

**CHARACTERIZATION OF GOAT PRODUCTION SYSTEMS AND
ON- FARM EVALUATION OF THE GROWTH PERFORMANCE OF
GRAZING GOATS SUPPLEMENTED WITH DIFFERENT PROTEIN
SOURCES IN METEMA WOREDA, AMHARA REGION, ETHIOPIA**

M.Sc. Thesis

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ON- FARM EVALUATION OF THE GROWTH PERFORMANCE OF
GRAZING GOATS SUPPLEMENTED WITH DIFFERENT PROTEIN
SOURCES IN METEMA WOREDA, AMHARA REGION, ETHIOPIA**

**A Thesis Submitted to the Department of Animal Science,
School of Graduate Studies
HARAMAYA UNIVERSITY**

**In Partial Fulfillment of the Requirements for the Degree of MASTER OF
SCIENCE IN AGRICULTURE (ANIMAL NUTRITION)**

**BY
Tesfaye Tsegaye**

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As Thesis Research advisors, we hereby certify that we have read and evaluated this thesis prepared, under our guidance, by Tesfaye Tsegaye, entitled “**Characterization of Goat Production Systems and On- Farm Evaluation of the Growth Performance of Grazing Goats Supplemented With different Protein Sources in Metema Woreda, Amhara Region, Ethiopia**”. We recommend that it be submitted as fulfilling the Thesis requirement.

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DEDICATION

This piece of work is dedicated to my father, Tsegaye Workneh (1944-1992) who was always immersed in fantasy about my success though death come ahead of his reveals a bit before my success in joining of the College.

STATEMENT OF AUTHOR

First, I declare that this thesis is my bonafide work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for an MSc degree at Haramaya University and is deposited at the University Library to be made available to borrowers under the rules of the Library. I truly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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BIOGRAPHICAL SKETCH

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“Lord, I am overflowing with your blessings, just as you promised.” Psalms 119:65

LIST OF ABBREVIATIONS

ARARI	Amhara Region Agricultural Research Institute
ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
ADG	Average Daily Gain
ACSI	Amhara Credit and Saving Institution
ANRS	Amhara National Regional State
CCPP	Contagious Caprine Pleuro Pneumonia
CF	Crude Fibre
CP	Crude Protein
CACC	Central Agricultural Census Commission
CSC	Cotton Seed Cake
CSA	Central Statistical Authority
CV	Coefficient of Variation
DM	Dry Matter
DAGRIS	Domestic Animal Genetics Resource Information Systems
DMI	Dry Matter Intake
EARO	Ethiopia Agricultural Research Organization
ESAP	Ethiopian Society of Animal Production
EE	Ether Extract
GARC	Gondar Agricultural Research Center
GLM	General Linear Model
IBC	Institute of Biodiversity Conservation
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
IPMS	Improving Productivity and Market Success
IVOMD	<i>In Vitro</i> Organic Matter Digestibility
LSM	Least Square Mean
MOA	Ministry of Agriculture

ME	Metabolized Energy
MJ	Mega Joule
MRR	Marginal Rate of Return
NI	Net Income
NRC	National Research Council
NSC	Noug Seed Cake
PA	Peasant Association
PPR	Peste De Petits Ruminants
PLW	Pilot Learning Wereda
RCBD	Randomized Complete Block Design
RMA	Rapid Market Appraisal
SAS	Statistical Analysis System
SDDP	Smallholder Dairy Development Project
SPSS	Statistical Package for Social Science
TDN	Total Digestible Nutrient
TR	Total Revenue
TVC	Total Variable Cost
UMB	Urea Molasses Mineral Blokes
WOARD	Wereda Office of Agriculture and Rural Development

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**CHARACTERIZATION OF GOAT PRODUCTION SYSTEMS AND ON- FARM
EVALUATION OF THE GROWTH PERFORMANCE OF GRAZING GOATS
SUPPLEMENTED WITH ISONITROGENOUS PROTEIN SOURCES IN METEMA
WOREDA, AMHARA REGION**

ABSTRACT

The study was carried out in Metema Woreda of Amhara National Regional State. The objectives of the study were to describe the goat production systems in the study area and to identify major constraints and opportunities of goat productivity; to evaluate the effect of supplementation with different protein sources on live weight gain of grazing goats under farmers management and to evaluate the economic feasibility of the feeding system under farmers condition. The results on production and marketing systems of this study were based on survey of 135 sample households and rapid appraisal of major goat market respectively. Following the Survey work, on-farm monitoring and feed trial were carried out. Records on birth weight, weaning weight, preweaning average daily gain and mature body weight were recorded from monitored flocks. Twenty intact male local goats owned by farmers were used for on- farm feeding trial experiment to evaluate the growth performance of grazing goats supplemented with isonitrogenous protein sources. The survey results revealed that goats were the most widely reared livestock species in the study area and the overall mean holding of goats per households was 19.7 ± 6.60 . The purposes of keeping goat in Metema Woreda was to generate income followed by meat production, saving and as means of ceremony, in that order. In Metema, the genotype of goat was entirely indigenous goat types. According to the respondents, the indigenous goat type dominantly (76.3%) found is locally known as “Habesha”, and small proportions of “Rutana 5.2%” and “Gumu 5.9%” goat types are also present. The major feed resource was natural pasture and source of water were from rivers, wells, natural ponds and springs. Enclosures near the fence or a separate hut for goats with a suspended wooden floor, about 0.5- 1 m above the ground, shelter were the two main methods of housing. The result revealed that uncontrolled mating within the household’s flock was predominant. In both farming systems cotton and sesame based, disease, theft and, labour were the most important goat production constraints in that order. There was neither regular market in formations on prices and supplies nor grades and standards. Animals are sold on a per head basis. The present pricing system in which agreement on price is reached by a long bargaining between sellers and buyers leaves the greater opportunities for benefiting the middlemen. The primary reason for selling of goat for the Metema goat owners was to generate money for labour wage payment followed by food crop purchase, input purchase, school fee and as means of tax in that order. Buying for consumption purpose in all market places showed a higher proportion followed by buying for profit /resale, reproduction and fattening. Regarding market composition, goats less than or equal to one year were the largest proportion in all markets and the percentage of goat sold decreased as the age increase. According to farmers’ report, the overall average age at puberty in males was 7.4 ± 1.95 and 8.2 ± 1.64 months in females. Age at first kidding and kidding interval were $13.6 \pm$

2.44 months and 8.4 ± 1.37 months, respectively. The over all average birth weight, weaning weight three months and pre-weaning growth rate were 2.28 ± 0.04 kg, 12.73 ± 0.13 kg and 115.74 ± 1.55 g/day, respectively. Kids born single, male and kids from later parity were heavier ($P < 0.01$) than twins, females, kids born from first parity. Kids born from does for the first time grew slowly and had significantly lower ($p < 0.01$) weaning body weight and pre weaning average daily gain. Type of birth had also significant effect ($p < 0.01$) on weaning weight but not on pre weaning average daily gain ($p > 0.01$). The overall body weight of mature goats from above dentition class 1 pair of permanent incisor (PPI) was 32.96 ± 0.61 kg. Sex and age group had significant effect ($p < 0.05$) and ($p < 0.01$), respectively on live weight. Live weight significantly (at least $p < 0.05$) increased from goat having 1PPI to 3 PPI and then showed a decreasing trend though not significant. In the feeding trial, twenty intact male Hebesha or Dega type yearling goats with average initial live weight of 22.35 ± 0.12 kg were used. The experimental goats were blocked into five groups of four animals each based on their initial body weight. Dietary treatments were randomly assigned to each animal in the group. Animals which were assigned randomly in each block were given to one farmer. Each farmer possessed all treatments. The treatments comprised of grazing alone (T1), grazing + mixture of 47% noug seed cake and 53% wheat bran (T2), grazing + mixture of 31% cotton seed cake and 69% wheat bran (T3) and grazing + mixture of 40% sesame seedcake and 60% wheat bran (T4). Supplemented goats attained better BW gain which were 52.9, 68 and 55.1 gm/day in T2, T3 and T4, respectively than nonsupplemented ones 34.4 gm/day. All the supplement feeds significantly ($p < 0.01$) improved final weight and average daily gain of goats. The partial budget analysis showed that supplementation with noug cake ;cotton seed cake and sesame seed cake with wheat bran mixtures for Metema goat under grazing condition was not potentially profitable compared with no supplementation (grazing only). Therefore from this finding it is conclude that, even though supplementation favor better growth rate and improved body condition it was not economically beneficial compared to unsupplemented groups.

1. INTRODUCTION

It has been reflected time and again that livestock in Ethiopia is an important and integral component of agriculture, which is the backbone of the economy. Not only does the sub-sector provide the much-needed animal protein for the ever-growing human population, but it also offers employment opportunities for millions of rural and urban dwellers involved in some form of livestock production and marketing (Asnakew, 2005).

Considering goats in particular, they have a great role in the economy of farming community of Ethiopia. Sale of goats and goat products (meat, skin and milk) by farming communities is the major source of cash for purchase of clothes, grains and other essential household commodities. In addition, goats are raised mostly to safeguard against crop failure and unfavorable crop prices in intensive cropping areas. Goats represent a more liquid form of capital than cattle and are readily tradable (MOA, 1985: cited by Sendros, 1993). The country earns annually on average about US dollar 8 million from the export sales of live sheep and goats and of mutton and goat meat. These export trades showed about 20 and 59 % annual growth rates, respectively (ILCA, 1991).

Despite the large size of the country's goat population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This may be due to different factors such as poor nutrition, prevalence of diseases, lack of appropriate breed and breeding strategies and poor understanding of the production system as a whole. However, the indigenous goat breeds have relative advantage in their natural habitat. According to Kiwuwa (1992), the broad genetic variability of African small ruminant breeds enables them to survive under stressful environmental conditions, including high disease incidence, poor nutrition, and high temperature. Environmental pressure also maintains a wide range of genotypes, each adapted to a specific set of circumstances.

The overriding constraint of livestock production in the country is believed to be shortage of feed (Seyoum and Zinash, 1995). In lowland areas, goats rely on browsing and grazing whereas in the highlands they depend on communal grazing, fallow lands, and crop residues (Aschalew *et al.*, 2000). The available feeds from such sources are insufficient to provide nutrients beyond maintenance requirements (Tsigeyohannes, 2000). Poor grazing and low quality feeds especially in terms of energy or protein leads to undernourishment and low productivity.

Under such circumstances, the concept of utilizing locally available agro-industrial by-products as a supplementary feed may be a feasible feeding system for farmers and commercial production and at the same time converting non edible agro- industrial by-products into highly nutritious animal origin foods. The system would create possibilities of getting alternative feeds to ensure that the animals take complementary rather than a competitive part with man (Alemu *et al.*, 1989). Among the various agro industrial by products, noug seedcake, sesame seedcake, cotton seedcake and wheat bran are believed to be important supplements for goats. These by products are relatively abundant and readily available for goat producers living in areas where oil and fiber crops dominantly grow and people living around towns and cities where oil and milling industries are built.

Eventhough some attempts have been made by institutions involved in Research and Extension of small ruminant to improve their productivity in the country, goat feeding is often an ignored area and little emphasis has been given to the development of goat production through research in the past. Moreover, much of the works published have the disadvantage of having been carried out under the controlled conditions at research stations. Thus, the results may not reflect the actual situations of small scale production systems prevailing in rural areas. On the other hand, lack of up-to-date and location-specific information on production and marketing systems is often a major limitation to productivity and production improvement endeavors in goats (Peters and Horpew, 1989; Ayele *et al.*, 2003). To design improvement measures relevant to specific systems and thereby properly respond to the growing domestic and foreign demands for live goats and

goat products systematic characterization of goat production, marketing systems and performance evaluation is indispensable. Therefore assessing the potential of available genetic resources, and identifying and prioritizing the major constraints limiting the traditional goat production system are immediate tasks in order to carry out research and development strategies

IPMS (Improving Productivity and Market Success) in collaboration with the Ministry of Agriculture and Amhara Regional Agricultural Research Institute (ARARI) in Ethiopia is designing a community-based sheep and goat breeding and meat production and marketing strategies for some Pilot Learning Woredas (PLWs) including Metema Woreda.

Metema woreda has immense goat population potential which is considerably higher than flocks in adjacent woreda and goats are the most important marketable livestock in the area (ILRI 2005). Thus, IPMS and the Woreda office of Agriculture and Rural Development (WoARD) have identified goats as potential and priority commodity for improvement. However, information on the smallholder goat production, marketing systems, growth responses to feed supplements at farmer's management, production constraints, opportunities and improvement options which are required for appropriate research and development intervention are not available in the Wereda. Therefore, this study was initiated with the following objectives.

Objectives

- To describe the goat production systems in the study area and to identify major constraints and opportunities of goat productivity.
- To evaluate the effect of supplementation with different protein sources on live weight gain of grazing goats under farmers management, and
- To evaluate the economic feasibility of the feeding system under farmers condition in Metema Woreda of North Gondar Zone.

2. LITERATURE REVIEW

2.1. Goat Population and Distribution in Ethiopia

The goat population of Ethiopia is estimated to be 18.5 million (CSA, 2007). It is maintained with a very little resource input under the traditional subsistence management system. Goats are important for diversifying production, creating employment, increasing income, building capital, contributing to human nutrition and reducing risk during crop failure, property security and investment (Workneh, 1992). Goats are easily adaptable animals. They are found in all agro ecological zones of Ethiopia (Alemayehu,1993). They are particularly important in marginal agricultural land especially in arid and semi-arid areas which together hold 64 % of the goat population in Africa (Rege and Lebbie, 2000).

In Ethiopia goat production has traditionally been an integral part of the farming systems in all agro-climatic conditions of Ethiopia (Workneh, 1992). It is estimated that about 70% of the goat population is found in the low lands and the rest 30% is found in the high lands (Alemayehu,1993). In lowlands, they are kept in large flocks by pastoralists, whereas in high lands, goats are integrated into the crop livestock systems with very small flock size playing complementary roles with other species of the livestock (Workneh, 1992). Contrary to the general assumption that goats are associated with arid and semi arid areas, they tend to replace sheep as the dominant small ruminant species in the highlands, especially most parts of northern, eastern and western highlands of Ethiopia (Aschalew *et al.*, 2000).

2.2. Goat Production Systems in Ethiopia

Goats are found in all agro-ecological zones from hyper-arid to super-humid and over the whole range of production systems from intensive smallholder production to very extensive nomadic pastoralists (Payne and Wilson, 1999). Goat production in Ethiopia is described under low input production system and is operated by smallholder farmers. This production system accommodates almost all of the goat population of the country (IBC, 2004). The main features of the low input goat production system are its full

dependence on natural resources and the limited demand for inputs. This system is characterized by land scarcity, severe resources degradation and recurrent drought (IBC, 2004). In Ethiopia, goats are maintained under two broad production systems (EARO, 2000).

2.2.1. Mixed crop-livestock farming system

In a mixed crop–livestock production system, which is prevalent in humid, sub-humid and highland agro–ecological zones, goats are kept by smallholders and graze together with sheep and/or other livestock such as cattle. In these mixed-species grazing systems, goats complement cattle and sheep rather than compete with them for feed, because of their inherent ability to eat a wider variety of plant species (Lebbie, 2004 cited by Yoseph, 2007). These mixed herds usually freely graze on communal pastures and seasonally on fallow cropland with no extra-supplement and receive minimum health care. However, due to the increasing population pressure in areas with this production system, free grazing is becoming limited and goats are now tethered, reflecting the challenge of procuring sufficient feed in this system (FARM-AFRICA, 1996). Furthermore, in highland agro–ecology, as in central Ethiopia, increased human population has led to decreased farm size and a gradual shift from keeping large to small ruminants, mainly goat and sheep (Peacock, 2005).

2.2.2. Agro pastoral and pastoral system

In pastoral and agro–pastoral production systems, which are found in arid and semi-arid agro–ecological zones, goats are kept by nearly all pastoralists, often in mixed flocks with sheep, freely grazing or browsing in the rangelands. This production system is associated with the purely livestock based nomadic and transhumance pastoral production systems based largely on range, primarily using natural vegetation. In the lowlands of Ethiopia, livestock is comprised of large flocks and herds of sheep and goats, cattle and camels mainly transhumants, where only surplus are sold at local markets or trekked to major consumption centers. Extensive livestock keeping is the backbone of the economies of the lowlands (EARO, 2000).

