definition of trait was used since it allow respondents to mention as many reason as possible for their preferences without being limited to predetermined lists (selection criteria).

The trait preference of households and their reason for each sex was presented in Table 26 and Table 27.

Milk yield (I=0.35), drought tolerance (I=0.14), kid sex (giving birth to female) (I=0.103) and behavior (I=0.10) of the dam were frequently ~~used~~ mentioned traits to define best females in both production systems except kid sex was ranked fourth in agropastoral system. Milk yield was the first and highly valued traits in both production systems ~~with an overall index value of 0.35.~~.

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Since milk is the principal and continually recurring ingredient of the diet in the area, there is no doubt that does with high milk yield ~~was~~ would be the first choice regardless of weakness in other traits. Besides, ~~T~~the reductions both in number as well as milk yield of cattle and camel have increased the dependency of households on goats as milk sources. Pastoralists and agropastoralists strong preference~~s~~ for milk production trait was in harmony with the breeding objective and selection criteria they have employed. Drought tolerance, the ability of doe to survive and produce under harsh environmental condition, was rated as the second important reason. Majority of the respondents mentioned that their best does is the one that give birth and milk during dry seasons providing milk for their children when the most of the female fail to do so.

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This survey result was in agreement with Workneh (1992) who stated that unlike small-scale farmers' pastorals and agropastorals attached more preferences toward milk yield, adaptability and drought resistance features of goats. The same author further stated that goat was ~~was~~ praised especially for its milk in the goat dominated pastoral systems ~~(Workneh, 1992)~~.

Though the proportion of male and female birth may be similar in the total population, a particular doe with most female birth will be given more preferences. In the area where goats are mainly kept for milk production, the main interest of the community is increasing the number of female goats, consequently milk ~~production,~~production; this may be the reason ~~that's~~ why the locale attached strong preferences of doe with female birth. Beside, seasonal parturition ~~patter~~ pattern accompanied by large flock results calving of many kids at similar time, hence caring for

kids is a very tedious job especially for ~~movable~~ mobile pastorals. Thus male kids are regarded as a burden this in turn influenced the preference of doe with most female birth.

Although there is an equal chance of both male and female birth, this great interest towards female kid should be put in to consideration if artificial insemination (AI) technology were going to be used or if there is any room for improving the trait. ~~Since a n~~Natural sex ratio at birth little in favor of females was reported for the tropics and subtropics as well as goat breeds in southern Ethiopia (Devendra and McLeroy, 1982; Workneh, 1992).

Table 2626 List of trait preference of households and their corresponding rating for does

Traits	Pastoral				Agropastoral				Overall			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Milk yield	42.0	25.9	12.3	0.317	53.7	29.3	9.8	0.382	47.8	27.6	11.1	0.349
Kid sex	8.6	18.5	12.3	0.126	7.3	9.8	7.3	0.081	8.0	14.1	9.8	0.103
Offspring quality	6.2	9.9	7.4	0.076	4.9	9.8	12.2	0.077	5.5	9.8	9.8	0.077
Drought tolerance	14.8	13.6	16.0	0.146	9.8	19.5	17.1	0.142	12.3	16.5	16.5	0.144
Behavior* & flock leading	7.4	9.9	18.5	0.101	4.9	12.2	17.1	0.093	6.1	11.0	17.8	0.097
Body size and conformation	4.9	4.9	9.9	0.058	7.3	2.4	2.4	0.049	6.1	3.7	6.2	0.053
Color	3.7	3.7	6.2	0.041	4.9	2.4	14.6	0.057	4.3	3.1	10.4	0.049
Twining rate	7.4	8.6	3.7	0.072	7.3	2.4	7.3	0.057	7.4	5.5	5.5	0.064
Family history	-	-	-	-	-	-	-	-	-	-	-	-
Mothering ability	0.0	1.2	4.9	0.012	-	-	-	-	-	0.6	2.5	0.006
Foraging ability	-	-	-	-	-	-	2.4	0.004	-	-	1.2	0.002
Kidding interval	2.5	2.5	6.2	0.031	-	7.3	7.3	0.037	1.2	4.9	6.7	0.034
Longevity	2.5	1.2	2.5	0.021	-	4.9	2.4	0.02	1.2	3.1	2.5	0.02

[a]R1, R2 and R3 = Rank 1, 2 and 3 respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual attribute divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall attributes. *behavioral traits like standing at night as guard, returning home, turning to the owner as he/she calls its name, docility

There were some "irrational" and non-genetic parameters mentioned constantly. However, not all the reasons seemingly "irrational" can be taken so for granted as the locals were driven by some concept of associations with important traits (Grum, 2010). For instances, s~~S~~ome

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behavioral characters like flock leading and the tendency of a goat standing during the night were associated with adaptive trait and mothering/fathering care.

In extensive grazing system especially with large flock size, behavior of goat like flock leading to good feed resources areas ~~and strait back to home at dawn~~ is associated with a character to exploit seasonal variations in feed resources and maximize "feeding competence" with other flock ~~and minimize the load of goat keepers~~. Similar phenomenon was indicated in Niger. The WoDaaBe herders in Niger select their animals for their "feeding competence", defined as the ability to select the best season-specific browse or graze (Krätli, 2008). Flock leading was also mentioned as preferred trait in *Issa*~~issa~~ pastoralists (Grum, 2010). The *Issa* community associates this behavior with behavior of "alertness" similar to the instinct employed by wild prey species to constantly remain cautious of and evade itself from a predator attack (Grum, 2010)

Other behavior like a goat standing in the flock during the night as guard or alert to predator (while other goats asleep) was also indicated as important character especially when predator is a great problem. The communities associated this behavioral ~~patter~~ pattern with a tendency of maternal caring for female and paternal caring for male. Nari herders' in India are well know developing Nari cows, which are special adaptive behavior of defending their calves from leopards by forming a circle around the young animals and shielding them with their extremely long and pointed horns and the cows will also defend their owners in the same manner, if they perceive a threat to them (Köhler-Rollefson and LIFE Network, 2007).

Nevertheless, there were some reasons which could neither be associated to other traits nor have any genetic basis, such as flock leading strait back to home at dawn, love of the animal to the owner, expressed through turning to the owner as he/she calls its name and goats that return home to be milked and rest at backyard after milked until the herder moves them.

~~**Table 26 List of trait preference of households and their corresponding rating for does**~~

~~Traits~~	~~Pastoral~~	~~Agropastoral~~	~~Overall~~

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	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Milk yield	42.0	25.9	12.3	0.317	53.7	29.3	9.8	0.382	47.8	27.6	11.1	0.349
Kid sex	8.6	18.5	12.3	0.126	7.3	9.8	7.3	0.081	8.0	14.1	9.8	0.103
Offspring quality	6.2	9.9	7.4	0.076	4.9	9.8	12.2	0.077	5.5	9.8	9.8	0.077
Drought tolerance	14.8	13.6	16.0	0.146	9.8	19.5	17.1	0.142	12.3	16.5	16.5	0.144
Behavior* & flock leading	7.4	9.9	18.5	0.101	4.9	12.2	17.1	0.093	6.1	11.0	17.8	0.097
Body size and conformation	4.9	4.9	9.9	0.058	7.3	2.4	2.4	0.049	6.1	3.7	6.2	0.053
Color	3.7	3.7	6.2	0.041	4.9	2.4	14.6	0.057	4.3	3.1	10.4	0.049
Twining rate	7.4	8.6	3.7	0.072	7.3	2.4	7.3	0.057	7.4	5.5	5.5	0.064
Family history	-	-	-	-	-	-	-	-	-	-	-	-
Mothering ability	0.0	1.2	4.9	0.012	-	-	-	-	-	0.6	2.5	0.006
Foraging ability	-	-	-	-	-	-	2.4	0.004	-	-	1.2	0.002
Kidding interval	2.5	2.5	6.2	0.031	-	7.3	7.3	0.037	1.2	4.9	6.7	0.034
Longevity	2.5	1.2	2.5	0.021	-	4.9	2.4	0.02	1.2	3.1	2.5	0.02

[a]R1, R2 and R3 = rank 1, 2 and respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons. *behavioral traits like standing at night as guard, returning home, turning to the owner as he/she calls its name, docility

Fig 5 An individual household's preferred female (left) and male (right) goat

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Unlike doe the best buck was primarily rated based on the physical appearance. Males with big body size and good conformation (tall, up right standing, strait back profile etc) was viewed as best buck in both production systems followed by a beautiful color (patchy or spotted) in agropastoral and behavior in pastoral system (Fig 5). Higher preferences for body Size was also reported for Kenya pastoral (Kosgey, 2004). As indicated earlier behavioral patterns like flock leading and guarding the flock at night were very important in pastoral communities where there exist large number of flock and constant mobility. Conversely, in agropastoral society that has better acquaintance to market, color is more important to attract good price than behavior. Some respondent mentioned that a household who owe bucks with an attractive physical appearance (big body size, beautiful conformation and color) receive a higher social status and honor. This might have influenced their rating

Table 27272727 List of trait preference of households and their corresponding rating for buck