2.3. Indigenous Goat type Classification and their Distribution in Ethiopia

Most tropical goats were not well characterized both by genotype and phenotype and can be called nondescript. However, there have been several attempts to assign goats to breed/types based on such variables as origin, utility, body size, ear shape and ear length (FARM Africa, 1996). Classification of tropical goats by function has not, so far, found a great deal of support. This is perhaps because goats indigenous to the tropics have been selected mainly for survival (Peacock, 1996). They have developed specific adaptations to survive and produce under adverse local environmental conditions (climatic stresses, poor quality feed, seasonal feed and water shortage, endemic disease and parasite challenge) which make them suitable for use in the traditional, low-external-input production system. According to Peters and Horst (1981), body size is a suitable criterion for classification since it also gives clues to potential performance. Based on physical, morphological and functional characteristics and other goat breed descriptors, Ethiopian goats have been phenotypically classified into 13 breed types and their distribution described according to distinct agro-ecologies and climatic conditions (FARM Africa, 1996; DAGRIS, 2006). A comprehensive survey of goats in Ethiopia identified 13 breed types under three families based almost entirely on morphological characteristics (FARM-Africa, 1996).

Almost all indigenous goat types in Ethiopia fall under the general group of short eared small-horned goats found through-out eastern, central and southern Africa (Table 1). They inhabit all agro-climatic zones and production systems in the areas. There is only one breed (the Barka) from a different breed group, and it comes mainly from Eritrea (Nigatu, 1994). Fellata, Arab, Gumuz, Agew and Oromo goat types have been identified as indigenous to Ethiopia (Getnet, 2001). According to Tesfaye (2004) indigenous goats of Ethiopia can be grouped as eight distinct genetic entities: Arsi-Bale, Gumuz, Keffa, Long-Ear Somali, Woyto-Guji, Abergalle, Afar, Highland Goats (previously separated as Central and North West Highland) and the goats from the previous Hararghe province (Hararghe Highland and Short-Ear Somali).

Table 1. Distribution of documented indigenous goat breeds/ types in Ethiopia

Breed group name	Breed name	Synonym	Distribution	Sources
Long eared goats	Barka	Bellenay, Beni Amer	Northern and northwestern Ethiopia near the border with Eritrea and the Sudan	FARM-Africa <i>et al.</i> , 1996; Hodges, 1992
Short eared Small-horned	Long eared Somali	Digodi, Melebo, Boran Somali, Benadir, Gigwain	Rangeland of the southern Ogaden, Bale, Borana and Southern Sidamo with the Somali and Borana Pastoralists	Bee <i>et al.</i> , 1992; David. and Stephen, 1991
	Short eared Somali	Ogaden, Mudugh, Dighier, Abgal, Issa-Somali, Bimal	Northern and Eastern Ogaden and around Dire Dawa	FARM-Africa <i>et al.</i> , 1996
	Western Highland	Agew	Highlands of Western Ethiopia (Gonder, Gojjam, Wollega and Shoa)	FARM-Africa <i>et al.</i> , 1996
	Western Low land	Gumuz	Lowlands of Western Ethiopia (Metekel, Assosa, and Gambella)	FARM-Africa <i>et al.</i> , 1996
	Woyto-Guji Abergelle	Woyto, Guji, Konso	North Omo, South Omo, Sidamo, Borana	FARM-Africa <i>et al.</i> , 1996
Short eared Small-horned	Afar	Adal, Assaorta, Denakil	Southern Tigray, North Wollo, and South Gonder	FARM-Africa <i>et al.</i> , 1996; Hodges, 1992
	Arsi-Bale	Arsi, Gishe, Sidama, Manta, Awarch	Afar region and parts of Eritrea and Djibouti with the Afar Pastoralists	FARM-Africa <i>et al.</i> , 1996; Hodges, 1992
	Central Highland	Brown Goat, Kaye	Arsi, Bale, Sidamo and Western Hararghe Zones	FARM-Africa <i>et al.</i> , 1996
	Hararghe Highland Keffa	Kotu-Oromo	Highland of Central Ethiopia from Tigray through Wollo, Gonder to Shoa	FARM-Africa <i>et al.</i> , 1996
		NA	Highlands of Eastern and Western Hararghe	FARM-Africa <i>et al.</i> , 1996
		NA	Keffa and adjoining parts of Kembata and Hadiya	FARM-Africa <i>et al.</i> , 1996

Source: Adapted from Nigatu, (1994) and Belay, (2008), NA=not available

2.4. Flock Demography of Goats in the Tropics

Flock structure is the proportion in the flock of the different age and sex classes of goats. The number of males and females in flocks and their ages are often used as an indicator of a particular traditional management system in Africa (Wilson, 1986). Flock structure is also a basis for calculating or forecasting flock productivity (ILCA, 1990). For instance, a relatively low proportion of young stock in a flock would suggest that adult mortality is low or pre weaning mortality is high, or the kidding percentage is low. Alternatively, it may mean that more kids were sold during the year (Ibrahim, 1998).

When the primary objective is to produce milk, the proportion of females retained is usually higher than when the objective is to produce meat (FARM Africa, 1996). A high proportion of castrates suggest that the system is likely to be related to meat production objectives. For example, in lowland goats of Ethiopia, the primary objective is to produce milk and castrates with four pairs of incisors account for 0.5% of the total flock, whereas for the Central Highland goats whose primary purpose is meat production and sale in times of need, the proportion of castrated male with four pairs of incisors is 2.2% (Nigatu, 1994).

2.5. Production and Reproduction Characteristics of Goats

2.5.1. Age at puberty

Puberty is generally considered to be related more to growth than age in tropical goats with first estrous occurring with the attainment of 60-70% of adult live weight (Devendra and Burns, 1983). According to the review of Payne and Wilson (1999) on the reproductive and production data on tropical goats, tropical male goats reach puberty at about 97 days, i.e., the age at which spermatozoa appear in the ejaculate, and reach sexual maturity at 132 day (Tolera and Abebe, 2007). In females, puberty 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. It is common in the tropics for goats to reach sexual

maturity at 4-6 months. Wilson (1991) reported that the average age at sexual maturity of Red Sokoto and Afar goats ranged between 120-150 days and 24 months, respectively.

2.5.2. Age at first kidding

This trait can be recorded easily in a farmer's flock. There is a big variation among production systems and breed for this trait (12-24 months). It is usually late in animals living in harsh environments (Wilson, 1991). Two kiddings per year are possible, but seldom achieved. The variation in age at first kidding is from as young as 7 months to as old as 2 years. Many of the African goat breeds give birth to their first kid at 12-18 months (Peacock, 1996). According to Lebbie and Manzini (1989), does of indigenous goats under traditional management in Swaziland kidded at 301 ± 55 days with the range of 262-340 days implying that the young females are mated an estimated age of 7.2 ± 0.4 months and at a low body weight (Saddul *et al.*, 1999). Similarly Sodiq *et al.* (2001) reported age at first kidding of 12.4 months for Peranakan Etawah goats of Indonesia. Similarly, Wilson *et al.*, 1989) reported age at first kidding for Togo, Sahel and Maradi goats as 15, 13 and 14 months, respectively. The age at which West African Dwarf goats first kid is between 16 and 18 months (Mamabolo and Webb, 2005). Karua (1989) reported age at first kidding for Nigerian Red Sokoto goats to be 14.5 months and for Malawi local goats 15.6 months under village management conditions.

2.5.3. Kidding interval

This refers to the number of days between successive kiddings (Steele, 1996). Kidding interval is one of the major components of reproductive performance that has significant influences on production systems. It contributes largely to the productive efficiency and it has been reported to be affected by nutrition, suckling, parity (number of times kidded) and breed (Banerje *et al.*, 2000). Under normal circumstances (no drought), tropical goats should be kidding at least three times in 2 years. For this to be realized, kidding interval should not exceed 8 months (245 days). The kidding interval in most tropical goats varies from 180-300 days (Wilson, 1991). The reported kidding interval for Somali (Boran) does was 14 months (Wilson, 1991). Kidding interval for Arsi-Bale and Central Highland

goats was reported to be 242.1 and 247.96 days, respectively, under traditional management practices (Tatek *et al.*, 2005 and Tesfaye *et al.*, 2006). A kidding interval of 268 ± 100 days has also been reported for indigenous goats under traditional management in Swaziland (Lebbie and Manzini, 1989). According to these authors, intervals between first and second births (256 days) were apparently shorter than those at higher parities (275 days). It has been reported that the average kidding interval for indigenous goats of South Africa in Mootse was 258 days (Mamabolo and Webb, 2005). These authors have also stated that the shortest interval generally occurred in traditional systems where uncontrolled breeding is the norm.

2.5.4. Birth weight and growth rate

Birth weight is strongly influenced by breed (genotype), sex of kid, birth type, age of dam, feeding conditions, season of birth and production system (Banerjee, 2000). Birth weight of animals is one of the most important factors influencing the pre-weaning growth of the young (Devendra and McLeroy, 1988). These authors have reported a positive correlation between birth weight and subsequent live body weight development in goat. In another study it is stated that kids heavier at birth grow faster than light weight kids. Kids which are heavier at birth are usually singles or are those produced by does with larger body sizes and good feeding conditions. The indication is that kids heavier at birth have larger adult weight and a higher growth capacity. Improvement in birth weight is known to have a positive influence on other productivity parameters. Different findings show that male and single kids had heavier birth weight than females and twin kids. According to Tesfaye *et al.* (2000) birth weight of male and female kids were 2.28 ± 0.54 and 2.36 ± 0.51 kg for Borana Somali goats and 2.00 and 1.00 kg for Mid Rift Valley goat types, respectively. In the same study the mean birth weight of single and twin births reported to be 1.69 ± 0.43 and 1.23 ± 0.37 kg for Mid Rift Valley goats, respectively. In a study conducted to evaluate the productivity of indigenous local goats under traditional management in Swaziland Lebbie and Manzini (1989) reported birth weight of male kids weighing more (2.0 kg) than females (1.8 kg). These authors also reported that kids born of primiparous does (1.8 kg) weighed less than those born of subsequent kidders (2.0 kg).

Mohammed and Amin (1997) reported that the average weights at birth for singles, twins and triplets of Sahel goat kids to be 2.7, 2.3 and 1.6 kg, respectively. Results on birth weight of Small East African goat breeds of Malawi were also reported to be 2.05 kg for single birth kids (Karua and Banda, 1989). Chikagwa-Malunga (2001) also indicated that mean birth weight for male and female born singles was 2.1 and 1.9 kg respectively, for local Malawi goats, while that of kids from multiple births were 1.6 kg for both male and female kids. The birth weight of single and twin kids (male and female) born from multiparous does was 2.0 kg while that of triplets was 1.5 kg with no significant sex effect in the birth weight of kids born from either multiparous or primiparous local goats of Mauritius (Saddul *et al.* 1999). Kids born as singles and twins had significantly higher birth weight than kids born as triplets (Saddul *et al.*, 1999).

Growth is a very important characteristic of animals for meat production and it depends on factors such as breed, sex, nutrition and other environmental factors. The principal factor affecting the growth of kids is the composite measure of feed intake as influenced by the milk yield of the doe, which in turn is depend on the availability of roughage feed and its quality. The weight gain of suckling kids (Morand-Fehr *et al.*, 1982) is closely associated with the level of milk intake during the early stages of the milk feeding period and declines with declining milk production. Wilson and Murayi (1988) reported that the season of birth affected birth weight and pre-weaning growth, mainly through influencing the nutritional status of the dam, the offspring and hence amount of milk available to the unweaned kid. The sex of the kid and type of birth also affects kid birth weight and pre-weaning growth; whereby male kids and singles were heavier than female kids and multiple kids, respectively.

Most of Ethiopia goats' adult BW range from 25-40 kg (Peacock, 1996). Mukassa-Mugerwa *et al.* (1989) stated that growth rate of goats in Ethiopia under traditional management declined from 104 g/day at 3 months to 87 g/day at 6 month, 65 g/day at 12 month and 44 g/day at 24 months, respectively. On-farm assessment of Arsi Bale goats indicated that the mean birth weight, weaning weight and pre weaning growth rate were

2.28 kg, 8.39 kg and 72.21 g/day, respectively (Tatek *et al.*, 2005). Similarly, Tesfaye, *et al.* (2006) reported that the mean birth weight, weaning weight and pre-weaning growth rate of Central Highland goats were 2.32 kg, 6.72 kg and 62.63 g/day, respectively. Tesfaye *et al.* (2000) stated that the mean birth, weaning, 6-month and yearling weight were 2.32 ± 0.46 , 7.17 ± 1.6 , 9.3 ± 1.72 and 13.04 ± 2.59 kg for Borana goats and 1.5 ± 0.46 , 6.32 ± 2.77 , 7.87 ± 1.62 and 12.85 ± 2.55 kg for Mid Rift Valley kids, respectively. On farm growth assessment of goats in Sekota woreda indicates that the average birth weight, weaning weight and daily pre weaning growth rate to be 2.27 kg, 7.91 kg and 62.63 g, respectively (Muluken, 2006).

2.6. Livestock Marketing System

Marketing includes moving products from producers to consumers and comprises exchange activities of buying and selling, the physical activities designed to give the product increased time, place and form utility, and the associated functions of financing, risk bearing and dissemination of information to participants in the marketing process (Jabbar *et al.*, 1997). Livestock marketing involves the sale, purchase or exchange of products such as live animals, and livestock products of milk, meat, skins, wool and hides for cash or goods in kind (ILCA, 1990).

The ultimate goal of interventions aimed at enhancing productivity of sheep and goats needs to consider the market aspect simultaneously (Endeshaw, 2007). Farmers need to be aware of the preferred characteristics of animals as well as price patterns so that they can plan breeding and fattening programmes and breed selection consistent with the best seasonal prices and consumers' preferences (Ehui *et al.*, 2000). Alleviating constraints to the export market and domestic trade and market structure increases the welfare of smallholder producers, urban consumers and improves the national balance of payments (Ayele *et al.*, 2003).

Population growth, urbanization and income growth fuel increases in meat and milk consumption and create a veritable livestock revolution (Delgado *et al.*, 1999). This

revolution presents new and expanding market opportunities for smallholder livestock producers (Lapar *et al.*, 2002). On the other hand, whether smallholders are able to participate and compete in the domestic and global markets is a critical question (Lapar *et al.*, 2002).

Potential production and market opportunities for small ruminant meat have not been exploited because of scant knowledge of small ruminant demand patterns (Ehui *et al.*, 2000). An important aspect of production and its response to demand and supply is knowledge of markets and marketing systems. To shift production from subsistence to a more commercial outlook is especially important to describe and intervening aspects of marketing infrastructure and facilities, market channels and outlets, buyer preferences for live animals and their meats, major market players, government intervention and role of the private sector (Devendra, 2007).

2.6.1. Structure and performance of livestock markets in Ethiopia

According to Ayele *et al.* (2003), livestock marketing structures of Ethiopia follows a four-tier system. The main actors of the 1st tier are local farmers and rural traders/rural assemblers who transact at farm level. Those small traders from different corners bring their animals to the local market (2nd tier). Traders/wholesalers purchase a few large animals (cattle) or a fairly large number of small animals (sheep and goat) for selling to the secondary markets. In the secondary market (3rd tier), both smaller and larger traders operate and traders (wholesalers or retailers) and butchers from terminal markets come to buy animals. In the terminal markets (4th tier), big traders and butchers (wholesalers or retailers) transact larger number of mainly slaughter type animals. Consumers get meat through purchase of the animals from terminal markets and slaughter at home or they may get meat from markets or they may access from butchers who process the meat via abattoirs.

Livestock markets are generally under the control of local authorities. Market locations

in primary and secondary markets are usually not fenced. There are no permanent animal routes and no feed and watering infrastructures. Yet buyers and sellers are subjected to various service charges by the local authorities as well as other bodies (Ayele *et al.*, 2003).

Market information is crucial to producers, wholesalers and consumers to help them make decisions on what and whether to buy and sell. In general, information is required on prices, traded or available quantities, forecasts of future supplies and demand, and general market conditions. Information must be relevant, accurate and timely and reflect all sectors of the market, especially consumer demand (ILRI, 1995). Nearly in all parts of the country, there is no regular market information on prices and supplies, nor formalized grades and standards of sheep and goats and other livestock (Kebede and Ray, 1992; Ayele *et al.*, 2003). Markets are dispersed with remote markets lacking price information. Generally, there is excess supply of animals beyond demands which effectively suppresses producer prices since the more mobile trader is better informed on market prices, while better information combined with excess supply places the trader in a better position during price negotiation.

Livestock are generally traded by 'eye-ball' pricing, and weighing livestock is uncommon. Animals are sold on a per-head basis and price agreement reached by a long one-on-one bargaining between a seller and a buyer. Under such circumstances, prices paid will reflect buyers' preference for various animal characteristics (weight, sex, age, condition, breed, color), the purpose of animals purchased (for resale, slaughter, fattening or reproduction), the season of the year (occurrence of religious and cultural festivals) and the bargaining skills of buyers and sellers (Kebede and Ray, 1992; Ehui *et al.*, 2000; Ayele *et al.*, 2003).

Marketing of sheep and goats is characterized by strong seasonality and subject to fluctuation. Demand and price increases during festival periods. Factors affecting market supply, as measured by the number offered, include high demand during religious

festivals, lambing season, quality and quantity of grazing, as well as cash needs for crop inputs and later for food purchase before harvesting (EARO, 2000).

It is essential to consider linking production, products and by-products to markets in the context of the production to consumption systems in the 'food or commodity system framework' or commodity production and marketing chain (Jabbar *et al.*, 1997). Recognition of this chain ensures promotion of the interdependence between the production resources, producer, processor and consumer (Jabbar *et al.*, 1997).

2.7. Feed Situation in the Study Area

The major feed source for livestock in the Amhara Region is natural pasture and crop residues, which comprise about 46.58 and 35.31%, respectively (CSA, 2002). The feed source from the range, which is available to the goats in the study area includes different types of grasses, browsing trees and shrubs. According to IPMS (2005), the main animal feed resources in the Wereda which are natural pasture, browse plants and crop stubble which account for 55, 35 and 10%, respectively. The predominant pasture grasses are *Cynodon dactylon* (semblete), *Hyparrhenia hirta* and *Cenchrus ciliaris*. Moreover; woody species like *Pterocarpus lucens*, *Ziziphus Spina-Christ*, *Boswellia papyrifera* and *Acacia* species like *Acacia polyacantha*, *Acacia seyal* are the dominant species in the area (Tesfaye, 2008). From this, one can conclude that the grazing lands in the district are characterized as an *acacia* tree dominated woodland. These woody vegetations serve as the most important sources of feed for ruminant animals in the area. Among cereal crops produced in the wereda, sorghum and rice are important crops, whose stover or straw makes the major feed source for cattle, especially during the dry season.

2.8. Effect of Supplementation on Feed Intake and Growth of Goats

Tropical forages have a large proportion of lignified cell walls with low fermentation rates and digestibility, leading to low rates of disappearance through digestion or passage, and thus limit feed intake (Ibrahim *et al.*, 1995). Protein and energy are the most important components of diets, other than any other nutrients needed by animals. Forbes (1980) demonstrated that animals normally eat enough amount of feed which satisfies their protein and energy requirements. So, strategic supplementation of energy, protein and minerals offer an important means to ensure that animal performance is not reduced, especially during critical periods of feed shortage (Ranjhan, 1980).

A review of the available information on DMI indicates, DMI of 1.8- 3.8 % of body weight for meat goats and 4.9-7.8 % for dairy goats in the tropics and sub tropics is recommended (Devendra and Burns, 1983). This could be attributed to the fact that lactation increased DMI. Dry matter intake is dependent on whether the forage is fed alone or with concentrate, the latter generally increases overall DMI (Payne, 1990).

However, in goats given forage *ad libitum* the main factor influencing performance is the level of DMI (Morand –Fehr and Sauvant, 1987). Concentrates may improve the level of forage intake by supplying fermentable carbohydrates or proteins. Moreover, goats ingest large quantities of concentrates to achieve high performance (Morand-Fehr and Sauvant, 1987). With concentrate feeds offered *ad libitum*, their level of intake depends on different factors: their physical form, their palatability, the type of forages and the fact that concentrates are in mixture or not (Giger *et al.*, 1991)

Mowlem *et al.* (1985) showed that high rates of concentrate allowance reduced forage intake by goats. Voluntary feed intake of concentrate before kidding is influenced by level of energy and protein in the diet. Data on doe performance after kidding indicated that the voluntary intake of concentrate was slightly above feed intake before kidding (Aregheore *et al.*, 1992). Furthermore, Silianikove *et al.* (1993) demonstrated breed

variation in utilization of poor quality diet, even within tropical breeds. In the study of Silianikove *et al.* (1993), the desert goats maintained higher feed intake without consequent decline in DM digestibility because of higher fermentation, than the non-desert goats, which exhibited relatively lower DM digestibility because of increased feed intake. The desert goats reportedly combined higher fermentation rate and longer retention time, which allowed maximum intake and digestibility

The quantity of protein together with the energy utilization determine growth rate (Vanes, 1979). Growth rate of kids increased with increasing protein content of concentrate feeds offered *ad libitum* to Damascus kids weaned at 76 days of age (Louca and Hancock, 1977). Similarly, Mavrogenis *et al.* (1979) reported that both the growth rate and feed utilization of kids fed on concentrate *ad libitum* (10.9, 14.7 and 16.2% CP) were higher with high protein diets up to seven months of age. In the same study, male kids responded positively to increased protein level in the diet, whereas female response was only marginal. Contrary to this, Shahjalal *et al.* (2000) reported that the higher CP intake from high protein diet in goats supplemented with high and low protein did neither improved growth rate nor feed conversion efficiency. However, there is evidence that DM intake and growth rate in Alpine and Nubian goats increased linearly as the level of protein concentration in the diet increased (Lu and Potchoiba, 1990). A research conducted by Kabir *et al.* (2002) using grazing goats and supplemented with high protein or low protein diet showed no significant difference between the diets in DM intake and live weight gain, although there was a tendency of increased live weight gain, in goats given high protein diet.

When ruminants are offered unsupplemented low quality roughage, they lose weight because of inability to meet both energy and protein requirements. Getnet (1998) reviewed that in an experiment that used wheat bran, alfalfa and brewers dried grain as supplements, the total DM intake of wheat bran supplemented crossbred goats was higher compared to alfalfa and brewers dried grains supplemented ones. The daily weight gain of 72 g in yearling Horro lambs supplemented with 300 g/day concentrate (on fresh basis)

was also reported by Demissie *et al.* (1987). Similarly, Ewenetu (1999) indicated average daily body weight gain of 60.7 ± 1.5 g/day and 60.3 ± 1.9 g/day for Menz and Horro sheep, respectively, when grazing on pasture and supplemented with concentrate at 150-200 g DM/day.

2.9. Agro- industrial By-products as Ruminant Feed

Goat production in the tropics relies mainly on grazing. Most tropical forages are low in nutrient content and cannot supply adequate nutrients for optimum animal performance. Hence, some form of concentrate feeding is necessary to attain optimum productivity. Improved animal performance is dependent on supply of good quality feed throughout the year. At present, most goats in Ethiopia are kept extensively under traditional management. There are many crop residues and agricultural by-products in Ethiopia, which are underutilized. Hence, to obtain sufficient energy for rapid growth and fattening, supplemental concentrates must be provided to animals. Among the existing agro-industrial by-products, noug seed cake, sesame seed cake cotton seed cake and wheat bran are available for potential utilization as animal feeds in some localities. Several oil-rich seeds are produced for extraction of vegetable oils for human consumption and for paint and other industrial purposes (Ensiminger, 2002). The same author reported that the residues after processing of the seeds result in protein rich cakes, which can be used as livestock feeds.

2.10. Nutritional Characteristics of Oil Seed cakes

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

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

Comparison of leguminous hay and oil seed cakes for supplementary value to growing sheep fed a basal diet of teff straw also demonstrated that equal intake of CP from different sources does not support the same live weight gain (Lemma, 1991). Protein sources which slowly degrade resulted in the highest live weight gain. Improvement in live weight gain compared to un-supplemented diet was 6% for noug seed cake supplemented diets vs. 158% for lucaena and 116% for siratro.

Chemical composition of oil seed cakes vary widely depending on species and methods of processing (Solomon, 1992). Oil seed cakes are generally characterized by high protein, fat and low fiber contents. The mean chemical composition of 68 samples of oil seed cakes belonging to 6 genera resulted in CP content of 35%, ether extract (EE) content of 11%, neutral detergent fiber (NDF) content of 30% and lignin content of 7% (Solomon, 1992).

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

2.10.1. Chemical composition and supplementary value of noug seed cake

Noug is an oil crop cultivated in the mid altitude areas of Ethiopia. Noug seed cake is one of the important by-products, which is widely available and is a high protein meal with a CP value of 29.5% (SDDP, 1999).

The supplementary value of noug seed cake is influenced by its protein quality which depends on variety, climate, cultural practices and methods of processing (Amaha, 1990). Tekeba (2005) reported the chemical composition of noug seed cake as 32.74% CP, 6.29% EE, 26.90% CF, and 1821 kcal ME/kg DM. The high CP and ME values are indicative of the potential of the oil seed cake as a protein and energy supplement in crop residue based feeds of for ruminants. Seyoum (1995) reported that the EE content of oil seed cakes ranged from 5.5% in noug seed cake to 14.6% in sunflower cake with a mean of 10%, and the IVOMD of oil seed cakes ranged from 58% in noug seed cake to 88% in peanut cake.

Earlier works indicated that noug seed cake and urea molasses blokes (UMB) can be used along with poor quality hay and teff (*Eragrostis teff*) straw for milk production (Little *et al.*, 1987) and fattening sheep (Solomon *et al.*, 1991a; Lemma, 1991) as protein supplement.

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

2.10.2. Chemical composition and supplementary value of sesame seed cake

Sesame seed cake is produced by hydraulic pressing or solvent extraction. The former have lower protein content about 400 g/kg DM compared with 500 g /kg DM for the solvent-extracted material. Mechanically pressed sesame seed cake have oil contents of more than 100 g/kg DM compared with 20 g/kg DM for the solvent extracted meal and make a significantly greater contribution to the energy contents of the diet. For ruminants, the protein has a degradability of 0.65-0.75 depending upon the rate of passage through the rumen (McDonald *et al*, 2002). It contains 42 - 44% CP and is relatively high in calcium and phosphorus, but low in lysine content and must be combined with other feed sources containing sufficient lysine for non- ruminant animals (Bush, 1979).

Sesame seed cake has DM content of 900 g/kg. It has medium to high energy content with average of 12.9 MJ ME/kg DM and CP of 47% (Lonsdale, 1989). The chemical composition of sesame seed cake reported by Tekeba (2005) were 43.28%,16.61%, 9.45% and 3557 kcal/kg DM of CP, EE, CF and ME, respectively. Njie (1995) reported that sesame seed cake contained DM (93.6%), ash (8.7%), CP (37.5%), NDF (16.5%), ADF (9.4%), and EE (31.9%). Similarly, 43.75% CP and 18.37% NDF in sesame seed cake was reported by Zemicael (2007).

Sesame hulls contain oxalic and phytic acids which make the meal bitter and bind Ca, P and other minerals. As with other expeller meals, the relatively high level of residual oil will, if given in excess, lead to soft and tainted fats (Lonsdale, 1989). It is essential that sesame seed cakes should be completely decorticated in order to avoid toxicities. Sesame seed cakes in good condition are palatable, but laxative. The diets of young ruminants should not contain more than 50 kg/t, whereas the maximum inclusion rate for adults is 100-150 kg/t (McDonald, *et al*, 2002). Lonsdale (1989) indicated that the meal is relatively high in methionine, cystine, and tryptophan and lysine, which complements soya bean meal. A maximum level of 3 kg/head/day for dairy cows or 15% sesame seed cake in the diet of beef cattle appears acceptable (Lonsdale, 1989).

The reported growth rate of small ruminants supplemented with 200 g DM sesame seed cake was a daily gain of 54 g which is intermediate between ground nut cake (26 g per day) and sunflower cake (79 g per day) supplemented diets (Solomon, 1992). Zemicael (2007) also reported daily body weight gain of 71.11 g/ day when Arado sheep fed teff straw basal diet was supplemented with sesame seed cake and 66-70.89 g/day for the same breed fed on teff straw and supplemented with sesame seed cake and wheat bran mixture. According to Njie (1995), daily weight gains of rams fed on ground nut hay basal diet and supplemented with fixed 150 g rice bran and 50-200 g inclusion of sesame seed cake was from 77.5 - 120 g/day from lower to higher level supplemented treatments as compared to the control animals which gained 53.3 g/day.

2.10.3. Chemical composition and supplementary value of cotton seed cake

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

Cottonseed has a thick coat or husk, rich in fiber and of low digestibility, which lowers the nutritive value of the material (McDonald, 2002). It may be completely or partially removed by cracking and riddling, a process known as decortication. Removal of the husk lowers the crude fiber content and has an important effect in improving the apparent digestibility of the other constituents. As a result, the nutritive value of the decorticated cake is raised significantly above that of the undecorticated. Cotton seed cake is an excellent protein supplement for fattening goats and is practically equal to linseed meal

for fattening goats. When small ruminants are fed with large amounts of cottonseed meal, there is danger of cottonseed meal injury, unless they are offered plenty of good legume hay or other roughages (Morrison, 1984). A major constraint to the use of cottonseed and cottonseed meal as feedstuff is the presence of toxic constituents of gossypol, a yellowish pigment that occurs in seeds. Ruminants are more tolerant of gossypol, but even in ruminants prolonged feeding of whole cotton seed for many weeks or months can cause heart and liver damage (Cheeke, 1991).

2.10.4. Chemical composition and supplementary value of wheat bran

Wheat bran is an important source of carbohydrates, protein, minerals and vitamins and considered as one of the feeds that can be used for fattening. Wheat bran is usually an abundant agro-industrial by-product that can be used in animal feeding and is readily available (Alemu *et al.*, 1989). The CP content and fat content of wheat bran ranges from 13.3 to 17.0% and 3.0 to 4.5%, respectively (Lonsdale, 1989). The CP in wheat bran reported by Solomon *et al.* (2004b) was 16.5%. Tekeba (2005) reported CP content of wheat bran at 16.40%, EE 4.20%, CF 10.98% and ME 2996 kcal/kg and 16.7% CP in wheat bran was also reported by Zemicael (2007). Lonsdale (1989), indicated that CF and CP contents of wheat bran may vary from 100 to 130 g/kg DM and 170 to 180 g/kg DM, respectively and its ME content may range from 10 to 11 MJ/kg DM.

Devendra and McLeroy (1982) reported that wheat bran is quite palatable, and well known for its ability to prevent constipation because of its swelling and water holding capacity. This capacity of wheat bran is due to its fiber and non-starch carbohydrate content. Wheat bran has an amino acid balance superior to whole wheat, high in phosphorus and low in calcium Devendra and McLeroy (1982). It consists of about 18% CP and 67.2% TDN. The CP of wheat bran has a digestibility coefficient of about 0.75 and has 0.51 to 0.70 rumen degradability (Lonsdale, 1989). Fiber and ME content of wheat bran vary slightly depending on the specification of the wheat being milled and the exact processes used in the mill, as these factors affect the overall blend of bran components. Zemicael (2007) reported 50 g of average daily body weight gain for Arado

sheep fed on teff straw and supplemented with 300 g/day of wheat bran and 66-78.89 g/day for the same breed when supplemented with 300 g/day of wheat bran and sesame seed cake mixture. Similarly, Simret (2005) reported daily body gain of 39.90 - 44.72 g/day for Somali goats fed on hay basal diet and supplemented with graded levels of peanut cake and wheat bran mixture.

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted in Metema woreda of the Amhara National Regional State (ANRS), Ethiopia. Metema is located at about 900 km Northwest of Addis Ababa and about 180 km West of Gondar town. Metema is one of the West most woredas of the ANRS (Figure 1). The woreda has an international boundary of more than 60 km with Sudan. Metema is found North of Quarra and Alefa, West of Chilga, South of Tach-Arma Choho woredas and East of Sudan border (ILRI, 2005).

3.1.1. Climate, vegetation and soil condition

The altitude of Metema ranges from as low as 550 to 1608 m.a.s.l. The minimum annual temperature ranges between 22 °C and 28 °C. The daily maximum temperature becomes very high during the months of March to May, during which the temperature can reach as high as 43 °C. The mean annual temperature is about 31 °C (ILRI, 2005).

Mean annual rainfall of Metema area ranges from about 850 to around 1100 mm, and it receives a unimodal rainfall (ILRI, 2005). The rainy months extend from June to the end of September. However, most of the rainfall is received during the months of July and August, during which the rainfall is erratic. According to ILRI (2005), the natural vegetation of Metema is predominantly composed of different *acacia* species with a lot of *hyparrhenia* grass under growth. Metema is one of the Woredas where gum and incense are collected. The main species for incense production is *Boswellia papyrifera*, while *Acacia seyal* and *A. polyacantha* are used for gum production.