Traits	Pastoral[a]				Agropastoral[a]				Overall			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Body size and conformation	40.2	32.9	11.0	0.329	42.9	39.3	3.6	0.351	40.9	34.5	9.1	0.335
Offspring quality	8.5	4.9	14.6	0.083	7.1	7.1	-	0.06	8.2	5.5	10.9	0.077
Behavior* and flock leading	17.1	22.0	20.7	0.193	17.9	10.7	28.6	0.173	17.3	19.1	22.7	0.188
Kid sex	7.3	4.9	4.9	0.061	3.6	-	7.1	0.03	6.4	3.6	5.5	0.053
Color	9.8	18.3	28.0	0.157	25.0	35.7	32.1	0.298	13.6	22.7	29.1	0.192
Growth rate	1.2	2.4	3.7	0.02	-	-	-	-	0.9	1.8	2.7	0.015
Drought tolerance	-	1.2	1.2	0.006	-	-	-	-	-	0.9	0.9	0.005
Walking style	-	-	2.4	0.004	-	-	-	-	-	-	1.8	0.003
Libido/ strength	12.2	9.8	9.8	0.11	-	3.6	10.7	0.03	9.1	8.2	10.0	0.089
Twining rate	2.4	-	-	0.012	-	-	-	-	1.8	-	-	0.009
Horn length	1.2	2.4	2.4	0.018	-	3.6	17.9	0.042	0.9	2.7	6.4	0.024
Dam milk yield	-	1.2	1.2	0.006	3.6	-	-	0.018	0.9	0.9	0.9	0.009

[a]R1, R2 and R3 = rank 1, 2 and respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons. *behavioral traits like standing at night as guard, returning home, turning to the owner as he/she calls its name, docility

Main behaviors of buck like flock leading and following the herder were frequently mentioned. Other behavioral characters such as male that respond when the owner call, standing at night as

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guard or alert to predator (regarded as father's care); not leaving with other flocks; ~~not mating other flock or~~ mating only his flock ~~&~~ and preventing outsider buck mating his flock~~/domain~~ were also mentioned. Additionally, ~~In addition to physical appearance and behavior,~~ sexual libido and vigor (0.09), offspring quality (0.08) and kid sex (0.05) were mentioned as important preferences reasons with a relatively intermediate index value.

4.8.3 Traditional breeding strategy

Breeding strategies are practices used to shape a breed intentionally according to peoples' preferences and priorities (LPPS and Kohler, 2005). The community has many IK that exercise them consciously in goat breeding. These IK includes identification system, oral record-keeping of genealogies, selection of breeding animals and mating control.

4.8.3.1 Identification system and genealogical keeping

Some of the respondents regarded identification of individual animal as easy as identifying their children. Identification techniques among or within flock varies based on number of flock and the association of the respondents' with the flock. A respondent who has longer and closer bond with the flock will have a better skill to identify individual goat. Some experienced goat keepers reported having the ability to recall each goat and identify their goat even using their sound and foot print.

In an endeavor to differentiate among and within flock, the most important identification system include recalling/memorizing (I = 0.32), coat color (I = 0.28), ear notching (I = 0.18), matrilineal naming (I = 0.12) of goats. Branding (I = 0.08) and horn shape and type (I = 0.05) ~~ear~~ were also used but ranked lower (Table 28). ~~Coat color (I = 0.273), recall system (I = 0.271), and aar notching (I=0.23) were the major identification means with an index value greater than 0.20 in pastoral production system while recalling (I = 0.37) was the first identification method followed by coat color (I = 0.26) in agropastoral PS. This may be due to the small number of goat possession in agropastoral production system that makes easily remembering of each goat.~~

Ear notching is mainly used to differentiate goats among various flocks. There is a unique type of ear cut for each clans and sub – clan flocks. Additionally, by varying the position of the ear cut, each household flock will be further separated among other flocks.

It was also observed that in some households best female goats are represented by the names of the family members. Consequently, her offspring belong to that same individual. For instance, the household ~~HH~~ may represent the best doe and consequently her offspring with his son. This coordination of does with family members facilitates easily sorting the descendents of best females and grouping of the flock. Elsewhere in Kenya the Maasai pastoral was reported to structure their cow herd in to "house", or female lineages. All descendants of a single cow form a "house", and they are all called by the same name (Galaty, 1989).

Table ~~28~~28 ~~various i~~Identification ~~methods~~ systems ~~used~~ employed in pastoral and agropastoral ~~production~~ systems

	Pastoral				Agropastoral				Overall			
Systems	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Recall system	39.8	16.9	9.6	0.27	56.1	17.1	17.1	0.37	47.9	17.0	13.4	0.32
Ear notching	21.7	25.3	19.3	0.23	14.6	9.8	19.5	0.14	18.2	17.5	19.4	0.18
Branding	2.4	6.0	10.8	0.05	7.3	14.6	14.6	0.11	4.9	10.3	12.7	0.08
Color	25.3	28.9	30.1	0.27	17.1	36.6	31.7	0.26	21.2	32.8	30.9	0.27
Horn type	2.4	10.8	16.9	0.08	-	2.4	4.9	0.02	1.2	6.6	10.9	0.05
Naming and family group	8.4	12.0	13.3	0.10	4.9	19.5	12.2	0.11	6.7	15.8	12.7	0.11

[a]R1, R2 and R3 = R~~r~~ank 1, 2 and 3 respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

The Afar community has a culture of memorizing personal ancestral genealogy as well as genealogy of their animals. Accordingly, 78.8% of overall respondents reported to mentally memorize genealogy ~~of every goat~~ through the maternal line of descent. Genealogy memorization is used to select breeding animals born to a superior maternal lineage. About 6 lines of maternal line recalling was mentioned in this survey result. Some respondents that raised goats for long period stated remembering about 14 ~~linages~~lineages. In the mean time, 80.6% of the respondents reported to recognize the sire of a kid (Table 33). They reported identifying sire of an offspring ~~thru~~ through observing the coat color, body conformation, ear form and horn shape and type of the offspring. They pointed out that buck with polled horn type and rudimentary ear form gives same offspring with similar horn type and ear form. This observation

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is different from the report of Dereje (2011) who indicated lower rate of sire identification. The higher percent of sire identification revealed in this survey may be facilitated by ~~due to~~ fewer breeding bucks kept in the flock.

This observation revealed that the community has a mechanism of keeping genealogy of animal and employ range of methods to identify individual animal among and within flocks. This indigenous knowledge enables the herders' to identify a particular animal throughout its lifespan. This imply that pedigree and performance recording has been practiced through intricate knowledge. Therefore, it was apparent that the pastoralists have deliberate selection criteria.

4.8.3.2 Selection of breeding animals

Selection of both male and female were reported (Table 33). However, the intensity of selection is more in male (93.5%) than female (45.2%). Similarly, Grum (2010) indicated higher intensity of selection for male (97.6%) than female (38.7%). Even though selection of breeding female is evident, the selection intensity was very low since disposal was limited to extremely inferior females locally referred as *'gundul'*. Instead of removing inferior females, goat owners rotationally mate them with superior bucks to improve the performances of their offspring ~~performances~~. Therefore, selection of breeding male is more sensible to the pastoralist than females to take the advantage of extra milk from inferior female and faster performance improvement from bucks'. This is in fact true since best male can sire many offspring, whereas the number of offspring from a female is far more limited (Bourdon, 2000).

Mathias and Mundy (2005) as well stated that in traditional breeding, selecting male animals is more practical than selecting females, since herd sizes are often too small to mate only the best females, and as the milk from all females in a herd is needed, smallholders and pastoralists may also let inferior animals get mated.

There was a consistency in selection criteria between pastoral and agropastoral production system. A list of selection criteria used in deciding which males and females to become the parents of the next generation was summarized in Table 29 and 30 in that order. Family history (I=0.30), big body size and conformation (I=0.26) and color (I=0.14) were the major selection criteria used for~~of~~ male goats in both production systems except body size and conformation (I=

0.32) was rated ~~positioned at first level with~~ slightly higher ~~value~~ than family history (I = 0.30) in agropastoral production system. According to the respondents, the male offspring of superior sire and/or dam with high milk yield if possible with twining incidence will be retained in the flock. Hence, the pastorals and agropastorals consider multiple ~~trait~~traits in the selection of breeding ~~stratagy~~strategy, which directs to design a community based genetic improvement program based on favored traits by the community.

The pastorals ability to memorize genealogy (75.8%) of their animal and identifying the sire of the offspring (85.5%) may have facilitated pedigree selection as the major criteria in bucks. However, sire identification and pedigree recalling may not be simple when the flock size is larger, which may necessitate to introduce a simple identification method in discussion with the community to set up community based genetic improvement.

Selection based on family history offers higher promise of success for characteristics with low heritability such as adaptation to drought or disease resistance (Hülsebusch und Kaufmann, 2002). This is in agreement with the breeding goal of households reported in section 4.8.2. It also facilitated selection of male a juvenile age. Consequently, unselected males mostly below ~~two~~ four weeks, ~~are~~ locally referred as *'bekel'*, ~~which~~ are disposed either through sell, gift or slaughtered for home consumption. This may best explain the selling of ~~*'bekel' which*~~*'bekel'* which is a unique feature to the Region~~region~~ and also major sources of income for households. In the same way, selection of breeding male at juvenile age was reported for Rendille and Gabra pastorals in Kenya and for Afar ethnic group (Nigatu, 1994; Mbuku *et al.*, 2006). Selection of male at adult stage is not uncommon. Among few buck that were retained in the flock, further selection will be made based on offspring testing (I=0.084) and sexual libido (I=0.076).

Male selection based on the performance of the dam was also reported in *Issa~~issa~~* pastoral community around Dire – Dawa district with high ranking (G~~i~~rum~~u~~, 2010). This observation was also in accordance with Dereje (2011) who found body size and conformation (I=0.27), coat color (I=0.2) and pedigree (I=0.15) as major criteria for selecting breeding male in low land area

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of west Harergha. ~~Else were~~Elsewhere in Kenya, Mbuku *et al.* (2006) also reported selection of male goats primarily using family performance.

Although scrotal type and tail type receive the lowest rating, it is important to note that the respondents associated these traits with fertility and milk production. The survey and the FGD revealed that buck's with separate testicular bag (cleft scrotal bag) is a better breeding male than with merged scrotal bag. Additionally, both male and female goats that possess wide and bent tail that touch the rump are regarded as good milk yielder.