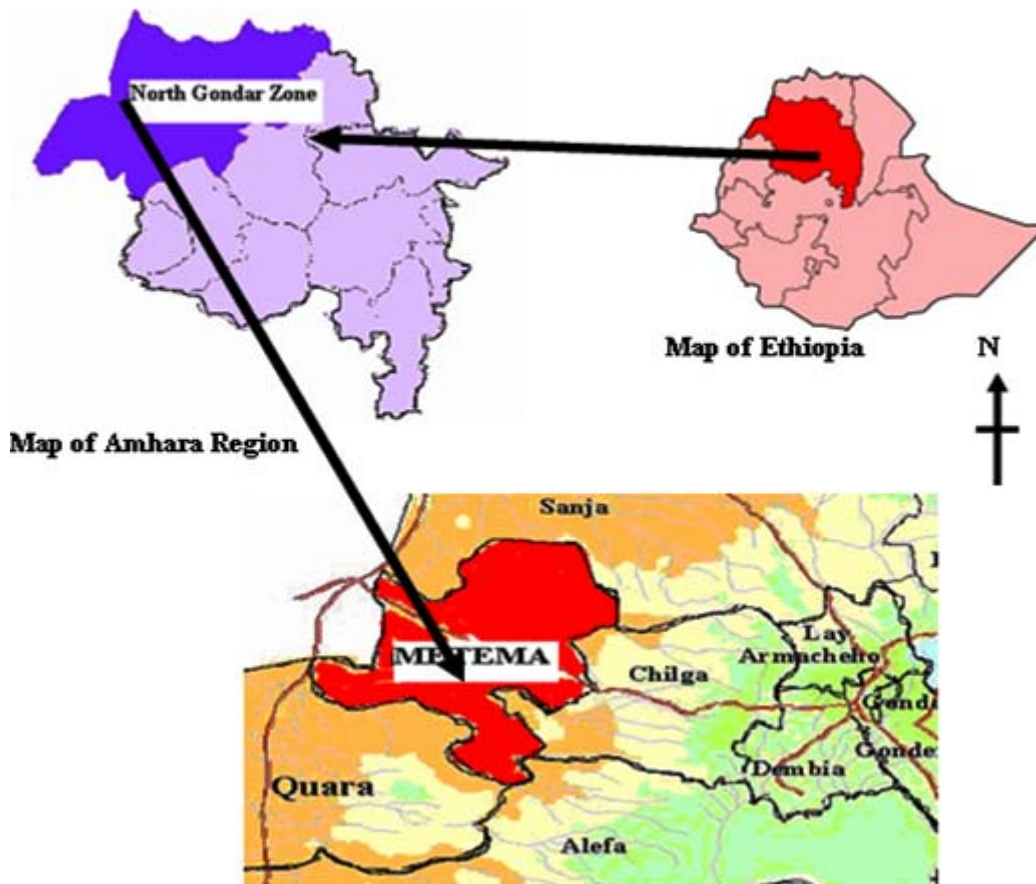


Figure 1. Location of Metema Woreda of the Amhara National Regional State

The soil in the area is predominantly black with vertic properties. Due to this reason, the soil in most areas is observed with excessive cracks, which could be as deep as 0.75 m in some places during the dry season. There are about 9 types of soil in the area, among which Haplic Luvisols prevail in about a quarter of the Woreda and Vertisols or soils with vertic properties exist in about 22% of the districts land area. On the other hand, Humic Nitosols account in about 6% (ILRI 2005). Seasonal water logging, especially during the months of heavy rainfall is so high, which needs the use of broad bed makers (BBM) to drain the excess over- flow and use the land for crop cultivation or grazing purpose (ILRI 2005)..

3.1.2. Human and livestock demography

According to CSA (2005), there are about 76,084 rural and 18,467 urban populations of which 41,202 were male and 34,882 were females in rural area. In the urban areas, 9,108 and 8,360 were male and female, respectively. The original residents of the area were Gumuz. Until recently, they have practiced slash and burning and hunting wild animals. They have also been engaged in making household furniture like chair, bed, pot and others. When the area became gradually populated, the natives were dominated by the new settlers. The original settlers are now found only in three peasant associations, the Kumer Aftit, Tumet and Shinfa. The total number of the indigenous people is around 500 (ILRI, 2005). Hence, much of the area is recently occupied by settlers from the highland part of the region. According to WoARD (2007), in the years of 2003, 2004 and 2005 during which new settlement programs occurred, 12,777, 4,124 and 16,258 new settlers were settled in the district, respectively. This shows that there is an aggregate of 33159 settlers during the three years and the trends were increasing.

Livestock production is an integral part of the land use system. Production of cattle (as draft power, milk and meat), shoat (income and meat), donkey and camel (as *Karoo* and transport) and poultry was commonly practiced. WoARD (2007) shows that the livestock population of the district is composed of 136,910 cattle, 32,024 goats, 1,686 sheep, 7,164 male donkeys, 7,127 poultry, 400 camels and 23,789 beehives. Cattle in the district were exported both legally and illegally, through smuggling to Sudan, while goats and other animals were mainly sold in local markets.

3.1.3. Farming system

The agricultural production system in the study area is mixed crop-livestock. The crop-livestock mixed production system is the predominant system and exists all over the district through out the year. Crop production is the main agricultural activity for the livelihood of the smallholder farmer in the study areas. The major crops grown include sorghum, rice, cotton, sesame, haricot bean, soybean and a little bit teff

According to ILRI (2005), Metema district was categorized into cotton, sorghum and rice/ livestock based and sesame, cotton, and sorghum/ livestock based farming systems based on the type of crop production. The livestock production system is similar in both farming systems.

Therefore, there are two types of farming systems used in the study districts namely cotton based farming system and sesame based farming systems. Each has its own characteristic features with regard to the nature of crop production.

3.1.3.1. Cotton based farming system

According to ILRI (2005), 4 out of 18 peasant association (PAs) belongs to this farming system. They are Maka, Awlala, Genda Wuha and Kemechela. They are found in the Northeast parts of the district. The PAs are relatively colder in temperature, have higher altitude and rainfall. Farmers in the PAs practice slightly early planting of crops. The soil is black and water logging is a problem. The majority of the soils in this farming system have vertic property. Many of the areas are also flat. The PAs in this farming system have different features in terms of suitability for crop production and amount of rainfall received. The majority of the soils are only suitable for growing cotton and rice. The PAs predominantly grow cotton and sesame in limited amount. Cotton is grown in wide areas, while sorghum and sesame are planted on very smaller areas.

3.1.3.2. Sesame based farming system

Fourteen PAs belong to this farming system. In order of importance, sesame, cotton and sorghum are the major crops produced in this farming system. A farmer could grow any one of these crops as the environmental conditions are equally suitable for these crops. The choice is set by the farmer upon observation of the season, high or low rainfall, and possible market prices. The altitude and rainfall in this farming system is less than the cotton based farming system. The altitude range for this farming system is between 550 and 700 masl (ILRI, 2005). Farmers and agriculturists believe that the underground water table is high. In some places, sufficient amount of water could be obtained at less than 10

m deep. Besides, three rivers are found in this farming system. These rivers make the area more potential for crop and livestock development. This farming system also has extensive grazing areas. There is also a place where the natural plantations for gum and incense are located.

3.2. Sample Selection Procedure

Prior to sampling of the PAs, discussions were held with Woreda livestock experts and development agents by preparing workshop to make clear the purpose of the study and for the establishment of community-based goat production improvement program. Expert consultation and field visits were also made to select the study peasant association (PA). Three PAs were purposively selected from the two farming systems based on the population of livestock in each PAs, their suitability for goat production, market and road access and willingness of the farmers to participate in the program. Since sesame based farming system prevails in 14 of the 18 PAs of Metema district, two PAs namely Kokit and Kumer Aftit were selected from sesame based farming system. Accordingly, one of the four PAs namely Gendahuwea that had relatively higher livestock population in the cotton based farming system was selected for the study.

In addition, secondary data on socio-economic characteristics, agricultural production, livestock population, farming practices and description of the woreda were collected from published and unpublished sources, so as to device suitable sampling stages.

A total of 135 households (90 in sesame based farming system and 45 in cotton based farming) were randomly sampled considering the area coverage of the farming system for interview from the selected PAs. Because of the similarity of livestock production systems within the two farming systems, two peasant associations, one PA from sesame based farming system (Kokit) and one from cotton based farming system (Gendahuwa) were purposively chosen for monitoring purpose based on the available goat population.

Eighteen households from sesame and eighteen households from cotton based farming system who possessed goats were randomly selected.

Following the survey work, Gendawhua PA from the cotton based farming system was selected to carry out on-farm feeding trial based on the willingness of the farmers, access to the main road and access to the provision of veterinary services to the experimental animals.

3.3. Experimental Procedures and Methods of Data Collection

The study was conducted by using three methodologies, which were survey, field measurement (short period monitoring) (ILCA, 1990) and on farm feeding trial. Data were generated by administrating a structured questionnaire, organizing group discussion employing field and experimental body weight measurements, flock monitoring, and from secondary sources

3.3.1. Survey

Informal and formal survey tools were employed to gather information on goat production and marketing details. Discussions using checklists were held with woreda livestock experts, development agents and key informants in all the selected PAs to collect relevant information on almost all aspects of livestock production in the woreda. A structured questionnaire was prepared (Appendix) and pre-tested before administration and some re-arrangement, reframing and correcting in accordance with respondents perception were made. The questionnaire was administered to the randomly selected household heads by enumerators recruited and trained for this purpose with close supervision by the researcher. Based on the questionnaire, the following major information were gathered.

1. Socio economic characteristics of the household: sex, education level, household size, livestock possession, economic benefit of goat and major production constraints;
2. Reproductive performances: age at first puberty, age at first mating, weaning age marketing age and age at first kidding.
3. Breeding practices: breed and mating type, goat production objectives, selection criteria, culling age and castration practices.
4. Feed situation: major feed sources, supplementation, grazing method and water source.
5. Major diseases of goat in the area.
6. Marketing and marketing problems.
7. Routine husbandry practices: access for goat extension and housing.

Rapid market appraisal (RMA) (ILCA, 1991) was employed to study the marketing systems of goat in the woreda. Producers (farmers), local traders, agents of butcher houses, terminal traders and consumers were interviewed using respective checklists. All possible goat market chains to and from Metema were identified.

3.3.2. On-farm flock monitoring

During this part of the study, growth performance, reproductive performance and matured adult body weight were measured. A total of thirty six (eighteen from each PA) household flocks were selected for monitoring activities. All animals of the selected farmers were ear tagged at the beginning of the study and individuals were established and data were collected by trained enumerators recruited from the locality and supervision was carried out on 15 day basis by the researcher.

A total of 168 adult animals out of which 124 were females and 24 were males were selected for the purpose of mature body weight measurement.. The male sample population was not equal because of low proportion of matured male animals in the existing flock. All animals of the farmers were weighed once to know weight of the animals at specified age and sex. The age and parity of adult animals of the flock were

determined by dentition and interviewing the owners at the beginning of the monitoring. A total 312 animals were available for the monitoring purpose. Birth weight and fortnightly weight of kids were measured by using suspended weighing balance during four months monitoring time (from January to end of April 2008).

3.3.3. On-farm feeding trial

3.3.3.1. Experimental feed and feeding

The supplemental feeds used were noug seedcake, sesame seedcake, cotton seedcake and wheat bran. The oil seed cakes were purchased from small scale oil seed press mills around the study area. The wheat bran was purchased from Gondar wheat flour milling factory and transported to the experimental area. Goats were grazing pasture during day between 8:00 and 17:00 hours and supplemented with 300 g DM per day concentrate mix (wheat bran with one of the oil seed cakes) The treatment comprised of feeding of grazing alone and supplementing of grazing with mixtures of wheat bran with noug, cotton and sesame seedcakes. The different concentrate mixtures were supplemented at the rate of 30% of the total daily feed DM intake as recommended by NRC (1981) for goats gaining 50 g/day. All the supplemental feeds were formulated to be isonitrogenous (22%) and to provide energy requirements for maintenances and growth of goats (NRC, 1981). Concentrate feeds were offered twice a day in two equal portions in the morning and evening hours throughout the feeding trial.

3.3.3.2 Experimental animals and their management

The study was conducted on five (5) voluntary farmers participated in the research activity which were selected with the help of agricultural development workers in the study area. A total of 20 intact male yearling local goats, from Gendawhua and Meka markets located at 5 and 30 km from Shehide (capital city of the study area), respectively were purchased using a revolving fund from IPMS, ILRI project. Four goats were randomly distributed to each selected farmers and were used in the trial. The mean initial body weight was 22.35 ± 0.12 kg. The experimental goats were grazed on the communal

grazing area for 9.00-10.00 hours in the day time. The vegetation of the grazing area consisted shrubs dominated by various tree legumes and browse species with a sparse ground cover of *Acacia* species. The experimental animals were vaccinated against common diseases as well as drenched and sprayed against common internal and external parasites in the area during the two weeks adaptation period.

Thereafter, animals were sprayed once every 3-4 weeks against ticks and biting insects during the actual feeding period. Animals were housed within the selected farmers' house together with other flocks under farmers' management and were taken for grazing or browsing together with the rest of the flock from 08:00 hours to 17:00 hours. Thereafter, the animals were trekked daily to the nearby water source for drinking once a day. During feeding, animals were tied until they finish eating the supplement to prevent eating of each others concentrate.

3.3.3.3 Experimental design and treatments

The design of the experiment was a randomized complete block design (RCBD). The experimental goats were blocked into five groups of four animals each based on their initial body weight and treatment diets were randomly assigned to each animal in the group in such a way that each animal within the block had equal chance to receiving one of the diets. Accordingly, five animals were assigned to each treatment diet. Animals which were assigned randomly in each block were given to one farmer. That is each farmer possesses animals receiving all treatments. The treatments consisted of supplementing isonitrogenous protein on DM basis from CSC, SSC and NSC with the mixture of wheat bran to grazing or browsing goats. The initial body weight of yearling goats were determined by two consecutive weighing after overnight fasting at the end of adaptation period and at the commencement of the actual feeding trial.

The treatments comprised of grazing alone (T1), grazing + mixture of 47% noug seed cake and 53% wheat bran (T2), grazing + mixture of 31% cotton seed cake and 69%

wheat bran (T3) and grazing + mixture of 40% sesame seedcake and 60% wheat bran (T4) as indicated below.

3.3.3.4. Live weight changes

Initial body weights of the experimental animals were taken at the beginning of the study by two consecutive weighing in the morning before feeding. Live weight gain of each animal was recorded at 10 days interval, at 800 hours in the morning before feeding. Average daily gain was calculated as the difference between final live weight and initial live weight divided by the number of days of the feeding trial.

3.4. Data Management and Analysis

Data collected from each site were coded and entered into the computer for further analysis. Data collected through questionnaires were entered into Statistical Package for Social Sciences (SPSS 13.0 for windows, 2004). Experimental and quantitative data were entered into Microsoft EXCEL. Preliminary data analysis like homogeneity test, normality test and screening of outliers were employed before conducting the main data analysis.

3.4.1. Questionnaire data

Data collected through questionnaire were described by descriptive statistics using Statistical Package for Social Sciences (SPSS 13.0 for windows, release 13.0, 2004). Chi-square was employed when required to test the independence of categories or to assess the statistical significance. Indices were calculated to provide ranking of the reasons of keeping goat, production constraint, selection criteria, and contribution of different farming activity to the family food and income e tc. Index was calculated as
$$\text{Index} = \frac{\text{Sum of } (3 \times \text{number of households who ranked first} + 2 \times \text{number of households who ranked second} + 1 \times \text{number of households who ranked third})}{\text{sum of } (3 \times \text{number of households$$

who ranked first + 2 X number of households who ranked second + 1 X number of households who ranked third) for overall reasons, criteria or preferences.

3.4.2. On-farm flock monitoring data

Growth data (birth weight, and fortnight weight for pre-weaning kids, monthly BW for kids and adults body weight), reproductive data (parity, birth type, and kids and adult sex) were taken. Quantitative characters (monthly, two month and weaning weight and adult body weight) were analyzed using the General Linear Model (GLM) procedures of the Statistical Analysis System (SAS, release 9.1, 2003). For kids and adult animals, the sex, parity and birth type and dentition of the monitored goat were fitted as fixed independent variables, while birth weight, weaning weight and adult body weight were fitted as dependent variables. When analysis of variance declares significance, least square means were separated using adjusted Duncan's Multiple Range test.

The pre-weaning growth performances were adjusted by the following formulae (Inyangala *et al.*, 1992).

$$\text{Adjusted monthly weight (kg)} = \frac{30(w_2 - w_1)}{D} + w_1$$

$$\text{Adjusted two months weight (kg)} = \frac{60(w_3 - w_1)}{D} + w_1$$

$$\text{Adjusted weaning weight (kg)} = \frac{90(w_4 - w_1)}{D} + w_1$$

Where:

w_2 , w_3 and w_4 = weight at a given age

w_1 = birth weight

D= number of days between weighing date and date of birth

$$\text{Average daily BW gain up to weaning (g)} = \frac{(AWWT - BWT)}{90}$$

Where:

BWT= birth weight

AWWT= adjusted weaning weight at 90 days

Birth weight, one month weight, two month weight and weaning weight were analysed using the following fixed effects model for each goat types separately.

The model used was:

$$Y_{ijkln} = \mu + S_i + B_j + P_k + \epsilon_{ijkln}$$

Where

Y_{ijkln} = observation (birth weight, one month weight and two months weight and weaning weight) on the n^{th} kid of the i^{th} sex and the j^{th} birth type born in the k^{th} parity

μ = the overall mean common to all animals in the study

S_i = fixed effects of the i^{th} sex (1=male, 2=female)

B_j = fixed effects of the j^{th} birth type (1= single, 2= twin)

P_k = fixed effects of the k^{th} parity (p= 1, 2, 3 4, 5, >5)

ϵ_{ijkln} is the random error term which is assumed to be normally distributed with a variance equal to δ^2 and a mean =0.

3.4.3. On- farm feeding trial experiment data

3.4.3.1. Body weight measurements and chemical analysis

Data collected from feeding trial were summarized and entered into the computer for further analysis. All summarized data were coded and recorded in excel sheet for initial body weight, final body weight and average body weight gain for all experimental animals and were analyzed using the General Linear Model (GLM) procedures of the Statistical Analysis System (SAS, release 9.1, 2003) In cases when the analyses of variance reveal the existence of significance differences among treatments means, these were separated using Duncan's Multiple Range test.

The analysis model for live weight gain was

$$Y_{ij} = \mu + a_i + b_j + e_{ij}$$

Where: Y_{ij} = response variable

μ = overall mean

a_i = i^{th} treatment effect

b_j = j^{th} block effect

e_{ij} = Random error

Representative samples of daily feed offers and major brows or grazing species that are mostly consumed by goats were taken and ground to pass screen size of 1mm. The ground samples were analyzed for contents of DM, ash, and N using the procedure of AOAC (1990) and NDF, ADF, and ADL were analyzed following the procedure of Van Soest *et al.* (1991). Crude protein was estimated as N x 6.25.

3.5. Economic Analysis

To facilitate the adoption of new research findings by farmers, both technical and economic benefits should be proven before making recommendations. There are circumstances where research outputs (new technology) could be technically feasible but is not profitable and hence not adopted. Partial budget was performed to evaluate the economic advantage of different feeding systems investigated in this study. Partial budgeting is a method of organizing experimental data and information about the cost and benefit from some change in the technologies used on the farm. It involves tabulating the costs and benefits of a small change in the farm practice.

The partial budget analysis was done to determine the profitability of supplementation of different protein and energy sources of yearling goats by using the procedure of Upton (1979). The partial budget analysis involved calculation of the variable cost and benefits. At the beginning of the experiment and before purchasing of experimental goats, 'market

price was assessed three times from local livestock market at Metema Woreda. The price of goats purchased was recorded and used for the partial budget analysis.

At the end of the experiment, field day was arranged and weight gain performance of goats in the different treatment groups were evaluated by the participants and nearby farmers. Thereafter, experienced goat dealers estimated the possible selling price of each experimental goat. The buying and selling price difference of the goats in each treatment before and after the experiment was considered as total return (*TR*) in the analysis. For the calculation of the variable costs, the expenditures incurred on various feedstuffs were taken into consideration. The costs of the feeds were computed by multiplying the actual feed intake for the whole feeding period with the prevailing prices. The prevailing prices of the feeds included in the transportation cost incurred to transport them to the experimental site. The labour cost was assumed to be constant across the treatment groups.

Partial budget measures profit or losses, which are the net benefits or differences between gains and losses for the proposed change. The amount of money left when total variable cost (*TVC*) is subtracted from total return (*TR*):

$$NI = TR - TVC$$

The change in net income (ΔNI) was calculated as the difference between the change in total return (ΔTR) and the change in total variable cost (ΔTVC) as follows

$$\Delta NI = \Delta TR - \Delta TVC$$

The marginal rate of return (*MRR*) measures the increase in net income (ΔNI) associated with each additional unit of expenditure (ΔTVC) and was calculated as

$$MRR = (\Delta NI / \Delta TVC) \times 100$$

4. RESULTS AND DISCUSSION

4.1. Socio-economic Characteristics of Household in Metema

4.1.1. Household size, sex and educational level

Sex, family size and education background of the respondents in the two farming systems are presented in Table 2. The overall mean family size in the study area was 5.6 ± 2.45 . Figures obtained for both farming systems in Metema district in the current survey were higher than the average values at the national (5.2) level (CACC, 2003). The survey also revealed that the majority of the households in both farming systems were headed by males which accounted for 97%. The remaining proportion of the households was headed by females. Female headed household in this particular study would indicate either the husband has died or they are divorce. The majorities (67.4%) of the household heads in Metema were illiterates and the remaining proportions (32.6%) were literate, who can read and write.

Table 2. Demographic and socio-economic characteristics of the respondent households in Metema Woreda

Descriptor	Cotton based farming (N = 45)	Sesame based farming (N= 90)	Overall (N = 135)
	Mean± SD	Mean ± SD	Mean ± SD
Family size	5.7± 2.51	5.6 ± 2.44	5.6 ± 2.45
Sex of household	Percent	Percent	Percent
Male	100	95.6	97
Female	–	4.4	3
Educational level	Percent	Percent	Percent
Illiterate	62.2	70	67.4
literate	37.8	30	32.6

N= number of households, SD= standard deviation,

Thus, better educational background obtained in study area compared to other studies in south region around Sidama might be a good potential for adoption of improved technologies and facilitate performance and pedigree recording (Holst, 1999). It is also mandatory to consider upgrading of the education status of farmers for the successful goat improvement strategies and other development interventions.

4.2. Livestock Holdings and Ownership Patterns

The mean number of various livestock species per household in the two farming systems is summarized in Table 3. The major livestock species in the study area were cattle, sheep, goats and equines (camels and donkeys). The number of goats is higher than all livestock species recorded per household in the study area. This is followed by cattle sheep, donkey and camel, respectively. None of the respondents reported the existence of mule and horses. This might be due to the fact that mules and horses could not adapt the hot conditions of the environment in lowlands and the relatively higher encroachment of the grass land by the bushes and trees could not support them. The average holding of goat in the present study was relatively close to the work of Muluken (2007) who reported 15.9 ± 5.6 heads per household in Sekota wereda.

Table 3. Average heads of livestock holdings per the respondent households in Metema Woreda

Type of live stock	Cotton based farming	Sesame based farming	over all
	Mean± SD	Mean± SD	Mean ±SD
Cattle	16.9 ±9.31	16.5 ± 9.32	16.7 ± 9.28
Sheep	9.2 ± 3.17	7.5 ± 2.4	8.1 ± 2.80
Goat	20.0 ± 5.94	19.5 ± 6.93	19.7 ± 6.60
Donkey	1.2 ± 0.44	1.1 ± 0.73	1.1 ± 0.50
Camel	0.04±0.21	0.04±0.21	0.04 ± 0.21

SD = standard deviation

Mean holding of 19.7 goats in Metema area is much higher than an average goat holding

of 7.0 heads of Arsi-Bale goats in the rift valley areas and 6.0 heads of Keffa goats in south western parts of Ethiopia (FARM-Africa, 1996). The present larger flock holding in Metema area could be related to the availability of enough grazing lands, attractive market price and higher demand for livestock in the area for export purpose.

The percentage of livestock possession per household in the farming systems is summarized in Table 4. All the households considered in the study areas had goat. This might be due to the ability of goat to survive and perform under harsh environmental conditions. Additionally, subsistence farmers prefer small stock to mitigate risks total loss of stock due to disease or other factors (Sölkner, *et al.*, 1998). Next to goat, large proportion of the interviewed households had cattle followed by sheep and equines.

Table 4. The percentage of livestock species possession per the respondent households in Metema Woreda

Species	Cotton based farming		Sesame based farming		Over all	
	N= (45)	%	N= (90)	%	N =(135)	%
Cattle	39	86.7	73	81.1	112	83
Sheep	33	73.3	72	80	105	77.8
Goat	45	100	89	98.9	134	99.3
Equine	38	84.4	65	72.2	103	76.3

N= number of respondents

Even though purposive sampling of the respondent may not reflect the true picture of the existing livestock ownership pattern in the study area, the current finding agrees with ILRI (2005), which reported that goats and cattle were the dominant livestock species in the study area. The higher proportion of goat and cattle as compared to sheep might be due to the fact that goat can thrive well under adverse and hot climate conditions (disease, and drought) and availability of vast communal and extensive grazing land may account to higher cattle holdings, respectively while sheep are considered more sensitive to hot environment.

4.3. Goat Breeds in the Study Area and Their Importance

A large number of goat in the study area showed that goat production is the dominant farming practice in the study area. However, substantial number of farmers kept sheep. In Metema, the genotype of goat was entirely indigenous goat types. According to the respondents, the indigenous goat types dominantly found in Metema district are locally known as “*Habesha*” or Dega and probably the naming referred to the places from where the goat originated. In addition to these goat types, small proportions of “*Rutana*” and “*Gumuz*” goat types were also reported in the marginal areas of the districts and where Gumuz ethnic people are settled. These two goat types were believed to be native to Sudan and Benishangul Gumuz National Regional State, respectively. The types of breeds identified and kept by the framers are indicated in Table 5.

Table 5. Breeds kept by the respondent households in Metema Woreda

Breed kept	Cotton based farming		Sesame based farming		Over all	
	N (45)	%	N (90)	%	N (135)	%
Gumuz	3	6.7	5	5.6	8	5.9
Rutana	1	2.2	6	6.7	7	5.2
Habesha	33	73.3	70	77.8	103	76.3
Mixed of the three	8	17.8	9	10.0	17	12.6

N= number of respondents

The majority of the respondent farmers in the cotton based farming system owned the Habesha goats followed by the mix of all breed types, the Gumuz and Rutana, respectively. Almost similar trend is observed in the type of goat breed type kept by respondents in the sesame based farming system except that farmers possessing the Rutana are higher than in the cotton based system. This might be because of the fact that in sesame based areas few farmers like to keep the Rutana breed due to the fast growing characters, but sensitive to disease and stress. Goats were ranked as the first (with an index of 0.45) important livestock species in both farming systems followed by cattle

with an index of 0.35 and 0.34 in cotton based farming and in sesame based farming system, respectively (Table 6). The usual reasons for ranking goats as the most important species were goat could serve as immediate source of income, reach for production within short period of time, require low initial capital, high prolificacy ,its adaptation to climate, fast growth and twin kidding capacity.

Table 6. Ranked livestock species according to their importance

Species	Cotton based farming				Sesame based farming			
	Rank1	Rank2	Rank3	Index	Rank1	Rank2	Rank3	Index
Cattle	22.3	66.9	3.6	0.35	31.3	51.4	9.9	0.34
Goat	76.8	23.4	2.7	0.45	62.6	33.8	12.7	0.45
Sheep	0	0	18.9	0.03	1.2	2.7	19.7	0.05
Chicken	0	0	27.1	0.06	3.6	4.1	19.7	0.06
Donkey	0.9	2.7	37.8	0.08	1.2	8.1	38.1	0.09
Camel	0	0	9.9	0.03	0	0	0	0

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular species of livestock divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for species

4.4. Flock Size and Structure

Determination of the best flock structure is strongly influenced by the production objective. Information on flock structure shed light on the owner's management objectives, whether the main interest is in the production of milk or meat, the prevailing constraints in the system and it can further provide the basis for calculating or predicting flock productivity (ILCA, 1990). Flock structure of goats in CFS and SFS is presented in Table 7. The mean \pm standard deviation of flock size of goats of different age in cotton based farming system, except for females greater than one year, was higher than the corresponding values for sesame based farming system.

Table 7. Flock size and structures of goats in Metema Woreda

Goat categories	Cotton based farming			Sesame based farming		
	N	Mean \pm SD	% of total flock	N	Mean \pm SD	% of total flock
Kids less than 6 months	360	4.04 \pm 1.63	27.6	222	1.93 \pm 1.29	23.5
Weaned kids between 6 months and 1 year	290	2.26 \pm 1.59	22.2	206	1.79 \pm 1.87	20.0
Males greater than 1 year	90	0.65 \pm 1.52	6.9	34	0.29 \pm 0.84	3.6
Female greater than 1 year	514	3.66 \pm 2.73	39.4	454	3.95 \pm 2.80	48.1
Castrates	50	0.66 \pm 1.70	3.8	27	0.23 \pm 0.85	2.9
Total	1304		100.0	943		100.0

N= Number of flocks within a given age

The breeding does made a major share of the goat population in cotton based farming systems followed by kids and weaned kids. The trend is similar; in sesame based farming system where populations of breeding does are dominant followed by kids of less than 6 months and weaned kids. The percentage of kids less than 6 months in both farming systems of the goat flock are lower than the finding of Markos (2000) who reported 48.9% in Sidama, Ethiopia. Percentage of bucks in the current study were considerably lower than 18.9% for Sidama goats (Markos, 2000) and 22.1% for Arsi-Bale goats in rift valley areas and 25.3% for Keffa goats in South Western Ethiopia (FARM-Africa, 1996). The proportion of castrates in the present study is comparable to 3.5% reported for Arsi-Bale and 4.4% for Keffa goats (FARM-Africa, 1996). Proportion of does in goat flocks of the present study area were comparable to 32.2% in Sidama Zone (Markos, 2000) and Alaba Wereda (Tsedeke, 2007). Larger proportion of breeding does in both systems could imply the production of larger number of kids which in turn might increase the intensity of breeding bucks. However, the proportion of adult bucks was very low in both farming system. Lower proportion of young bucks compared to young does might be because of marketing of young bucks due to theft problems in the area.

4.5. Trend in Livestock Population and Land Holding

The perception of households on the population status of livestock species for the last ten years in the study area is summarized in Appendix Table 1. The majority of the farmers in cotton based farming system reported an increasing trend in cattle (88.9%) and goat (93.3%) population. Similarly, for sesame based farming; about 85.6% and 90% respondents reported an increasing trend for cattle and goat population, respectively. The possible reasons reported by respondents for this trend were mainly related to the increasing human population due to resettlement, availability of extensive grazing land and attractive price for livestock due to cross-border market in both of the farming systems. Similar reasons were reported by Solomon (2007). Contrary to this, Fikerte (2008) indicated that the population of livestock declined in Shinnle Zone due to rangeland degradation, frequent occurrence of disease, drought, shortage of feed and water. In contrast, a decreasing pattern for land holding was observed by about 64% of respondents in cotton based farming and 43% of the farmers in sesame based farming. Human population growth, land degradation, and settlement program with government policy are some of the mentioned factors for declining landholding across the two production systems.

The overall land holding shows that the majority of the respondents (60%) have greater than 5 and less than 10 hectares. This figure is better representative of the average holding of the majority in Metema area. The landholding in Metema area is quite large compared to many places in the Zone. For example, the overall average land size in Debark area was 1.14 ha per household (Sisay, 2006), which is much smaller than the average holding of Metema in the present study area.

The reason for large landholding per household in Metema may be the fact that Metema is relatively a recently inhabited area. In addition, it is arid marginal land and the population is fairly sparse compared to cooler highlands, which are inhabited several generations back. Comparing land holdings within Metema, relatively more inhabitants owned larger than 5-10 ha of land per household in cotton based farming systems than in

sesame based farming (Table 8). This might be because of the fact that areas in cotton based farming system were relatively cooler and were inhabited relatively earlier and there have been chance to get more land.

On the other hand, few inhabitants owned < 1 ha of land in cotton based farming and in sesame based farming system. Similarly, there were few households that possessed > 15 ha in sesame based farming system.