Table 2929 Selection criteria of breeding male in pastoral and agropastoral areas

Criteria	Pastoral*					Agropastoral*					Overall Index
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	
Body size & conformation	18.1	39.8	13.3	14.5	0.233	28.1	59.4	12.5	-	0.316	0.256
Family history	47	25.3	14.5	6.0	0.299	46.9	25	15.6	6.3	0.30	0.299
Offspring quality	4.8	6.0	21.7	12.0	0.093	6.3	-	9.4	18.8	0.063	0.084
Color	10.8	7.2	20.5	26.5	0.133	12.5	12.5	31.3	18.8	0.169	0.143
Kid sex	4.8	3.6	3.6	6.0	0.043	-	-	-	9.4	0.009	0.034
Behavior[1]	-	2.4	3.6	6.0	0.02	-	-	9.4	12.5	0.031	0.023
Libido	13.3	2.4	9.6	10.8	0.09	3.1	-	3.1	18.8	0.038	0.076
Growth rate	1.2	7.2	4.8	4.8	0.041	3.1	-	12.5	6.3	0.044	0.042
Adaptability	-	1.2	-	4.8	0.008	-	-	-	6.3	0.006	0.006
Twining	-	2.4	-	1.2	0.008	-	-	-	-	-	0.006
Cleft testicle	-	2.4	6.0	4.8	0.024	-	-	6.3	3.1	0.016	0.022
Tail type	-	-	2.4	2.4	0.007	-	3.1	-	-	0.009	0.008

*R1, R2, R3 and R4 = R~~r~~ank 1, 2, 3and 4 respectively. Index = sum of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4) given for an individual reason (attribute) divided by the sum of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4) for overall reasons. [1]Behavior =alertness, active, preventing other buck mating his flock, flock leading

The major selection criteria used to decide which females to become the parents of the next generation were milk yield (I=0.41), twining rate (I=0.11) and body conformation (I=0.10). Milk yield was rated as the first selection criteria as reported by 68.4 percent of the households. The physical appearance of doe also receives great attention in choosing breeding female. Female with larger body size, strait back profile and big udder size were perceived as fertile, dairy type and having a better probability of twin birth. According to some respondents, in addition to a

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good udder shape and size, a female that ~~drop~~ let milk when her udder was squeezed before age at first ~~calving~~ kidding or during puberty ~~age~~ will be regarded as best dairy goat and locals referred her as "*wahi-han*". Similar to this outcome, body conformation (I = 0.23), milk yield (I = 0.19) and twining (I = 0.18) were reported as the major selection criteria of breeding female in the low land area of west Hararghe (Dereje, 2011).

Milk yield, reproductive performance and adaptive traits were the major selection criteria employed for breeding females. This observation is in agreement with other studies conducted in pastoral and agropastoral area where livestock raising is primarily to improve milk production without undermining adaptation and survival traits (Nigatu, 1994; Workneh and ~~Rowlands~~Rowland, 2004; Grum, 2010).

Phenotypic and behavioral traits were also frequently mentioned for selection of breeding animals, however, when households are inquired to prioritize their preferences, these traits were the least valued. Similarly Nigussie *et al.* (2010) indicated that farmers both in the low and high altitude of Ethiopia exerted the highest emphasis on plumage color for selecting males and females chicken. However, following the participatory rating of trait categories, it was one of the traits farmers would like the least to be considered in improving both classes of sex.

Table 30~~30~~ List of selection criteria of breeding female in pastoral and agropastoral areas~~PS~~

	Pastoral*					Agropastoral*					overall Index
Criteria	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	
Milk yield	65.9	22.0	4.9	4.9	0.411	75	6.3	6.3	-	0.406	0.409
Kid sex	2.4	12.2	24.4	19.5	0.093	-	18.8	12.5	12.5	0.083	0.091
Offspring quality	7.3	9.8	4.9	7.3	0.077	12.5	12.5	18.8	18.8	0.135	0.094
Body size and conformation	7.3	12.2	17.1	12.1	0.106	6.3	12.5	25	12.5	0.115	0.108
Mothering ability	-	4.9	9.8	2.4	0.033	-	6.3	6.3	12.5	0.031	0.032
Family history	-	4.9	4.9	14.6	0.024	-	18.8	-	12.5	0.063	0.035
Early maturation	-	-	7.3	-	0.012	-	-	6.3	6.3	0.01	0.012
Twining rate	12.2	14.6	7.3	2.4	0.122	6.3	12.5	12.5	12.5	0.094	0.114
Short K~~C~~I	-	2.4	4.9	9.8	0.016	-	6.3	-	-	0.021	0.018
Color	-	-	2.4	17.1	0.004	-	6.3	12.5	6.3	0.042	0.015
Adaption*	4.9	7.3	-	4.9	0.050	-	-	-	6.3	0.000	0.035
Diseases tolerance	-	2.4	-	-	0.008	-	-	-	-	-	0.006

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Longevity	-	-	-	-	-	-	-	-	-	-	-
Udder size	-	7.3	7.3	2.4	0.037	-	-	-	-	-	0.026
Flock leading	-	-	4.9	-	0.008	-	-	-	-	-	0.006
Tail type	-	-	-	2.4	0.000	-	-	-	-	-	0.000

*R1, R2, R3 and R4 = Rrank 1, 2, 3and 4 respectively. Index = sum of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4) given for an individual reason (attribute) divided by the sum of (4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4) for overall reasons. KI=kidding interval.

*adaptation=drought, feed shortage and diseases resistances

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Patchy and spotted coat color pattern especially black/white coat color type with white/black patch or spot was most preferred color (Fig 4). Coat color greatly influenced selection of males. The respondents are aware of the heritability of coat color and reasoned out that a beautiful buck have the ability to inherit its color to many offspring's. Besides, they associated ~~they believe that~~ black ~~goat~~ coat color with white patch or spotted goat with hardiness and ~~are~~ good milk yield~~er~~. Grey was the least preferred color and plain white color is not favored too. The respondents and the FGD stated that plain white goats are susceptible to drought and tick infestations referring to short eared Somali breed type as ~~an evidence~~evidence.

4.8.3.3 Mating control and castration

Mating control is widely practiced all over the globe by both pastoralists and small-scale farmers (FAO, 2009). Controlled breeding is practiced as responded by pastoral and agropastoral, 84.3% and 75.6%, respectively (Table 33). The techniques employed to control breeding were culling undesirable males and females (31.5%), running selected buck continuously in the flock (~~4~~49.1 ~~1.9~~%), castration (16.7%) and physical restraining of genitals (2.8%) (Table 31).

This investigation is not ~~concurring~~ concurrent with the report of Dereje (2011) ~~that~~ who indicated high rate of uncontrolled ~~mating,~~mating; however, ~~this~~ it is in agreement with Workneh and ~~Rowlands~~Rowland (2004) that reported high rate of breeding control (86%) using selected breeding buck. Unlike Grum (2010) who reported castration as the major mating control (76.4%), this finding was in agreement with the result of Workneh (1992) who revealed higher rate of selection through culling poor looking animals and keeping superior male continuously in the flock among the pastoralists at southern Ethiopia. Few pastoralists also reported tying the prepuce of buck to control immature male serving the flock and the practice was reported for breeding rams in the Region~~region~~, Afar (Tesfaye, 2008) and also tying an apron in front of the genitals of breeding buck was reported in the Bellen societies of Eritrea (Nigatu, 1994).

Table 3131 Reported methods of mating control in pastoral and agropastoral systems (%)

Production systems	Techniques of mating control				
	Running selected	Culling	Castration	Physical restraining	
Pastoral					
Count	34	25	14	3	79
Percent	44.7	32.9	18.4	3.9	100
Agropastoral					
Count	19	9	4	0	32
Percent	59.4	28.1	12.5	0	100
Total (%)	49.1	31.5	16.7	2.8	100

Goats are castrated in the area, but the practice appears to be significantly higher ($p<0.001$) in pastoral (85.5%) than in agropastoral (53.7%) systems (Table 33). Likewise more frequency of castration in pastoral (90%) than other production systems was also reported in Oromiya Regionregion (Workneh and RowlandsRowland, 2004). This may be due to the fact that most agropastoralists and small-scale farmers owe small flock size hence there will be very few bucks that remains only for breeding or they may not at all get male goats for breeding.

Castration is mostly practiced after six months of age (95.7%) consistently across both production systems (Table 33). The reasons for castration were listed in Table 32. Castration to shape behavior (flock leading and docility) was the main reason mentioned by with higher proportion of the respondent (38.3%). Castration of rams for the motive of leading flock was reported in Syrian Bedouins pastorals (FAO, 1985). Reasonable proportion of respondent (18.1%) mentioned castration for multiple reasons, but castration only for mating control was rated low in pastoral system. The other notable reason for castration of goats was to improve

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fattening to earn a better price on sell and to receive a better social status and respect. Presence of two or more big and fatty castrated male in the flock confers higher social status and respect in the community.

Table 3232 Reported reasons for castration of buck male goats in pastoral and agropastoral areasPS (%)

Production system	Reasons for castration					Total
	Mating control	Improve fattening	Good behavior	Social status	combination of reasons	
Pastoral	6.9	25.0	38.9	12.5	16.7	100
Count	5	18	28	9	12	72
Percent	6.9	25.0	38.9	12.5	16.7	100
Agropastoral	13.6	22.7	36.4	4.5	22.7	100
Count	3	5	8	1	5	22
Percent	13.6	22.7	36.4	4.5	22.7	100
Total %	8.5	24.5	38.3	10.6	18.1	100

Production system	Reasons for castration					Total
	Mating control	Improve fattening	Good behavior	Social status	combination of reasons	
Pastoral	6.9	25.0	38.9	12.5	16.7	100
Count	5	18	28	9	12	72
Percent	6.9	25.0	38.9	12.5	16.7	100
Agropastoral	13.6	22.7	36.4	4.5	22.7	100
Count	3	5	8	1	5	22
Percent	13.6	22.7	36.4	4.5	22.7	100
Total %	8.5	24.5	38.3	10.6	18.1	100

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Table 3333 Indigenous knowledge of pastorals and agropastorals about goat breeding

Breeding strategies	Percentage of respondents			P - value
	Pastoral (N=83)	Agropastoral (N=41)	Overall	
Selection of breeding males				
Yes	100	80.5	93.5	
No	0	19.5	6.5	
Selection of breeding females				
Yes	49.5	36.6	45.2	
No	50.6	63.4	54.8	
Oral record keeping of genealogy				
Yes	71.1	85.4	75.8	p>0.05
No	28.9	14.6	24.2	
Castration of male goat				P<0.001
Yes	85.5	53.7	75.0	
No	14.5	46.3	25.0	
Mating system in the flock				
Controlled	84.3	75.6	81.5	
Uncontrolled	15.7	24.4	18.5	
Identifying sire of an offspring				p>0.05
Yes	83.1	75.31	80.6	
No	16.9	9.8	14.5	
Preventing a buck mating to his close family?				
Yes	2	4.9	3.2	
No	97.6	95.1	96.8	
Cross breeding incidence?				P=0.84
Yes	15.7	17.1	16.1	
No	84.3	82.9	83.9	
Castration age				
3-6 months	4.2	4.5	4.3	
>6 months	95.8	95.5	95.7	

4.8.3.4. Sources of breeding buck

The source of breeding bucks in the district was own farm (83.1%), neighbors (11.3%), borrowed (4.0%) and a combination of reasons (Table 34). Bucks considered to be superior are retained for breeding. Similarly, Workneh and ~~Rowlands~~Rowland (2004) reported home breed males as the major sources of breeding buck for agropastoral (87.5%) and pastoral (89%) systems. When males were not reared, significant number ($p<0.05$) of agropastorals tended to use

neighbors bucks (22%), whereas pastoral tended to use neighbors buck only 6%. High rate of using neighbors buck in agropastoral area may be attributed to the smaller flock size.

There is a custom of sharing or borrowing superior buck among the community members. Household with best breeding buck is morally obliged to share it among his neighbors and may borrow if someone requested. The receivers reported using borrowed buck as long as two weeks in their flock. The usage of communal breeding male owned and cared by the community has been reported for Indian pastoralists by Anderson and Centonze (2006). Use of purchased breeding bucks was not reported as well the households did not trust the merit of the bucks purchased from the market. The custom of sharing bucks among the community is an appealing to introduce community based genetic improvement programs (particularly through sharing superior buck).

Most of the ~~In about a three – quarter of the cases~~ households reported use of their own flock as the sole source of breeding buck ~~(90.4% pastoral and 68.3% agropastoral)~~. The probable service life of a buck as estimated by respondents was 4.4 ± 2.01 years after which it will be castrated or disposed through sale or slaughter.

Table ~~34~~34 Source of breeding buck in pastoral and agropastoral ~~production~~ areas (%) ~~systems~~

Source of breeding buck	Percentage of respondents		
	Pastoral (N=83)	Agropastoral (N=41)	Overall (N=124)
Home breed	90.4	68.3	83.1
Neighbors	6.0	22.0	11.3
Borrowed	2.4	7.3	4.0
Home born & neighbors	1.2	2.4	1.6

4.9 Effective Population Size and Level of Inbreeding.

Despite the advantages of inbreeding for gene fixation, it has a tremendous negative effect through erosion of genetic diversity. Although the effect of inbreeding is expected to be more pronounced in the highlands where flocks are small in size, the breeding managements stated in this study such as routine utilization of limited breeding bucks that are mainly obtained from home breed, longer service life of buck, high rate of mating among close family and low number of

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flock mixing may contribute to incidence of inbreeding in the area. Majority of the households did not have understanding of inbreeding which can result from mating among close family. About 98.4% of the respondent claim not preventing a buck from mating his close family. Beside the lower chances of crossing with different goat type or population ~~breeds or type~~ can worsen the problem (Table 33).

The inbreeding problem can be reduced through flock mixing which in turn depends on grazing management. The average number of households mixing their flock was 2.14±1.4 for pastorals and 1.4±1.7 for agropastorals. Nevertheless, in some instant the whole villages' flocks may be mixed in common browsing/grazing area, whereas some household~~HH~~s mentioned not mixing their flock fearing for diseases transmission. ~~–~~In other cases, flock mixing can happen even with other localities pastorals that come to share crop aftermath immediately after harvest.

Assuming under closed breeding management the rate of inbreeding coefficient in pastoral and agropastoral areas were 0.067 and 0.14, respectively (Table 35). The higher rate of inbreeding in the agropastoral systems may be attributed to smaller flock size. These figures are comparable to Dereje (2011) and Grum (2010) outcome in lowland (0.065) and agropastoral (0.14) areas, respectively. However, lower than the report of Grum (2010) which was 0.10 in pastoral system. The overall rate of inbreeding (0.08) under isolated flock was higher than the standard maximum acceptable level of 0.063 (Armstrong, 2006). However, during flocks mixing effective population size has increased and so the overall rate of inbreeding too reduced to 0.042, which is ~~lower~~ within ~~than~~ the recommended rate of inbreeding per generation. Therefore, assuming higher flock mixing, selection can be implemented without risking inbreeding depression.

Table ~~35~~35 Effective population size and level of inbreeding for ~~goat~~ the population

Production system	Closed population				Mixed population				
	No.m	No.f	Ne	ΔF	No.m	No.f	Ne	ΔF	% Δ
Pastoral	2.0	25.7	7.42	0.067	4.28	55.0	15.9	0.031	53.7
Agropastoral	0.95	12.4	3.53	0.14	1.33	17.36	4.94	0.101	27.9
Total	1.7	21.3	6.30	0.079	3.23	40.47	12.0	0.042	46.8

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5. SUMMARY AND CONCLUSION

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Knowledge acquisition pertaining to livestock breeds through characterization must primarily be intended for pragmatic use as an input towards optimum utilization and conservation schemes. Such demand-driven characterizations in turn stipulate holistic portrayal of all appropriate ecological and human contexts of breeding apart from measurable traits of the animal. This study was conducted in the rural setting around Aysaita district to characterize the Afar goat population and associated contexts based on the concepts and priorities of the local community.

The study site is densely populated with higher family size than the Region~~region~~. Literacy rate, infrastructure and extension services are also comparatively better. This can makes the area relatively better place to initiate village breeding programs in the future.

This survey result revealed a number of socio-economic factors that have an effect on livestock and farm management, decision-making and the general perception of breed and species of the farmers. These factors will therefore affect the design and implementation of a breeding program and should be considered seriously for success in breed improvement strategy.

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Goats are kept for multifaceted purposes ranging from socio – cultural functions to source of food to the owner. Goats provide several functions that allow an owner to socially amalgamate within the community. These include use of goats as mediums of social exchange in various social circumstances, means to confer social identity and status as well as ceremonial and ritual uses.

The breeding goal or households most preferred traits to be improved were milk yield, adaptation and behavioral traits for female goats, while body size and conformation as well as coat color were favored for males. Breed improvement is mainly undertaken through selection of male goats at juvenile age. Breeding males are principally selected based on family history. Body size and appearance are also important selection criteria especially in agropastoral systems. Pedigree

selection indicates the society implicit knowledge on improvement of adaptive traits. The breeding objective is to ensure improved milk production for the household consumption and increased net income per flock through increased number of marketable animals without undermining adaptation and survival.

The community has a mechanism of keeping genealogy of animal and employ range of methods to identify individual animal among and within flocks. The most important identification systems used include recall system, coat color, ear notching and matrilineal naming. It was clear that whatever system used, the herders are able to identify a particular animal throughout its lifespan. This imply that pedigree and performance recording has been practiced through intricate knowledge. Therefore, it was apparent that the pastoralists have deliberate identification method and selection criteria.

The average flock size was 37.0 ± 25.0, but significantly smaller (21.0) in agropastoral systems. Flock structures are invariably dominated by breeding females which account 82.8% of the flock. The overall buck to does ratio was 1:13.

More than three quarter of households (81.5%) practice controlled breeding through running selected buck continuously in the flock and culling undesirable males and females. Assuming closed population, the overall rate of inbreeding was 0.08 which is higher than the standard maximum acceptable level of 0.063. ~~but~~But, rate of inbreeding reduced to 0.042 when flock mixing (2 household~~HH~~s) considered. The high rate of using home born breeding buck and inability to prevent mating among close family can worsen the problem of inbreeding depression in the future.

Average age at sexual maturity was 9.3 ± 3.3 months for female and 9.8 ± 2.2 months for males. Age at first kidding was 17.1 ± 2.3 months while the average kidding interval was 8.0 ± 0.97 months. The average number of kids born per year per breeding female ~~is~~ was 1.4. The reported average daily milk yield was 1.1 ± 0.4 liter per doe for an average lactation length of about 2.7 months.

One of the key identification features of afar goat population is their patchy (44.3%) and spotted (26.8%) coat color pattern. The dominant coat color types were black (46.6%) and white (43.8%). Majority of the population have a convex facial profile (49.9%), straight back profile (80.6%) and forward-pointed ears (42.0%). Almost all males (98.5%) and females (95.1%) are horned with high frequency of strait horn shape pointed upward. Most males have beard (67.6%) and ruff (82.4%) whereas small proportion of females have beard (2.3%) and ruff (1.5%). while wattles appear in 13.5% of females.