Table 8. Land holdings in two farming systems of the respondent households in Metema Woreda

Land holding particulars	Cotton based farming	Sesame based farming	Over all
	%	%	%
<1ha	2.22	2.22	2.22
1-5ha	26.67	36.67	33.33
5-10ha	71.11	54.44	60.00
10-15ha	0.00	4.44	2.96
>15ha	0.00	2.22	1.48

4. 6. Purpose of Keeping Goats

Ranking of the goat production objectives by smallholder farmers in both farming systems is presented in Table 9. Knowledge of reasons for keeping animals is a prerequisite for deriving operational breeding goals (Jaitner *et al.*, 2001). The primary reason for keeping goat for the cotton based farming system goat owners was to generate income followed by meat consumption, ceremony, and as means of saving in that order. The corresponding reason in sesame based farming system were income followed by meat consumption, savings and ceremony. In general the reason for keeping goat is similar for both farming systems.

The results indicate the relative importance to the farmers of tangible benefits of the goat (e.g. regular cash income, meat, manure and saving) versus intangible benefits (e.g. the role of small ruminants as insurance against emergencies). Purpose of keeping goat by the Metema farmers is different from that of the Sekota Wereda farmers. In Sekota farmers gave higher ranking for regular cash income and milk than meat and saving (Muluken, 2007). None of the surveyed farmers in Metema area kept goats for milk.

Table 9. Ranked purpose of keeping goat as indicated by respondent households in Metema Woreda

Purpose of keeping	Cotton based farming				Sesame based farming			
	Rank 1	Rank 2	Rank 3	Index	Rank1	Rank2	Rank 3	Index
Income	98.9	4.5	2.1	0.72	97.6	13.4	0.9	0.70
Meat	0.9	39.1	50	0.22	4.6	42.8	30	0.22
Saving	-	0.9	15.6	0.03	1.8	16.2	8.3	0.08
Ceremony	-	2.6	15.6	0.03	0.9	0.9	0.9	0.01
Manure	-	-	-	-	1.8	10.5	26	-

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular purpose divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all purpose.

4.7. Goat Production and Management

4.7.1. Feed resources and availability

The different feed resources reported in the area were natural pasture, crop residue, crop after math non conventional feeds and hay (Table 10). Based on interview result the main feed resource for goat in Metema Woreda is natural pasture and browsing species both during dry and wet seasons. This is because, rangelands provide the major source of feed in both wet and dry seasons and extensive system of grazing is the only grazing practice in the two farming systems throughout the year.

Table 10. Major feed resources for livestock during the dry and wet seasons in the Metema Woreda

Feed resources	Cotton based farming		Sesame based farming	
	Wet season	Dry season	Wet season	Dry season
	%	%	%	%
Natural pasture	100	100	100	100
Hay	2.22	28.89	1.11	41.11
Crop residue	-	6.67	2.22	7.78
Aftermath	-	68.89	-	46.67
Non conventional feed	-	13.33	-	23.33
Concentrate	-	24.44	-	15.56

In general the main feed resources to livestock in Metema Woreda are range lands which include communal grazing lands fallow lands, stubble grazing, and forest and shrub areas. Among the feed resources, the natural pasture consists of a wide range of browse species and grasses and to some extent annual legumes and other herbaceous species. Small trees and shrubs also contribute a good source of feed for goats and cattle during the dry season where there is no other source of feed. This result is in line with the previous studies (Sisay, 2006; Solomon, 2007).

During the dry season, an important feed source that farmers use next to natural pasture was crop aftermath in both farming system in the district. The availability of goat feed in both farming system was prioritized as adequate. This might be because of the fact that goats largely depend on the browse species that are available in abundance in the woody vegetation of the study area and goats are wide range browsers by nature. This result is in agreement with the previous studies (Tsfaye, 2008).

In both farming systems, farmers did not stress lack of feed as a limiting factor for productivity of goats, and did not indicate the importance of improving their feeding regime as an essential step towards any improvement program. This finding was in

contrast with that of Fekrite (2008) who reported feed shortage as the most important limiting factor for Black head Somalia sheep in Shinille zone. None of the respondents used concentrate feed for goats

4.7.2. Water sources and watering

Out of the total farmers interviewed, the majority in cotton based farming and in sesame based farming system obtained water from rivers for watering their animals and the remaining of the farmers used spring water and ponds, respectively as their major water source during wet and dry season (Table 11).

Table 11. Water sources for livestock in Metema Woreda

	Cotton based farming (N=45)		Sesame based farming (N=90)	
	Wet season	Dry season	Wet season	Dry season
Water source	%	%	%	%
River	95.6	77.8	85.6	68.9
Well	-	4.4	-	13.3
Pond	2.2	17.8	6.7	17.8
Spring	2.2	-	7.8	-

N= Number of farmers interviewed

The distance to the nearest watering points from homestead during wet and dry season was less than one kilometer and 2-5 kilometers in both farming systems, respectively. All farmers responded that newly born kids were separated from adults and watered at home. Water was offered at different frequencies per day and was generally associated with availability and distance of watering points. Almost all of the respondents allow their goats to drink water once per day and at midday during dry season.

However, during the wet season, 22.2% and 38.9% of farmers allowed their flock to drink water freely as they want in cotton based farming system and sesame based farming system, respectively. Watering was more frequent in this study compared to similar

studies in other places. Watering once in two to three days was common in some other area like lowland of Afar area (Tesfaye, 2008). The more frequent watering in the present area might be related to the hot climatic condition of the area and availability of water is relatively better than other lowland areas.

4.7.3. Housing

In the study area, different types of housing were reported (Table 12). The majority (62.2%) of the respondents in cotton based farming and 42.2% in sesame based farming system by tradition have a separate hut for goats with a suspended wooden floor, about 0.5-1 m above the ground. Kids and adults were housed in isolation and joined only during the morning and evening hours. Goats were kept too overcrowded in the house. In this type of house, goats do not come in contact with manure as it collects under the wooden slat floor. The manure is dumped out as waste and not put to any use. Open barn (within the fence) is the second goat housing type in the study area. Shelter inside the main house and shelter constructed adjacent to the main house were also reported as form of goat housing in both farming systems

Table 12. Type of goat housing conditions in Metema Woreda

Descriptors	Cotton based farming	Sesame Based Farming
	%	%
Shelter constructed only for goat	62.22	42.22
Shelter constructed in main house	8.89	11.11
Adjacent to the main house	2.22	13.33
Around fence (Enclosure)	26.67	33.33



Figure 2. Goat housing system around Metema Woreda

4.7.4. Household division of labour for management of goats

In general, all activities regarding work of goat management in all study areas was similar and done by the family labor. Although all household members were involved in goat management activities to a varied degree, respondents reported specific responsibilities of each individual of household members. In both the surveyed farming systems, the responsibility of purchasing and selling of goats was the responsibility of husband (mostly household heads). However, wife and children are responsible for several important routine tasks. Wives were reported to be responsible for cleaning flock barns (66.0%), caring for kids (44.9%), and engaging in flock herding (8.5%). Boys were responsible for flock herding (45.2%), watering (35.8%) and deliver extensive caring (26.6%) for young animals. This is in agreement with Sinn *et al.* (1999) who reported that even when men and women farm side by side throughout the day planting and harvesting crops, herding and carrying for the small livestock are typically the primary responsibility of women and children.

About 85.0% traditional and veterinary services for sick flock were rendered by husband. Girls provided assistances to their mothers and carried out cleaning of barns and providing care for the young. Large proportion of the flocks is owned by the husband. Women owned considerable (29.0%) flock, while boys own some 2.8% of the flocks. Women owned flocks could be sold or exchanged as needed unlike flocks owned by the other households, which often decided by aspiration of the household heads (husband). Women and children may have property right over the flocks ,but are not decision makers when it comes to selling or exchange. About 82.2% of goats were sold by husbands. Husbands possess more power in deciding the use of incomes generated from sale of animals and skins.

Table 13. Labor allocation in goat management of the respondent households in Metema Woreda

Responsibility					
Tasks	Husband (%)	Wife (%)	Boys (%)	Girls (%)	Hired labor (%)
Flock herding	15.5	8.5	45.2	8.3	22.5
Watering flock	20.6	5.6	35.8	10.5	27.5
Clean flock barn	-	66.0	2.9	31.1	-
Cares young flock	20.6	44.9	26.6	7.9	-
Treat sick flock	85.0	1.8	13.2	-	-
Sale and purchase of goats	82.2	5.2	12.6	-	-
Owner within a flock	68.2	29.0	2.8	-	-

In Metema area, all classes of the goat are herded together during the day time, though new born kids were managed separately for some days (at least one month) near the house. The percentage of households mixing their goat flock with other species (sheep flocks), keeping separately and no herding practice during grazing in the two farming systems are presented in Table 14. The majority of the goat owners in sesame based farming areas keep goat separately followed by mixed herding with sheep and no

herding. In cotton based farming system ,the majority of the respondent are not herding their goats followed by separate and mixed herding with sheep, respectively.

Table 14. Herding practice of respondent households in Metema Woreda

Descriptors	Cotton based farming		Sesame Based Farming		Over all	
	N (45)	%	N(90)	%	N (135)	%
Together with					32	23.7
sheep	8.00	17.78	24.00	26.67		
Separately	16.00	35.56	47.00	52.22	63	46.7
No herding	21.00	46.67	19.00	21.11	40	29.6

N = number of respondents

Because of their feeding habit farmers prefer to manage goats separately but shortage of labor force them to keep them with other livestock. The main reason of not herding was noticed to be the high labor demand for other activities and the type of crop produced. Labor is relatively expensive in this area. Large scale productions of cash crop (sesame and cotton) are labor intensive. The crops grown in the area are not easily damaged by small ruminants.

4.7.5. Breeding (Mating)

Uncontrolled mating within the household's flock was predominant. 96.6% farmers in cotton based farming system and 98% farmers in sesame based farming system practiced uncontrolled mating of goats. On all the farms, the flocks consisted of goats of all ages except newly born kids and they were kept as a single flock. The bucks ran throughout the year with the does. There was no definite mating season; hence kids were born all the year round (Figure 3). Information obtained from the interviewed farmers indicated that, kids were born all the year round. However; the most common months of the year with frequent births were from November to January (Figure 3).

This indicates that, most conceptions thus took place in months of mid June to end of August, when new growth of grasses is available due to rain during this season. Of the total interviewed farmers, 98% of the respondents reported that breeding bucks were kept for breeding purposes and 72% of the farmers keep their own breeding bucks whereas the remaining (28 %) use neighbor's bucks. Most farmers had one buck running with the flock throughout the year. During group discussion, farmers said that bucks were usually used for service the first time at about 12 months although bucks in exceptionally good body condition were used at younger ages. It is said by the respondents that bucks were usually taken out of mating for castration or for sale at the eruption of the second pair of permanent incisors. Exceptionally good bucks were not taken out of mating until about eruption of three pairs of permanent incisors.

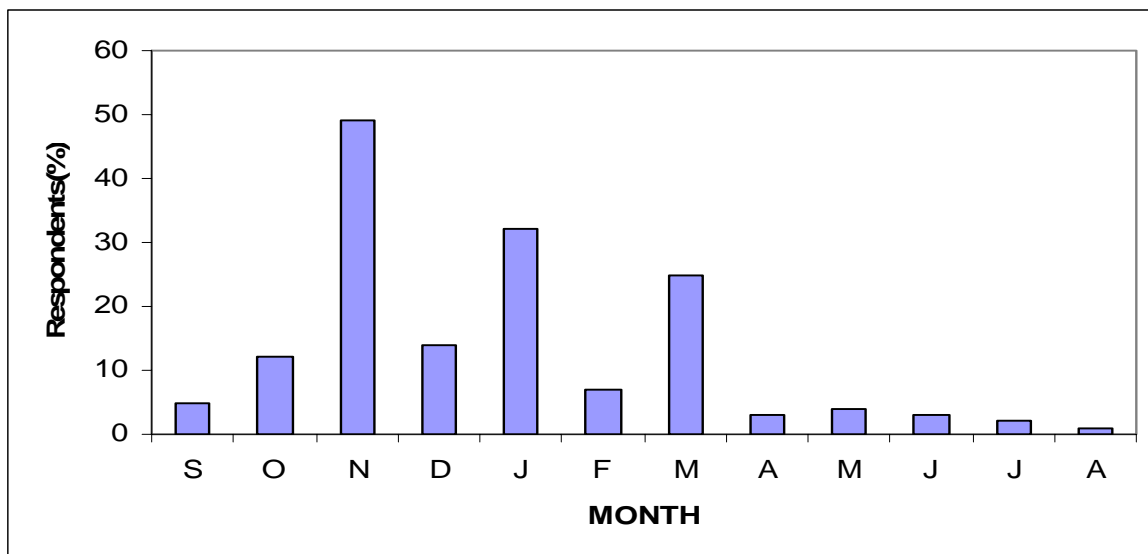


Figure 3. Reported monthly occurrences of kid births in Metema Woreda

All farmers kept suckling goats in the house during the first 24-72 hours after which the mother joins the flock for grazing. Farmers also tended to keep kids inside for periods of up to two months during the rainy and drought periods. Free and uncontrolled mating practices and occurrence of births through out the year reported in the present study is in

agreement with many reports for traditional goat production systems in tropical Africa (Ndamukong *et al.*, 1987; Ngere, *et al.*, 1989; Peacock, 1996).

4.7.6. Major disease types and prevalence

Farmers of the study area were able to identify the types of diseases affecting their animals by recognizing the common symptoms through experience. From the description of symptoms, it was obvious that many farmers were able to identify diseases such as PPR (Peste des Petits Ruminants), pasteurellosis, anthrax, CCPP (Contagious Caprine Pleuro Pneumonia), sheep pox, foot rot and lung worm. Among these diseases, the most commonly affecting goats and causing most losses as cited by farmers were afrite (pasteurellosis) and PPR (peste des petitis ruminants). The most serious diseases reported by Farmers were pasteurellosis, PPR, CCPP, and sheep pox, respectively in (Table 15).

Table 15. . Ranking of goat disease in Metema area

Local name	Common name	Households			Index
		Rank 1 st	Rank 2 nd	Rank 3 rd	
Embeke	PPR	11	29	19	0.18
Sal	Lung worm	8	7	15	0.09
Afrite	Pasteurellosis	64	23	3	0.39
Koffle	Sheep pox	15	15	2	0.12
Tifena	CCPP	9	21	25	0.15
Ferkeke	Foot rot	2	1	1	0.01
Kezen	Diarrhoea	1	3	2	0.02
Yesanba mich	Pneumonia	1	4	0	0.02
Wara	External parasite	1	0	1	0.01

Index= sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for each disease within a district divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all of the disease within a district Numbers in parenthesis are index values while out of the parenthesis are rankings PPR= Peste des Petits Ruminants, CCPP = Contagious Caprine Pleuro Pneumonia

Most of the farmers use modern drugs from government clinics and open markets. Some farmers reported that they sometimes use traditional treatments (branding when the goats

become sick and just dipping them in a river). The district had only one government veterinary clinic located at Sheide, the capital of Metema wereda providing animal health services to all PAs (18) found within the district. The governmental clinic provided veterinary services in two ways; veterinary service at its clinic and special vaccination and treatments of internal and external parasites campaign at PA level. There is no private institution working on providing veterinary services in the area.

All the farmers solely depended on governmental clinic to vaccinate and treat their animals themselves. Important drugs and vaccination services were only provided from the district Office of Agriculture and Rural Development. Among the respondents, 87.4 percent expressed that lack of veterinarian and inadequate veterinary clinic were the major problem in health management. According to the respondent (87%), vaccination was provided only when there is an outbreak of disease reported by farmers or extension centers. This is reflected by the frequent occurrence of many of these diseases in most parts of the district and brings a great production lose in the area. Farmers in the study area have relatively good income compared to the farmers in the highlands of the zone. As a result financial problem wasn't reported as a health management problem.

4.8. Reproduction

4.8.1. Age at first service (mating)

Puberty in terms of farmers view point is the age at first service. Acceptance of service for the first time depends upon the sexual maturity and body condition. According to respondents, the overall average (Mean \pm SD) age at first service (mating) in months both in male and female goats was 7.4 ± 1.95 and 8.2 ± 1.64 , respectively (Table 15). The average age at first service of Metema goats obtained in the present study is within the range of maturity age reported for most of the tropical goat breeds under traditional management systems (Wilson, 1991; FARM-Africa, 1996). However, Metema goats showed delayed age at first service compared to Red sokoto goats (4-5 months) of Nigeria, but younger than Afar (24 months) goats (Wilson, 1991).