Body measurements for males verses females were (26.44 and 20.87 kg) for body weight, (64.8 and 59.5 cm) for chest girth, (63.1 and 58.9 cm) for body length, (59.6 and 55.4 cm) for height at wither, (13.3 and 12.4 cm) for pelvic width, (13.0 and 12.5 cm) for ear length and (26.44 and 20.87 cm) horn length. In all measurements, males are significantly ($P<0.01$) superior than female except ear length ($P>0.05$). Age significantly ($P<0.05$) influenced body measurements. Most body measurements increased consistently as age advances. Most of the linear parameters depicted positive and highly significant ($P<0.01$) correlation with body weight. Regression analysis showed that body weights could be predicted from heart girth, body length, wither height and body condition.

The average body weight of the breed was 23.8 kg (sample taken from 6 months onward)~~which is lower than all the breed type in the country.~~. This may indicate selection for adaptive trait. Consequently, the higher milk production combined with the ability of the breed to survive and thrive in the harshest environment of the country can makes Afar goat breed the best dairy goat especially for arid and semi – arid areas.

The grazing system in the area is extensive grazing system usually herded by female. Natural pasture was indicated as the primary feed source in both seasons. Sever feed shortage occurs during April – June/July. Mobility was the principal coping mechanism employed, however, considerable amount of agropastoral (46.3%) bypass the critical feed shortage season through the provision of supplementation and leaves and pods from tree branch cut. Majority of pastoral are transhumances (74.4%) that partly move their animals in search of feed while 21.7% represent nomadic pastorals

The major threats for sustainable use of goats were diseases, feed shortage, expansion of intensive farming and invasion of range land with *Prosopis juliflora* in their decreasing order of severity. Expansion of intensive farming can be an opportunity for crop residues, but alternative coping mechanism should be provided to the community for losing the rangeland.

Tick infestation and Contagious Caprine Pleuropneumonia (CCPP) were most prevalent diseases reported in the area. Liver fluke, anaplasmosis (blood parasite) and respiratory diseases were also reported as frequently occurring diseases. Tick and mange mite infestation probably complicated by other diseases, were causing heavy loss in productivity.

The results of the survey revealed a number of pertinent issues (i.e., opportunities and constraints) that, if addressed adequately, could help in developing effective goat breeding programmes and in increasing the general productivity of the animals.

Recommendation

Tick and mange mite infestation and Contagious Caprine Pleuropneumonia (CCPP) need urgent attention. Since most of the PAs are accessible, ~~at least~~ provision of ecto-parasite treatments and vaccination for CCPP is suggested to responsible bodies.~~acaricides to control tick or mange mite infestations or provision of dipping vat per village will be a small mercy for the professionals but a great relieve for pastorals.~~

Selection of male at an early stage can causes the loss of male with high individual performance (i.e. there will not be chance of evaluating them) and loss of a better income that can be fetched by allowing the kid to grow in to a better live weight. Hence, offering counseling to goat owners in this regard is recommended.

This study was limited to one ~~woreda out~~woreda out of the 29 woredas in the Region~~region~~. Therefore, to make a sound conclusion, it should be strengthened with further on – farm survey. Parellelly, flock inventory and existence of any different strains, type or subtype within breed should also be investigated. The on-farm assessments made on the reproductive and productive performance need to be strengthened by further on-station evaluations. Moreover, the physiological mechanism for drought tolerance of the breed, which is ~~well~~ appreciated by the locals, needs to be studied in detail.

The Afar goats are the smallest in size from goats studied in pastoral and agropastoral areas that may require to improve the mature weight by ~~combinging~~combining the indigenous knowledge and the experience of community based genetic improvement through learning from the community based genetic improvement in sheep in Ethiopia. The traits preferred by the community coupled with the practice of community goat breeding including buck sharing warrants the introduction of community based breed improvement program through the participation of the community

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7 APPENDICES

7.1 Appendix I. List of table including analysis of variances

Appendix Table 1 List of quantitative traits and method of measurements[a]

Parameter	Units	Descriptions
Body weight	Kg	Taken early in the morning using 50 kg spring balance
Body length	cm	The horizontal distance from the point of shoulder to the pin bone to the nearest centimeter.
Chest girth	cm	The circumferential measure taken around the chest just behind the front legs and withers to the nearest 0.5cm.
Height at wither	cm	The height from the bottom of the front foot to the highest point of the shoulder between the withers to the nearest centimeter.
Chest width	cm	The width of the chest between the briskets to the nearest centimeter.
Pelvic width	cm	The distance between the pelvic bones, across dorsum to the nearest centimeter.
Ear length	cm	The length of the ear on its exterior side from its root at the poll to the tip to the nearest centimeter.
Scrotal circumference	cm	The circumference of the testicles at the widest part to the nearest centimeter.
Horn length	cm	Length of the horn on its exterior side from its root at the poll to the tip.

[a]Adapted from Girma and Alemu (2008)

Appendix Table 2 Pair wise ranking of goats most common browse feeds

No.	Local name	Scientific name	1	2	3	4	5	6	7	Score	Rank
1	Keselto	*Acacia nilotica*	X	1	1	1	1	1	1	6	1
2	Eebe	*Acacia tortolis*	X	X	2	2	2	2	2	5	2
3	Mekanita	*Acacia seyel*	X	X	X	4	3	3	3	3	4
4	Ti-kibleyta	*Acacia asak*	X	X	X	X	4	4	4	4	3
5	Adedo	*Acacia Senegal*	X	X	X	X	X	6	7	0	5
6	Gerento	*Acacia oerfota*	X	X	X	X	X	X	6	2	6
7	Mekarto	*Acacia mellifera*	X	X	X	X	X	X	X	1	7

Appendix Table 3 Goats' physical description and body measurement format, attributes and codes

Production system _____ PA _____ HH code _____ Flock size. _____

		Coat color						Horn			Ear											
Id No	sex	pattern	type	wattle	ruff	bear	Head profile	shape	Orientation	Length	form	Length	Back profile	Body length	Heart Girth	Ht at Wither	Chest Width	Pelvic width	Scrotal Cf.	Dentition	BCS	Body Wt
1																						
2																						
3																						
4																						
5																						

Attributes and codes'

1. Sex: 1 = female 2 = male 3 = castrate
2. Coat color: Pattern: 1 = plain 2 = patchy 3 = spotted 4 = Streak
   Type (if combined - indicate dominant color): 1 = white 2 = creamy white 3 = black 4 = brown 5 = grey 6 = red
3. Wattle / Beard / Ruff: 1 = absent 2 = present
4. Head profile: 1 = straight 2 = slightly convex 3 = markedly convex 4 = slightly concave 5 = markedly concave
5. Ear form: 1 = erect 2 = carried horizontally 3 = semi-pendulous 4 = rudimentary
6. Horn:- Shape: 1 = polled 2 = rudimentary 3 = straight 4 = spiral 5 = curved
   Orientation: 1 = lateral 2 = upward 3 = backward
7. Back profile: 1= Straight 2= slightly bent down 3= Bent down
8. Body condition sore (BCS): 1 = very thin 2 = thin 3 = average 4 = fat 5 = obese
9. Dentition classes: 0PPI = with ~~milk teeth~~ fully grown milk teeth and zero pair of permanent incisor eruption
   1PPI = with erupted and growing 1st pair of permanent incisors
   2PPI = with erupted and growing 2nd pair of permanent incisors
   3PPI = with erupted and growing 3rd pair of permanent incisors
   4PPI = with erupted and growing 4th pair of permanent incisors

Appendix Table 4 Scales for body condition scoring[1]

Score	Features			Condition
	Spinous and transverse process of Lumbar region	Eye muscle area	Rib cage	
1	The spinous processes are prominent and sharp. The transverse process are also sharp, the fingers pass easily under the ends, and it is possible to feel between each process.	The eye muscle areas are shallow with no fat cover.	Ribs are clearly Visible	Very thin
2	The spinous processes feel prominent but smooth, and individual processes can be felt only as fine corrugations. The transverse processes are smooth and rounded, and it is possible to pass the fingers under the ends with a little pressure.	The eye muscle areas are of moderate depth, but have little fat cover.	Some ribs can be seen. There is a small amount of fat cover. Ribs are still felt.	Thin
3	The spinous processes are detected only as small elevations; they are smooth and rounded and individual bones can be felt only with pressure. The transverse processes are smooth and well covered, and firm pressure is required to feel over the ends.	The eye muscle areas are fully covered to end of spinal processes. Feels rounded and have a moderate degree of fat cover.	Ribs are barely seen; an even layer of fat covers them. Spaces between ribs are felt using pressure.	Moderate
4	The spinous processes can just be detected with pressure as a hard line between the fat covered eye muscle areas. The ends of the transverse processes cannot be felt.	The eye muscle areas are full, and have a thick covering of fat.	Ribs are not seen	Fat
5	The spinous processes can't be detected even with firm pressure, and there is a depression between the layers of fat in the position where the spinous processes would normally be felt. The transverse processes cannot be detected.	The eye muscle areas are very full with thick fat cover. There may be large deposits of fat over the rump and tail.	Ribs are no visible and are covered with excessive fat.	Very fat

[1]Adapted from McGregor (2007) and Girma (2009)

Appendix Table 55 Preferred goat browse feeds during dry and wet season

Local name	Scientific name	Type	Season of availablity	Description
Keselto	*Acacia nilotica*	Tree	Both	• The leaves, pods and flower are edible feed for goat and camel • The flower and pods are favorite feed for goat. • The pods used as traditional medicine for human disease treatment • Used for good taste of water in Afar traditional water container made from hide. Used for house and fence construction • The bark used to remove hair during hide processing • Used as good quality charcoal and shade tree
Kilayto		Trees	Wet	• Leafy tree, needs more water or rainfall • the bark used as a rope for house construction to bind poles • the bark also serve as traditional medicine
Ee-be (□□□)	*Acacia tortolis*	Tree	Both	• Thorny tree, the leaves & pods are edible feed for goat and camel • The pods are favorite feed for goat.
Mekanita	*Acacia seyel*	Tree	Both	• Thorny tree, the leaves, pods and flower are edible feed for goat and camel • The flower and pods are favorite feed for goat.
Ti-kibleyta	*Acacia asak*	Tree	Both	• Thorny tree, the leaves & pods favorite feed for goat and camel
Bel-ene		Shrub	Both	
Delento		Shrub	Wet	
Gele-ato			Wet	• Its flower is a good source of feed during dry season • It grows in fallow land and river basin
Adedo	*Acacia Senegal*	Tree	Both	• Feed for goat, camel and cattle, the gum used as sweet feed for children
Gerento	*Acacia oerfota*	Tree	Both	• The leaves are feed for camel and goat. • Its flower is also good feed source for goats • Used for construction of Afar traditional house,
Mekarto	*Acacia mellifera*	Tree	Both	• Good feed sources for goat and camel
Weyane	*Prosopis juliflora*	shrub	Both	• Invading weed but ever green legume its leaves and pods can be used as feed sources for goat, sheep and cattle during dry season

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Appendix Table 6 Preferred goat graze feeds during dry and wet seasons

Local name	Scientific name	Type	Season of availability	Description
Melif	*Ischaemum afrum*	Grass	Wet	Very palatable grass for cattle, sheep, goat and camel
Durfu	*Chrysopogonplumulosus hochst*	Grass	Wet	Imprtan feed for cattle and sheep, but they are also well prefered by goats
Sita-abu		Grass	Dry	More prefered by cattle, very long grass, harbour worm in its stem. Goat too like it but due to its length, they graze after cattle. Grow with flood water or swap area, cuase for liver flock attack Commonly referred as hippopotamus grass
dile (□□)		Grass		Most prefered by goat Have soft and easly digestible stem with plenty of leaves Mostly grows inside crop farm as weed
Melabi (□□□)		Grass	Wet	Prefered grass by goat, '*melabe'* its name refers honey Have somewhat strong stem that carries a few of leaves Mostly grows inside crop farm as weed
Suriktu (□□□□)		Grass	Wet	Grows at the peripheral of irrigatioon canal and in crop farm as weed Strong grass species that can cuase weary of teeth
hali-forois (□□-□□□□)		Legume	Wet	Favourite feed of goats Mostly grows inside crop farm as weed
anterba (□□□□□)		Legume	Wet	Grows in swapy area. Have a long hollow stem that harbour worms inside, hence serve as a host for liver fluck, Mostly grows inside crop farm as weed
Serdo	*Cenchrusciliaris*	Grass	Both	Important grass species during dry season
Bunket		Legume	Wet	Feed sources for all livestock, but more preferred by goat
Wetde-levi-s		Legume	Wet	Feed sources for all livestock, but more preferred by goat

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Appendix Table 7 Most prevalent goat diseases and seasons of occurrences

Type of disease		Symptom	Season of occurrence	Remark
Local name	English name			
Gublo	CCPP	Coughing, mucus, dizziness	Dry	
Kirbi	Fascioliasis/ liver fluke	Emaciation	Wet	
Sur-atu	PPR	Coughing	Dry	
Kilmi	Tick infestation		Infection in wet and impact in dry season	
Agera	Mange	Skin lesion and wound	//	
Begi-daria/ dairia or Uruga	Internal helminthesis (endoparisite)	Diarrhea in wet season, emaciation in dry season	//	
Undahi	Metabolic diseases	Enteritis, emaciation, diaria, poor milk yeild	//	
Sengite	Internal parasite or worms	Emaciation	//	
Ni-eile	Metabolic disorder	Emaciation, head drop, infertility, turgidity	Not season specific	Caused when goats drink stagnant hot water
Andero	Anaplasmosis/blood parasite	Emaciation		Tick born disease
Ablae	Babesiosis/blood parasite			Tick born disease
Ha-leb/ un-kubo	Acute form of FMD			
kuru-bud	Chronic form of FMD			
Gorgoda	Shoat pox			
Hama	Hyper photosensitization	skin lesion and taxis movement	Dry hot season	
Inkata/ke-nadi	Lice infestation			
Eiba/Kosso	Foot – rot	Wound between foot		Trauma or injuries of toe, can be complicated by tick and secondary bacterial infection
Gosen	Respiratory diseases complex or pneumonia			

CCPP = Contagious Caprine Pluero-Pneumonia; PPR = pest des petit ruminanti; FMD = Foot and mouth diseases

Appendix Table 8 Reported severe feed shortage seasons of the year

Seasons	Production system				Total	
	Pastoral		agropastoral			
	Count	Percent	Count	Percent	Count	Percent
Kerma (July/August – October)	7	8.4	5	12.2	12	9.7
Debayba (December – February)	2	2.4	-	-	2	1.6
Hagay (April – June/July)	74	89.2	36	87.8	110	88.7

Appendix Table 9 Cause of goat mortality

Cause	Production systems								Overall			
	Pastoral				Agropastoral							
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Diseases	80.7	14.5	4.8	0.48	80.5	12.2	4.9	0.57	80.6	13.7	4.8	0.50
Predators	2.4	47.0	42.2	0.25	4.9	24.4	4.9	0.14	3.2	39.5	29.8	0.22
Drought	16.9	37.3	24.1	0.26	14.6	17.1	7.3	0.18	16.1	30.6	18.5	0.24
Accidents	-	-	14.5	0.006	-	-	2.4	0.01	-	-	3.2	0.01
Poisoning	-	-	14.5	0.025	-	7.3	2.4	0.01	-	2.4	10.5	0.03
Unknown	-	-	6.0	0.01	-	2.4	2.4	0.02	-	0.8	4.8	0.01
Abortion	-	1.2	4.8	0.01	-	9.8	7.3	0.06	-	4.0	5.6	0.03

Appendix Table 10 Reported reasons for reduction of rangeland in the last 10 years (%)

Reasons for reduction	Production system		Total
	Pastoral	Agropastoral	
Extensive farming	16.9	57.5	30.1
Invasion of *Prosopis juliflora*	7.2	-	4.9
Drought or flood	10.8	5.0	8.9
Deforestation	7.2	-	4.9
All reasons mentioned above	27.7	-	18.7
Extensive farming and drought	4.8	7.5	5.7
Extensive farming and Invasion of prosopis	13.3	-	8.9
Extensive farming, invasion of prosopis and drought	3.6	12.5	6.5
Loss of traditional institute	8.4	17.5	11.4

Appendix Table 11 Respondents rating for types of goat sold for cash

Goat type	Production system										Total
	Pastoral[a]					Agropastoral[a]					
	R1	R2	R3	R4	Index	R1	R2	R3	R4	Index	Index
Male< 6 month	42.2	20.5	9.6	12.0	0.26	39.0	22.0	17.1	12.2	0.27	0.26
Male 6-12 months	25.3	22.9	12.0	12.0	0.21	22.0	36.6	7.3	12.2	0.22	0.21
Male >12 months	-	4.8	6.0	7.2	0.03	-	2.4	2.4	4.9	0.02	0.03
Castrate	10.8	3.6	7.2	7.2	0.08	4.9	-	2.4	4.9	0.03	0.06
Old buck	4.8	10.8	12.0	18.1	0.09	17.1	14.6	14.6	7.3	0.15	0.11
Old doe	7.2	12.0	36.1	19.3	0.16	9.8	19.5	29.3	24.4	0.18	0.17
Inferior female	9.6	24.1	16.9	20.5	0.17	7.3	4.9	22.0	34.1	0.12	0.15
Female < 6 months	-	1.2	-	-	0.004	-	-	4.9	-	0.01	0.006
Female 6-12 months	-	-	-	3.6	0.004	-	-	-	-	-	0.002

[a]R1, R2, R3 and R4 = rank 1, 2, 3and 4 respectively. Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

Appendix Table 12 ANOVA for body weight of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	189.059320	189.059320	20.50	<.0001
sex	1	1980.727521	1980.727521	214.77	<.0001
age	4	5392.179718	1348.044930	146.17	<.0001
sex*age	4	852.574538	213.143634	23.11	<.0001
Error	880	8116.00	9.22273		

Appendix Table 13 ANOVA for chest girth of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	144.712413	144.712413	13.32	0.0003
sex	1	1678.633727	1678.633727	154.54	<.0001
age	4	6903.476613	1725.869153	158.89	<.0001
sex*age	4	719.024975	179.756244	16.55	<.0001
Error	880	9558.88	10.86237		

Appendix Table 14 ANOVA for chest width of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	76.16290051	76.16290051	82.34	<.0001
Sex	1	48.74859554	48.74859554	52.70	<.0001
age	4	83.15344639	20.78836160	22.47	<.0001
sex*age	4	6.80002698	1.70000675	1.84	0.1195
Error	880	813.997324	0.924997		

Appendix Table 15 ANOVA for body length of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	26.779404	26.779404	2.01	0.1562
sex	1	1199.177538	1199.177538	90.18	<.0001
age	4	5219.898962	1304.974741	98.14	<.0001
sex*age	4	714.368796	178.592199	13.43	<.0001
Error	880	11701.63044	13.29731		