Table 16. Reproductive performances of goats in Metema Wordea

Characters	Cotton based farming	Sesame based farming	overall
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Weaning age of female (month)	3.9 \pm 0.97	4.1 \pm 1.01	4.0 \pm 0.99
Weaning age of male (month)	4.2 \pm 1.01	4.2 \pm 0.98	4.2 \pm 0.99
Age at puberty of male (month)	7.5 \pm 2.14	7.1 \pm 1.3	7.4 \pm 1.95
Age at puberty of female (month)	9.3 \pm 2.2	7.8 \pm 2.4	8.2 \pm 1.64
Age at first kidding (month)	14.9 \pm 3.1	13.3 \pm 1.7	13.6 \pm 2.44
Reproductive life span of female (yrs)	7.0 \pm 1.2	7.5 \pm 1.2	7.3 \pm 1.22
Number of kidding per life time	13.5 \pm 1.9	13.5 \pm 1.7	13.5 \pm 1.75
Kidding interval (month)	8.9 \pm 2.1	7.8 \pm 2.4	8.4 \pm 1.37

SD= standard deviation

4.8.2. Age at first kidding

Age at first kidding is a good indicator of sexual maturity in does. The overall mean age at first kidding of local Metema goats was found to be 13.6 ± 2.44 months (Table 16). This is in agreement with that reported by Belay (2008) for Abergelle and Central Highland goats that have the mean ages at first kidding of 14.9 and 13.6 months, respectively. Workneh (1992) also reported that 36% of the does had their first kidding at the eruption of their first permanent incisor teeth among the goat types of southern Ethiopia; which is lower age as compared to the current result. The current result is also in agreement with reported age at first kidding for Nigerian Red Sokoto goats which is 14.6 months and earlier than for Malawi local goats which are 15.6 months old age at first kidding under village management conditions (Karua, 1989).

4.8.3. Kidding interval

Kidding interval is one of the major components of reproductive performance that influences production systems. The overall mean kidding interval of Metema goats were 8.4 ± 1.37 months (Table 16). These results were lower than reported kidding interval for Abergelle and Central Highland goats which were 11.31 ± 2.21 and 10.3 ± 1.42 months, respectively (Belay, 2008). These results were similar with the reported kidding interval for most Small East African goats' that ranged from 236-265 days (Wilson and Durkin, 1988).

The overall kidding interval implies the possibility of achieving three kidding over a two-year period. However, there was a wide variation in the kidding interval reported by the farmers despite the fact that the breeding males run continuously with the breeding females within the individual flock or other flock throughout the year. Nonetheless, the kidding interval of 8.4 months indicated the ability of the goats to breed throughout the year.

4. 9. Goat Marketing in Metema Area

It was noted by ILRI (2005) that the marketing of goats in the study area is neither organized nor competitive. The present pricing system in which agreement on price is reached by a long bargaining between sellers and buyers leaves the greater opportunities for benefiting the middlemen. Smallholder farmers are the main suppliers of the goats and sale at any time when immediate income is required

Farmers mainly sold their goat to consumers, traders and to a lesser extent to other farmers. Eventhough farmers in the study sites sell their animals when financial problems force them to sell, they also do prefer to sell their goat when their animal is poor in productivity. Goat is primarily sold in the nearby market where the local traders were the principal actors in the marketing process.

4.9.1. Household marketing

4.9.1.1. Purposes of sales

Farmers usually sell goats when they become poor in productivity and/or when there is shortage of money in the household to fulfill immediate household requirements. There are several reasons why producers in the Wereda sell their animals (Table 17). The primary reason for selling of goat for the Metema goat owners was to pay labour wage followed by food grain purchase, input purchase, school fee and as means of tax in that order with an index of 0.25, 0.15, 0.17, 0.11 and 0.14 in cotton based farming system, respectively. The corresponding figure in sesame based farming system was 0.29, 0.24 and 0.13, 0.08 and 0.16, respectively.

Table 17. Reasons for sale of goats in Metema wereda

Descriptors	Cotton based farming				Sesame based farming			
	Rank	Rank	Rank	Index	Rank	Rank	Rank	Index
	1st	2nd	3rd		1st	2nd	3rd	
Poor in								
productivity	11	2	3	0.13	2	1	5	0.02
Labor payment	11	17	8	0.25	29	26	18	0.29
Grain purchase	3	10	17	0.15	13	36	21	0.24
For school fee	1	5	19	0.11	2	9	19	0.08
Input purchase	8	8	10	0.17	14	6	18	0.13
Deposited	1	5	2	0.05	12	2	2	0.08
Tax	12	2	2	0.14	19	8	12	0.16
Total	47	49	61	1	91	88	95	1

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular reasons divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all reasons

During June to August, farmers need more money to pay for daily laborers hired for weeding and other agricultural activities. Thus, most farmers in both farming systems sold out different age groups of goats for this purpose. The second major reason for selling goat is input purchase and taxes in cotton based and sesame based farming, respectively. This finding agrees with the earlier reports on goat and sheep marketing in mixed farming areas, where sheep provide 40% of farmers cash income and used for purchasing of agricultural inputs, hired labour, household goods and services (Gryseels and Anderson, 1983).

4.9.1.2. Types of animals marketed and their prices

Classes of goats marketed and the price in the study area is summarized in Table18. All age, sex and weight classes of goats with majority of young flocks are marketed. Sale price of 590.5 ± 63.74 Birr and purchase prices of 555.9 ± 65.70 Birr for fattened goats and this price were higher than the other classes of goats. Average sale price and purchase prices for all classes of goats were higher than in the highlands of the North Gondar. This could be attributed to the fact that, Metema district is one of the routs for transport of goats to Sudan and formal and informal (smuggling) export was practiced. The increase in population due to settlement programme in the area and investment sectors also increased the demand for meat in the area. Therefore, this situation indicated that there is a great demand for goat in local markets and farmers get reasonable price not only from the goat ,but also from other livestock species.

Table 18. Average price of goats sold and bought during the month from February-May

Classes of goats	Average sale price	Average purchase price
	Mean \pm SD	Mean \pm SD
Breeding female (Does)	443.2 \pm 46.23	393.1 \pm 34.90
Breeding male (Buck)	326.4 \pm 35.55	324.1 \pm 36.42
Castrated (Fatten)	590.5 \pm 63.7.4	555.9 \pm 65.70
Young female (6-12 month)	284.4 \pm 27.90	246.9 \pm 42.92
Young female (6-12 month)	289.82 \pm 40.51	272.0 \pm 43.11

During group discussion, all farmers agree that goat price is related to the local holidays and festivals and agricultural activities. It was reported that better price is fetched during holidays such as Ethiopian New Year, Christmas, Easter, Muslim holidays and the main breeding seasons (early May to July). In general local marketing opportunities for goat in Metema are higher, due to the great demand of meat by consumers.

4.9.2. Market composition and buyers' purpose

Goats bought in all markets were different in some way by buyers' purpose. Kokit (54%), Negadabahir (61.4%) and Meka (56.1%) are markets where large proportions of goats were bought for profit by individuals especially traders and middlemen. Sheheide (68.8%), MetemaYouhannes (50.1%) and to some extent Shifa (31%) markets represent buying for consumption purpose. This could be because market centers are found in areas where large proportion of urban peoples, butcheries and restaurants were found. Purchasing for reproduction and fattening purpose have the lowest proportion in all markets (Table 19).

Table 19. Percentage market structure of the study markets by buyers' purpose in Metema Woreda

	Market names					
	Shinifa	Kokit	Metema youhans	Shehedie	Meka	Negadabahir
Buyers purpose	%	%	%	%	%	%
Consumptions	31	10.9	50.1	68.8	26.8	21.6
Profit/resale	46.6	54	26.1	11.8	58.1	61.4
Reproduction	13.5	23.8	18.5	16.2	13.9	11.2
Fattening	9.5	12.1	5.3	3.3	2.2	5.8
No of observations	112	78	155	256	125	115

Buying for consumption purpose in all market centers showed a higher proportion (Table 19). Rural assemblers buy animals from farm gates and local markets to sale in Shehedie

and other surrounding markets. They were usually farmers who ran business often during off-farm seasons to generate income from trade of goats or other animals (cattle and sheep). They purchase few animals usually below 10 and move them to different markets (Sheheid, Metema Youhanse, Negadebahir, etc) where they can make some profit. They maintained the unsold animals on their farms until sold in subsequent market days. This implies that local assemblers were in a better position to hold flocks and bargain for better prices unlike medium and large traders in urban areas who face serious difficulty of holding the unsold animals.

Table 20. Distribution of goats by sex and age group in the study markets

Age (year)	Metema youhanse			Negade bahir			Meqa			Shehide		
	M	C	F	M	C	F	M	C	F	M	C	F
	%	%	%	%	%	%	%	%	%	%	%	%
A ≤ 1	66.0	0	58.8	81.7	2.9	63.1	49.6	2.0	62.4	32.9	1.6	45.2
1 < A ≤ 2	19.0	9.8	13.4	9.9	16.7	8.9	43.5	18.8	19.0	37.4	11.1	30.2
2 < A ≤ 3	6.0	7.9	3.4	1.4	12.1	1.3	3.3	31.0	3.0	10.7	4.2	6.7
3 < A ≤ 4	5.3	31.5	4.5	2.2	21.9	5.2	2.2	28.1	5.8	12.4	30.7	9.4
≥ 4	3.6	50.8	19.9	4.7	36.5	21.5	1.4	20.1	9.8	6.7	52.4	8.4
Total N	101	14	91	104	96	78	94	10	83	218	18	186

A= Age in year, M= male goat, C= castrate goat, F= female goat and N= number of observation.

Individual consumers or those who provide catering services purchase animals from Shehide and other local markets. Household consumers often purchase during cultural and religious holidays/festivals. As mentioned by farmers and traders in six market places, goats for meat purpose are supplied to markets throughout the year. Observation made during the market assessments regarding the different goat group supplied at these four different market places indicated that most of males and females goats in all markets were less than one year of age; this implies that they possessed lower weight.

In general, age- wise, goats less than or equal to one year were the largest proportion in almost all markets and the percentage of goat sold decreased with age increase (Table 20). Mainly male goats were supplied in all markets followed by female goats and castrated goats were the lowest in proportion. More proportion of castrated goat in Metema youhannes and Shehide markets place might be due to the demand of permanent butcheries and restaurant in Shehedie town and Metema Yohannes (boarder town), who slaughtered goats and provided meat to consumers.

4.9.3. Marketed goat sources and market routes

Live goats and their products like skin come from different adjacent Woredas and different PAs of smallholder farms in Metema area and supplying for the local markets. Farmers market goats at farm gates or the nearest local/primary markets. The mid to highland of goat come from Chiliga and Alifa Taqusa supplying the major markets of Negadea Bhair and from this market area, the rural assemblers /traders purchase goats and then move them to the terminal market place Shehedie and to lesser extent to Metema youhannes market on foot.

The lowland goats are collected at Quara and Shifa, markets and brought to Shehdie (terminal market) and as well as towards Metema Youhannes markets. Some farmers and rural traders found goat at adjacent Wereda collect different classes of goats from their nearby local markets and brings to the main market place (shehedie). This is because Sale price of animals in Shehide is perceived to be better than other local markets. However, farmers/producers sale in markets near to their localities to avoid walking long distances, and to minimize transaction costs and personal expenses.

The other reason why farmers and rural assemblers from different local markets supply animals to shehide (terminal market) was that Shehedie livestock market is operating everyday although the major market day is Saturday. Saturday followed by Wednesday is the major market day for goats of varying sex, age and weight in all local and terminal market places through out the Wereda.

4.9.4 Goat marketing channels and mode of price setting

In the studied area, five different marketing agents participated in the transaction of goat marketing. These included producers, itinerants, goat traders, butcheries and as well as consumers (Figure 4).

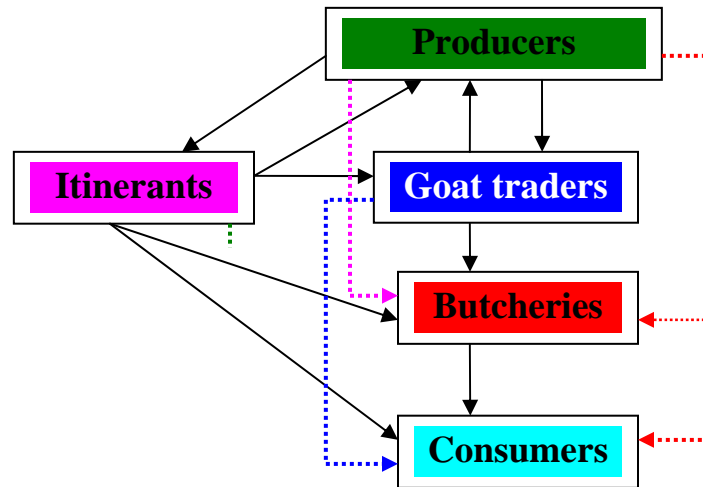


Figure 4. The goat marketing chains in Metema Woreda.

The producers in the study raised and provided different age groups of goats in to their respective market to meet the family need for cash income. Goat itinerants/traders included individuals, who were farmers or persons involved in other business, but occasionally involved in goat and other livestock business. These agents usually traveled to distant locations in local areas to collect goat with cheaper prices. They selected this activity to generate income and supplement income earned from other agricultural activities. The sources of their capital could be own sources or credit from individuals or ACSI (Amhara Credit and Saving Institution). The collectors could purchase different age groups of goats from different small local market place and farm gate of the producers in the district. There are few number of permanent butcheries and small scale hotels and restaurants in shehedie town and Metema Yohanse (boarder town), who purchase and slaughter goat and sale meat to consumers.

Almost all of the producers market their animals on ‘eye-ball’ estimation. Selling on live weight basis in and around Metema area is not known but it fetches better prices.

Animals are marketed on individual basis and agreement on prices reached after a long one-to-one bargaining between buyers and sellers and some times brokers. Local traders and itinerants are better informed of the demands and prices of animals and are decisive to fix prices. Producers usually sale with the trader prices for their immediate cash needs. This is in agreement with findings of Kebede and Rey (1992). However, respondents said that they market in ‘eye-ball’ due to lack of awareness of marketing on live weight bases.

4.10. Major Constraints and Opportunities to Goat Production

Production constraints, which were defined by goat owners in both farming systems, are presented in (Table 21). Disease, labour, and theft were the most pertinent constraints for goat production in that order of importance in both farming systems. Feed shortage problem was ranked low in both production systems. This might be due to the availability of enough feed or good range condition which was more likely good in Metema area. According to the respondents, the most serious problem encountered in goat farming was prevalence of disease in both farming systems in the study area followed by theft.

The absence of marketing policies, illegal market and inappropriate extension strategies for goat keeping, were also some of the constraints mentioned by Metema Woreda Agriculture and Rural Development Office (personal communication). The great production loses due to common and non-specific disease problems encountered could largely be due to climatic condition of the study area which might aggravate the prevalence of disease. In addition to this, low attention for livestock sector in government, inadequate health management by farmers and less efficient veterinary service contribute to the problem.

Table 21. Constraints of goat production in Metema woreda

Constraints	Cotton based farming				Sesame based farming			
	Rank 1 st	Rank 2 nd	Rank 3 rd	Index	Rank 1 st	Rank 2 nd	Rank 3 rd	Index
Disease	36	5	4	0.34	78	10	2	0.38
Feed	1	1	2	0.02	3	6	6	0.04
Labour	10	20	8	0.22	19	28	22	0.20
Market	3	8	9	0.10	7	14	18	0.10
Predator	3	7	14	0.10	4	5	19	0.06
Theft	15	10	13	0.22	30	23	20	0.23
Total sum	68	51	50	1	141	86	87	1

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular constraints divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all constraints.

It was observed that the farmers complained on the veterinary service of Woreda Agricultural office. As discussed earlier, relatively higher proportions of the respondents (21.0 %) do not herd their goat, thus leading to more chances of theft. This is because the fact that large scale production of cash crops demands high number of labor and farmers usually faces labour shortage. Constraints to goat production mentioned and reported by farmers in the present study were similar with the constraints which were ranked and reported in characterization of Gumuz sheep in Metema Woreda (Solomon, 2007)

Regarding the opportunities of goat production in the woreda, there was enough grazing (communal as well as individual) land that was not utilized for growing food crops in Metema Woreda. If this grazing land is properly managed, it could be a good source of good quality feed to boost goat production in the area. At the world market, the demand for mutton and goat meat have been increasing due to an increase in income and increased population hence there is a growing demand for sheep and goats in both the domestic and export markets. Young male flocks have huge demand by the export abattoirs. With the increased competitiveness in the market, farmers are looking for the alternative ways of breeding and fattening to increase their income.