Appendix Table 16 ANOVA for height at wither of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	1.105887	1.105887	0.13	0.7144
sex	1	1101.282893	1101.282893	133.46	<.0001
age	4	2532.534329	633.133582	76.73	<.0001
sex*age	4	295.840250	73.960062	8.96	<.0001
Error	880	7261.49622	8.25170		

Appendix Table 17 ANOVA for pelvic width of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	0.1472313	0.1472313	0.10	0.7543
sex	1	61.5544291	61.5544291	40.99	<.0001
age	4	458.7668506	114.6917126	76.38	<.0001
sex*age	4	67.4876673	16.8719168	11.24	<.0001
Error	880	1321.477	1.501679		

Appendix Table 18 ANOVA for BCS of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	12.45951347	12.45951347	28.53	<.0001
sex	1	9.41266627	9.41266627	21.55	<.0001
age	4	2.46003295	0.61500824	1.41	0.2293
sex*age	4	7.08361616	1.77090404	4.06	0.0029
Error	880	384.3077223	0.4367133		

Appendix Table 19 ANOVA for ear length of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	0.15922452	0.15922452	0.08	0.7795
sex	1	8.89504053	8.89504053	4.38	0.0366
age	4	32.09983316	8.02495829	3.95	0.0035
sex*age	4	3.99382404	0.99845601	0.49	0.7417
Error	840	1705.037307	2.029806		

Appendix Table 20 ANOVA for horn length of Afar goat for the effect of PS, sex, age and sex by age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	260.60278	260.60278	19.24	<.0001
Sex	1	6995.71386	6995.71386	516.45	<.0001
Age	4	10801.56816	2700.39204	199.35	<.0001
sex*age	4	2771.56530	692.89132	51.15	<.0001
Error	839	11364.81622	13.54567		

Appendix Table 21 ANOVA for Scrotum circumference of Afar goat for the effect of PS and age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
PS	1	51.5000897	51.5000897	7.80	0.0073
age	4	273.5424333	68.3856083	10.35	<.0001
Error	52	343.5128974	6.6060173		

7.2 Appendix II Semi – structured questioner

I. Socio-economic aspect

I. General information of ~~HH~~household

1.1 PA _____ _____ 1.2 code No. of HH _____ 1.3 clan/sub clan_____

1.4 Sex: 1. male, 2. Female 1.5 Age (in years) _____

1.6 Educational level. 1. Illiterate 2. Religious school 3. Writing & reading

4. Primary (1-6) 5. Junior & high school (8 -12)

1.7 HH head sex 1. Male 2. Female

1.8 Family size living in the house by age and sex

Males < 15 yrs _____ Males >15 _____ Females < 15yrs _____ Females >15_____

1.9. What is your main farming activity?

1. Livestock production 2. Crop production

1.10. What is the average land holding (in ha)? _____

1.11. What are the major crops grown?

1. Maize 2. Vegetables 3. Sesame 4. Cotton 5. Others_____

1.10. What are the sources of household's cash income? Then rank the 3 major ones

NO.	Income source	Yes (√)	Rank	Remark
1	Selling of live animal			
2	Selling of livestock product			
3	Crops & vegetables			
4	Forest & forest product			
5	Off farm income			
6	Others			

1.9 Who is responsible for the following activities?

Activities	**Male**		**Female**		**not specific**	**Remark**
	< 15 year	> 15 year	< 15 years	> 15 year		
Camel raising						
Cattle raising						
sheep & goats raising						
Rearing kids						
Selling of goats						
purchasing of goats						
Milking does						
Processing milk						
Breeding decision						

II. Livelihood significance

A. Goat products and function

2.1. Why you keep/ raise goats (purpose of keeping goats)?

No.	Particulars	Yes (√)	Rank	Remark
1	Milk			
2	Source of income			
3	Meat			
4	Traditional identity (way of life)			
5	Social status (sign of wealth & strength)			
6	As an insurance			
7	Ceremonies & rituals			
8	For dowry			
9	Others			

2.2 Mention if goat products like milk, butter or meat have any medicinal value____

2.3. What is the basis of the staple diet (a food that forms the basis of the diet)?

1. Milk 2. Cereal based 3. Meat 4. Other specify _____

2.4. What is the contribution of your goats in securing the staple diet?

No.	Factors	Yes (√)	Rank
1	Source of cash		
2	Continually produce food items (milk)		
3	Source of meat		
4	Others		

2.5. How is goat milk used?

No.	Ways of usage	Yes (√)
1	Family consumption (raw)	
2	Family consumption (processed)	
3	For sales (raw)	
4	For sales (processed)	
5	home consumption & sale	
5	Other	

2.6. How often do you sell goats?

1. Every month 2. Every 3 month 3. Every 6 months

4. Every year 5. During holiday 6. Whenever cash needed

2.7. Reasons for selling (more than one choice possible)

1. Cash needed 2. Disposal/culling 3. Mitigation against drought loss 4. Others _____

2.8. Which class of goat do you sell first in case of cash needed? *(Rank the 1st 3 class)*

No.	Class	Yes (√)	Rank	Reason if any
1	Male kids less than 6 months			
2	Female kids less than 6 months			
3	Buck kids between 6 months and one year			
4	Doe kids between 6 months and one year			
5	Old does			
6	Old buck			
7	Castrated male			
8	Less fertile/infertile goats			
	Others			

2.9 Flock acquisition and disposal in the last 12 months

Acquisition mode	Male	Female
Own farm born		
Gift		
Purchase		
Loaned		
Exchanged		
Others		

Disposal mode	Male	female
Sold		
Slaughtered		
Died		
Predator		
Lost		
Donated/gift		
Exchanged		
Others		

B. Reproductive and productive performances

2.10 Age at sexual maturity of male (in months)? _____

2.11 Do you fix age at first mating for the males? 1. Yes 2. No

2.12 Age at sexual maturity of female (in months)? _____

2.13 Age at first birth of female (in months)? _____

2.14 What is the birth interval of your doe (in months)? ___

2.15. What is the average reproductive lifetime of a doe (in year)? _____

2.16. Number of kids per does' life time _____

2.17. What is the average reproductive lifetime for a buck (in year)? _____

2.18. During which season do occurrence of most births (kidding pattern) take place?___

2.19. How many parturition occurred within your flock during the last 12 months? _____

2.20. Of these parturitions how many were Male__ Female___ Single birth_____ Twins_____

Milk production and kid rearing

2.21 Milk production per day per doe

1.one cup 2. two cups 3. three cups 4. Four cups

2.22. Frequency of milking per day 1. once 2. twice 3. three times

2.23. Lactation length (months) _____

2.24. Average weaning age of kids

1. < 3 months 2. 3 – 4 months 4. 5–6 months 5. > 6 months

2.25. Milk feeding of kids up to weaning

1. Unrestricted suckling 2. Restricted suckling 3. Others (specify) _____

III. Production and management systems

A. herd size, livestock composition and flock structure

3.1 Total numbers of livestock species owned by the HH & rank based on their relative importance

No.	Types of livestock	Total number	Rank	Reason if any
1	Goat			
2	Camel			
3	Cattle			
4	Sheep			
5	Chicken			
6	Others			

3.2 Classify your goat flock according to age, sex and breeding category (number)

	Age			Remark
Sex	kids < 6 months	6 -12 months	> 1 year	
Female				
Intact male				
Castrated male				

3.3 How is goat flock herded during the day time?

1. Male and female are separated 2. Kids are separated
3. All classes herded together 4. Others (specify) _____

3.4 Way of herding

1. Goats of an individual household run as a flock
2. Goats of more than one household run as a flock
3. Others (specify) _____

3.5 If more than one HH flock run together, how many HH mix their goats together? ___

3.6 Why they mix? _____

B. Goat population trend

3.6. How is your goat flock size in the last 10 years? 1. Increasing, 2. Decreasing, 3. Stable

3.7. Reason _____

3.8. Mortality in the last 12 months (No.)

	Young <1 yr	Adults>1 yrs
Male		
Female		

3.9. Reasons for death

	Yes	rank
a. Predators		
b. Disease		
C Drought		
d. Accident		
e. Poisoning		
f. Unknown		

C. Feed source

3.7. Mention the feed source during wet & dry season. Then rank the top 4 in each season

Source	Wet season	Rank	Dry season	Rank	Remarks
Rangeland					
Established pasture / forage					
Hay					
Crop residues					
Fallow land					
Concentrate					
Others					

3.8 Mention most preferred goat grazing/browse species in both season.

Wet season _____ dry season _____

_____ _____

_____ _____

3.9. Grazing land ownership?

1. Communal 2. Private 3. Both private & communal

3.10. Grazing system 1. Free grazing 2. Extensive (herded)

3. Semi-intensive (Herded & Tethering) 4. Tethering

3.11. Trend in communal grazing areas (in the last 10 years)

1. Decreasing, 2. Increasing, 3. Stable

Reason _____

3.12 At which season of the year do you experience sever feed shortage? _____

3.13 What is your copping mechanism or responses to feed shortage? *multiple choice is possible*

1. Mobility 2. De-stocking, 3. Supplementation 4. Others _____

3.14 Mobility pattern? 1. Nomadic 2. Transhumance, 3. Settlement

3.15 If transhumance, which livestock species and age class move?

Species	Age class	Season of mobility
1. _____	_____	_____
2. _____	_____	_____
3. _____	_____	_____

3.16 Types of supplementation (if any) and goat types during dry and wet season

Season and type of supplements	Goat types			Way of supplementation[a]
	Adult female	Adult male	Kids	
Dry				
Roughage/crop residues				
Minerals & Vitamins				
Concentrate				
Wet				
Roughage/crop residues				
Minerals & Vitamins				
Concentrate				

[a]Way of supplementation (1. At its natural source, 2. Supplied at home)

D. Watering

3.17. Sources of water, distance to the nearest source and its quality during dry and wet season

No	Source of water	Dry season					Wet season			
		Yes	Rank	Distance[1]	Quality[2]	Freque[3]	Yes	Rank	Distance	Quality[2]
1	River									
2	Dam/pond									
3	Spring									
4	Rain									
5	water well									
6	Others									

[1]Distance to the nearest water source (1. at home, 2. < 1km, 3. 1-5km, 4.6-10km, 5. >10km)
[2]Quality of water (1. clean/good, 2. muddy, 3. Salty, 4. Smelly)
[3]Watering frequency (1. freely available, 2. Twice/day, 3. Once a day, 4. once in 2 day, 5. once in 3day)

E. Housing

3.18. How do you house your goats?

1. Open camp 2. Penned at night without shelter

3. Housed at night 4. Other _____

F. Production constraints

6.1 What pressures does the breed face that threatens its survival or sustainable use? *(tick as many reason as possible and rank the top 4)*

No.	Pressure/constraints	Yes	Rank	Possible action
1	Loss of grazing opportunities (invasion of range land)			
2	Expansion of intensive agriculture			
3	Diseases or lack of health care			
4	Lack of market demand			
5	Drought, floods or other natural catastrophes			
6	Lack of interest by young generation			
7	Conflict or war			
8	Loss of traditional institutions			
9	Water shortage			
10	Others			

G. Health

3.28. Mention major goat diseases which are most prevalent and rank them based on importance

Diseases	Symptom	Seasons of occurance[1]	Susceptible age group[2]	Rank	Treatment	
					Traditional	Modern

[1]*Seasons of occurrence (1. wet, 2. Dry, 3. throughout the year/ not season-specific)*
[2]*Susceptible age group (1. Kids, 2. Adults, 3. All age group)*

3.29. Access to veterinary services and distance to the nearest service

Access	Yes	Distance to the nearest service *(km/walk hr)*			
		< 1 km	1 – 5 km	6 – 10km	> 10 km
Government veterinarian					
Private veterinarian					
Shop or market					
None					
Others (specify)					

IV. Socio-cultural context

4.1 Are there any breeding institutions, such as a communally kept buck?

4.2. Will you still keep your goat flocks even if it loses its market demand or if in the future you are given the access to high milk producing or early growing exotic goat breeds?

1. Yes, 2. No Reason _____

4.3. Mention social events and occasions worth sacrificing goats? _____

4.4. Is there special goat color or other typology preferences for respective social, cultural or religious events, rituals and devotions involving goats and goat products? If yes, specify _____

4.5 Mention the social regulations about the lending, giving or exchange of goats?

4.6 Where did you get your initial goat flock? And what does its composition look like?

Mode	Yes	Total	How many?		
			Breeding does	Breeding bucks	Kids
Dowry					
Groom wealth					
Help from relatives					
Compensation					
From market					
Government/NGOs'					
Heritage from family					
Other					

V. Indigenous knowledge on goat breed and breeding

5.1. Where do you think is the origin of the breed and how it arrived in the community? _____

5.2. Do you think that your goat breed/type is unique or maintained only by this community?

1. Yes, 2. No, Reason _____

5.3. What distinguishes this particular breed from others kept in adjoining areas, or from high performance breeds?

No	Characteristics	Yes	How do you support these special attribute claims?
1	Disease resistance/ tolerance		
2	Parasite tolerance		
3	Drought/heat tolerance		
5	Feed shortage tolerance		
6	Tolerance to water scarcity		
7	Long distance walk		
8	Behavioral patterns		
9	Process-ability or taste of their products		
10	Other		

5.4. What is/are the characteristics (traits) of a desirable (best) female goats? _____

5.5. What is/are the characteristics (traits) of a desirable (best) male goats? _____

5.7. Do you allow your does to be served by a buck from breeds other than Afar goat? 1. Yes, 2. No. Why/Why not? _____

5.8. How do you identify individual goat in the flock? _____

5.9. Do you remember (keep) genealogy of individual goats? 1. Yes 2. No. 5.10. If yes, how?_____

5.11. Could you be able to identify the sire of a kid (offspring)? 1. Yes 2. No 5.12. If yes, how? ____

5.13. Do you allow a buck to mate his close family (mother, daughter and sister)? 1. Yes, 2. No why/why not _____

Breeding management

5.14. Do you practice selection for?

Breeding male (1. Yes 2. No) If yes, at what age? _____

Breeding female (1. Yes, 2. No) If yes, at what age? _____

5.16. What are the selection criteria used in deciding which males and females to become the parents of the next generation? *(Tick as many reason as possible for selection in 'yes' column, then rank the top 4).*

Criteria for breeding male	Yes	Rank	Criteria for breeding female	Yes	Rank
Color			Body size		
Body conformation/ appearance			Color		
Temperament /behavior			kids survival, Lamb size or vigor at birth		
drought/ heat tolerance			drought/ heat tolerance		
Diseases resistances			Diseases resistances		
Body size			lifetime calf crop		
Growth rate			Short kidding interval		
Good Pedigree/family history			Age at first kidding		
Ability to walk long distance			Twining ability		
Libido/ alertness			Milk yield		
Foraging ability			Foraging ability		
Tolerance to Water stress			Ability to walk long distance		
Flock leading abilities			Longevity		
Others			Mothering ability		
			Others		

List most preferred colors _____, _____, _____

Mating system

5.17 How is mating/breeding system in the flock?

1. Controlled 2. Uncontrolled

5.18. If controlled mating, what are the techniques?_____

1. Culling undesirable male/female

2. Running selected bucks continuously in the flock (how many males are needed to cover all females?

3. Running a buck with the herd continuously but with physical restraining of genital

4. Castration 5. Others specify _____

5.19. Source of breeding buck

1. Homebred 2. Neighbors/relatives 3. Communal

4. Bought 5. Borrowed 6. Unknown

5.20. Do you castrate male goats? 1. Yes, 2. No

5.21. If yes, reasons for castration

1. Control mating 2. Improve fattening 3. Better temperament 4. Others _____

5.22. If yes, at what age do you castrate? 1. < 3 months, 2. 3–6 months, 3. >6 months

7.3 Appendix III Focus group discussions check list

Socio-cultural underpinnings of the breed

1. Local myth about the origin of the breed/type
2. Do you think your community will continue to keep the Afar goat even if it loses its market demand or if in the future the community is offered access to high milk producing or early growing exotic breeds?
3. What are the social regulations about the access (giving), sharing and exchange of goats? For instance lending/giving breeding goats to poorer relatives, blood compensation etc.

Breeding objective and trait preferences

4. What is the purpose of keeping/raising goat flock? For instance, is the community interested in maintaining the breed for milk, meat, generating income, for prestige, identity or culture?
5. What are the characteristics (traits) of a desirable/best female and male goat? Or what are the ranges of traits preferred by goat breeding community members for further improvement (both male and Female)?

Key and special characteristic of the breed

6. Do members of the community identify individual members of the Afar goat population among members of other goat breeds (strains)?
7. If yes, what are the key characteristics features locally employed to differentiate members (flock group specific) of the goat population from other breeds or sub types? For instance, features like facial profile, coat color, ear form, horn, size and legs etc
8. Are there any distinct goat types in the area (zonal or regional level)?
9. What distinguishes this particular breed from others kept in adjoining areas, or from high performance breeds? Special characteristics can relate to disease resistance (or also proneness to certain diseases), behavioral patterns, or the processability or taste of their products.
10. Is there oral record-keeping of genealogies in the community?

Ecological and production context

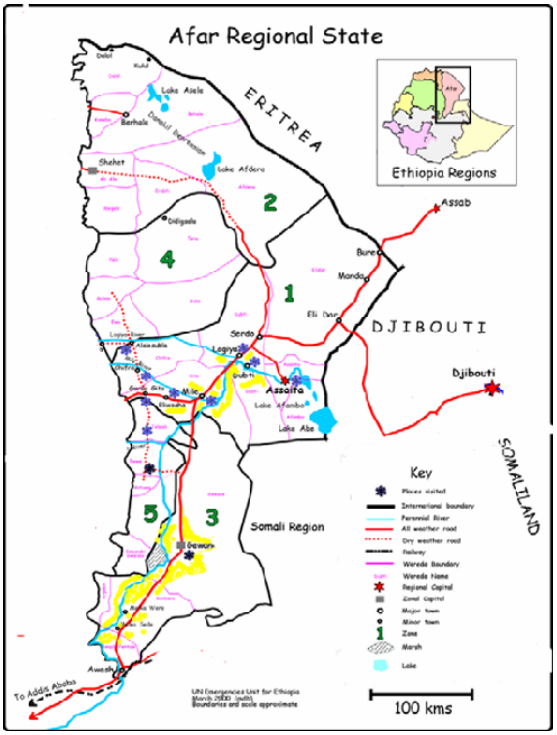
11. Local calendar systems, where animals graze/browse, at what time of the year, and which fodder or forage species they prefer?
12. Describe the concentration and distribution of Afar goat breeds
13. Population trend of goat and trends of grazing/browse land in the last 10 years
14. The major goat diseases in the area

15. What pressures does the breed face that threatens its survival or sustainable use?

For example: Loss of grazing opportunities; Changes in agricultural production systems; Loss of traditional institutions; Lack of health care; Lack of market demand; Lack of interest by young generation; Drought, floods or other natural catastrophes; Conflict or war.

16. What types of action do respected local people and other community members suggest?

7.4 List of figure



Appendix Fig 1 Physical map of Afar Rregion


Appendix Fig 2 Preferred browse species of goat, left *acacia nilotica* and right flower and pods of *acacia tortolis*


Appendix Fig 3 Irrigation canal in Gahirtu PA (left) and children milking doe (right) at Romaytu PA