Small holder farmers are aware of the current high market values and demand for sheep and goats. Several development partners involved in higher learning, research and development are currently committed to sheep and goat development in the woreda. These could facilitate entry of intervention (inputs, technology and recommendation). The support of IPMS under ILRI is sharing a good experience of community-based sheep and goat improvement program with full participation of the beneficiaries. It also makes substantial contribution in building flock ranging from production to marketing holdings targeting women and model households. Considering these emerging and existing opportunities, the extension system needs to organize and guide to focus on sheep and goat production and marketing in order to improve income and enhance smallholder livelihoods.

4.11. Birth Weight and Pre-weaning Growth Rate

The body weight, weaning weight and pre weaning average daily gain of goat monitored in Metema Woreda are presented in Table 22. Males were significantly heavier ($p < 0.01$) at birth and weaning than females. Pre-weaning average daily gain of males were larger ($p < 0.01$) than for females. Does that kidded for the first time gave kids with lower ($p < 0.01$) birth weight than those does gave birth at least for the second time. Kids born from does that kidded for the first time grew slowly and had significantly lower ($p < 0.01$) body weight at weaning and pre weaning period. Type of birth had also significant effect ($p < 0.01$) on birth weight and weaning weight, but not on pre weaning average daily gain ($p > 0.01$). Larger birth weight and pre-weaning growth rate were recorded for males than their female contemporaries. Single born kids had heavier weight than those born as multiple births. The result obtained in this study was in agreement with other studies (Lebbie and Manzini, Tatek *et al*, 2004; Tesfaye *et al*, 2006; Belay, 2008).

Average birth weight, weaning weight and pre-weaning growth rate of goats were 2.28 ± 0.04 , 12.73 ± 0.13 and 115.74 ± 1.55 g/day, respectively. Birth weight of goats obtained in this study is similar with that of Arsi Bale goats under on-farm management (Tatek *et al*, 2004) and North Eastern Highland goats (Tesfaye *et al*, 2006) while weaning weight and pre-weaning growth rate was better than for Arsi Bale goats reported to be 8.39 kg and 72.1 g/day, respectively (Tatek *et al*, 2004). Weaning weight of goats obtained in this

study was also better than 6.8kg and 9.02 kg reported for Abergelle and Central Highland goats around Sekota (Belay, 2008) about 8 kg reported for Central Highland goats (Tesfaye *et al.*, 2006) even comparable with the reports of six month weight for Abergelle and Central Highland goats (Tesfaye *et al.*, 2006; Belay, 2008). This might be due to better feed availability in the current study area. The better feed situation of the area might favour those genes responsible for better production thus the breed might be used for the improvement of other breeds through crossbreeding.

Table 22. Birth weight, weaning weight and pre weaning average daily gain of monitored goats in Metema Woreda

Factor and levels	Birth weight (kg)		Weaning weight (kg)		PWADG (g)	
	N	LSM ± SE	N	LSM ± SE	N	LSM ± SE
Overall	93	2.28±0.04		12.73±0.13	99	115.74±1.55
R ²		0.59		0.49		0.29
CV (%)		13.93		7.93		10.26
Sex		**		**		**
Male	46	2.36± 0.05	40	13.18±0.18	40	120.12±2.11
Female	47	2.20± 0.05	39	12.27±0.17	38	111.35±2.05
Parity		**		**		*
1	15	1.92± 0.09 ^a	12	11.43±0.32 ^a	12	105.84±3.28 ^a
2	18	2.34±0.08 ^b	17	12.78±0.26 ^b	17	116.18±3.01 ^b
3	33	2.35± 0.06 ^b	31	13.24±0.20 ^b	30	120.43±2.36 ^b
4	27	2.50±0.06 ^b	19	13.46±0.24 ^b	19	120.51±2.84 ^b
Type of birth		**		**		NS
1	35	2.72± 0.06 ^a	35	13.37±0.19 ^a	35	118.38±2.16
2	35	2.25± 0.06 ^b	29	12.95±0.20 ^a	28	117.73±2.36
3	23	1.85± 0.07 ^c	15	11.86±0.29 ^b	15	111.10±3.34

Means with the same letter within the same column are not significant by different; * significant at 0.05 level, ** significant at 0.01 level PWADG = preweaning average daily gain *= $p < 0.05$, **= $P < 0.01$; CV= coefficient of variance; LSM=least square mean; N= number of observation; NS=not significant and SE= Standard error

4.12. Live Body Weight of the Monitored Goat

Live body weight of monitored goat by sex and age group are presented in Table 23. The overall body weight of mature goats from above dentition class 1 pair of permanent incisor (PPI) was 32.96 ± 0.61 kg. Sex and age group had significant effect ($p < 0.05$) and ($p < 0.01$), respectively on live weight. Males body weight was 33.99 kg which was significantly ($p < 0.05$) higher than their female (31.92 kg) contemporaries. Live weight significantly (at least $p < 0.05$) increased from goat having 1 pairs of permanent incisors (PPI) to 3 PPI and then showed a decreasing trend though not significant. Body weight of male goats from 1 to 4 PPI were 27.50 ± 1.61 , 35.22 ± 1.67 , 39.0 ± 1.90 and 39.22 ± 2.16 kg respectively. The corresponding values for females were 26.83 ± 0.99 , 32.28 ± 0.81 , 34.61 ± 0.81 and 33.99 ± 0.91 kg respectively. The effect of sex and age group obtained in this study was in agreement with previous reports (Tesfaye *et al.*, 2006; Belay, 2008)

The overall mature body weight obtained in this study was higher than the 26.25 kg body weight observed for Central Highland goats in Eastern Amhara region (Tesfaye *et al.*, 2006). Live body weight obtained for males were comparable with that for Abregelle goat (33.6 kg) and lower than Begait goat (45.3 kg) reported by Berhane and Eik (2006) under farmers management. Whereas, live body weight of does obtained in this study was higher than the Abergelle does in Ethiopia (Berhane and Eik, 2006) and East African does in Kenya (Njoro, 2001) which weighed 28.6 kg and 25-30 kg, respectively. However, the body weight of does in the present study was slightly lower than 33.8 kg reported for Begait does (Berhane and Eik, 2006).

Table 22. Live body weight of monitored goat by sex and age group in Metema Woreda

Factor and levels	N	LSM	SE
Overall	148	32.96	0.62
R ²		0.33	
CV (%)		14.84	
Sex		**	
Male	24	33.99	1.17
Female	124	31.92	0.44
Age group		**	
1 PPI	32	27.29 ^a	0.99
2 PPI	45	33.75 ^b	0.90
3 PPI	38	38.31 ^c	1.76
4 PPI	33	36.48 ^c	1.17
Sex by age group		NS	
Male 1 PPI	8	27.50	1.61
Male 2 PPI	9	35.22	1.67
Male 3 PPI	4	39.00	1.90
Male 4 PPI	5	39.20	2.16
Female 1 PPI	24	26.83	0.99
Female 2 PPI	36	32.28	0.81
Female 3 PPI	36	34.61	0.81
Female 4 PPI	28	33.96	0.91

Means with the same letter within the same column are not significant by different; * significant at 0.05 level, ** significant at 0.01 level *= $p < 0.05$, **= $P < 0.01$; CV= coefficient of variance; LSM=least square mean; N= number of observation; NS=not significant and SE= Standard error and PPI =pair of permant incisors

4.13. Feeding Trial

4.13.1. Live weight change

Initial weight, final weight and average daily gain of goats during the 90 days feeding trial are presented in Table 24. Overall mean of initial weight, final weight and average daily gain were 22.35±0.12 kg, 27.09±0.19 kg and 52.61±2.01 g/day, respectively. As expected there was no significant difference in initial body weight of goats among treatments and all the supplement feeds was significantly ($p<0.01$) improved final weight and average daily gain of goats. The effect of supplementation on final body weight and average daily gain obtained in this study was in agreement with previous reports (Abule *et al.*, 1998; Tesfaye *et al.*, 2006; Ameha *et al.*, 2007). Final weight and average daily gain of goats in non supplemented treatment group was 25.5 kg and 34.4 g/day, respectively.

Table 23. Initial weight, final weight and average daily gain of goats

Treatment	IW (kg)	FWT (kg)	ADG (g/day)
Overall	22.35±0.12	27.09±0.19	52.61±2.01
R ²	0.97	0.92	0.76
CV (%)	2.35	3.14	17.4
SE	0.23	0.38	4.09
Treatments	NS	**	**
Grazing only	22.4	25.5 ^a	34.4 ^a
Grazing + noug cake +WB mixtures	22.4	27.2 ^b	52.9 ^b
Grazing + cotton cake +WB mixtures	22.6	28.7 ^c	68.0 ^c
Grazing + sesame cake +WB mixtures	22.0	27.0 ^b	55.1 ^b

WB = wheat bran; * significant at 0.05 level, ** significant at 0.01 level, IW= Initial weight, FWT=Final weight, ADG=Average daily gain, Kg= kilo gram g= gram*= $p<0.05$, means with the same letter within the same column are not significant by different; CV= coefficient of variance; LSM=least square mean; NS=not significant and SE= Standard error

Goats supplemented with cotton seed cake with wheat bran mixtures had significantly ($p < 0.01$) higher final weight (28.7 kg) and average daily gain (68 g/day) than the non supplemented and goats supplemented with noug cake and Sesame cake with wheat bran mixture whereas the noug cake and sesame cake with wheat bran mixture supplemented groups were not different ($p > 0.01$) from each other reflecting the fact that the supplements were comparable in their potentials to supplying nutrients for growth of yearling goats. Goats supplemented with noug seed cake and sesame seed cake had average daily gain of 52.9 g/day and 55.1 g/day, respectively. This result was similar with a research conducted by Kabir *et al.* (2002) using grazing goats and supplemented with high protein or low protein diet showed no significant difference between the diets in DM intake and live weight gain, although there was a tendency of increased live weight gain, in goats given high protein diet.

The increased daily weight gain for concentrate supplemented groups in the present study can be attributed to the higher protein and energy intakes. Average live weight gain observed in the present study in the supplemented groups was comparable to the reports of different studies. Similar to the present study, Galal and Kassahun (1981) reported that goats supplemented with concentrate showed heavier BW and daily BW gain. Solomon (1992) in his study using sheep fed maize stover supplemented with different oil seed cakes reported ADG of 46.7 and 45.4-90 g/d, respectively for NSC and CSC supplemented animals at 60 g/d/sheep level of supplementation. Bonsi *et al.* (1996) in their study using Ethiopian Menz sheep fed a basal diet of teff straw supplemented with different protein sources, reported growth rate of 62.9 g/d for CSC supplemented animals and the authors attributed the higher growth rate to its superior amino acid profile coupled with its phosphorus concentration, higher nitrogen consumption and microbial protein supply post ruminally might have enhanced growth rate. Osuji *et al.* (1993) reported an ADG of 44 and 52 g, respectively for CSC and NSC supplemented animals in their study in sheep fed maize stover supplemented with isonitrogenous amounts (40 g CP) of CSC, NSC and sunflower cake

4.13.2. Chemical composition of the experimental diets and major browse species

The chemical composition of feed offered and major browsing species is presented in Table 25. The chemical compositions of oilseed cakes varied widely based on the environment in which they grew, variety and processing methods used during the extraction of oil from the oilseeds (Solomon, 1992). In this trial, the DM content of protein supplements was above 90%.

Table 24. Chemical composition of the experimental feeds and major browsing species in Metema Woreda

Feed ingredients	DM (%)	Ash (%DM)	OM (%DM)	CP (%DM)	NDF (%DM)	ADF (%DM)	ADL (%DM)
WB	89.28	4.4	95.60	13.8	32.72	9.46	2.35
NSC	92.25	11.88	88.12	33.60	27.53	25.27	10.45
CSC	92.77	6.30	93.70	40.50	34.06	16.77	5.32
SSC	91.48	11.32	88.68	34.64	13.84	9.15	1.65
NSC +WB	90.95	8.51	91.49	21.95	21.99	20.56	5.48
CSC +WB	90.63	5.37	94.63	23.86	34.39	15.95	4.88
SSC +WB	89.95	6.93	93.07	22.14	28.21	14.77	4.95
Browse species							
Gaba	90.23	9.43	90.57	17.23	41.18	25.31	11.41
Kerekera	90.97	12.92	87.08	11.47	37.98	26.28	7.77
Chara	90.49	10.63	89.37	15.33	40.45	28.14	11.30

WB = Wheat bran; CSC = Cotton seed cake; NSC = Noug seed cake; SSC = Sesame seed cake, DM = Dry matter, OM = Organic matter, CP = Crude protein, Ash = Ash, NDF = Neutral detergent fiber, ADF = Acid detergent fiber, ADL = Acid detergent lignin

The CP content of cotton seed, sesame seed cake and noug seed cakes was 40.50%, 34.64% and 33.60% DM, respectively. The CP content of CSC was higher than CSC reported by McDonald *et al.* (2002), and Matiws (2007) which was 239 and 253.4 g/kg DM,

respectively. Contrary to the result of the current study, high CP content was reported by Mulat (2006) 41.90 % on DM basis and 43% reported by Amare (2007) as fed basis. The relatively higher CP content of CSC in the present study could be due to the partial dehulling during the process of oil extraction. According to McDonald *et al.* (2002), decorticated (dehulled) cottonseed meal contains high CP than undecorticated meal containing 46 and 23.9 percent, respectively.

The CP content of noug seed cake was also in agreement with the findings of Seyoum and Zinash (1989) and Alemu (1981) who reported values of 35.5 and 34.89%, respectively. The CP of sesame seed cake in this study was 34.64% which was higher than the value of 30.93% reported by Solomon (1992), but lower than the CP content of 43.28, 47 and 42-44% reported by Tekeba (2005). The CP content of wheat bran used in this experiment was lower than the value of 14.90% and 16.5% reported by Mulat (2006) and Tesfay (2007), respectively. This might be due to the effect of processing in milling industries and the quality of the grain used in the milling industries.

4.13.3. Partial budget analysis

The partial budget analysis was conducted to assess the economic benefit of different protein supplements fed to grazing Metema goats under farmer's management. The partial budget analysis indicated that yearling Metema local goats supplemented for 90 days with 300 g/h/day of noug seed cake with wheat bran mixtures, cotton seed cake with wheat bran mixtures and sesame seedcake with wheat bran mixtures was found to give a net return of Birr 81.40,84.23 and 62.33 per head, respectively. On the other hand the net return of 92.20 birr per head was generated from un supplemented groups (grazing only)

According to partial budget analysis, However, Feed supplement of NSC and WB CSC and WB, and SSC and WB mixture was showed good net profit of yearling goats but was not found to be economically feasible compared to the unsupplemented groups. Feed

supplement of NSC , CSC and SSC returned less profit margin than the unsupplemented ones (Table 26).The present result suggested that supplementation with NSC, CSC and SSC for Metema goat under grazing condition was not potentially profitable compared with no supplementation (grazing only). The potential reason for this condition was likely due to the higher price of total variable costs specially the price of the supplemented feeds was not reasonable price. The other potential reason was the relative growth rates and the marketing system in which animals are marketed on individual basis rather than weight basis and agreement on prices reached after a long one-to-one bargaining between buyers and sellers. The relative growth rate result was attributed to better feed availability in the current study area and during the time of the study the pasture condition was good both in quality and quantity. This better feed situation of the area might favour those genes responsible for better growth rate. That is why supplemented and non supplemented groups of goats gained live weight though the magnitude of gain has differed between the two groups. The second reason is there was an attractive market price during the time of animals sold to the nearby markets.

From the results of the current study, it can be said that in areas where concentrate protein sources are available at required time and quantity and reasonable price, finishing of yearling Metema goats with noug seed cake, cotton seed cake and sesame seed cake at a level of 300 g/head/day for about 3 months was profitable. But compared to the control group it was in question when it was seen to the other works/findgs. To make the margin higher, however, it is imperative to consider price of the feeds and strategic time of fattening. Actually, supplementation is most profitable under range conditions when pastures decline in quality and quantity, such as in dry season, and when goat's growth potential is not being met with natural forage (Richard and Church, 1998).

Table 25. Partial budget analysis of experimental feeds

Particulars	Treatments			
	T1	T2	T3	T4
Purchase price of kids, ETB/head	183	183	183	183
Total concentrate consumed (kg)	-	29.24	29.34	29.25
Cost for concentrate, ETB	-	50.60	50.10	62.00
Total feed cost, ETB	-	50.60	50.10	62.00
Estimated gross income, ETB/head	275.20	315.00	317.33	307.33
Estimated total return, ETB/head	92.20	132.00	134.33	124.33
Estimated net income, ETB/head	92.20	81.40	84.23	62.33
Δ NI	-	-10.80	-7.97	-29.87
Δ TVC	-	50.60	50.10	62.00
MRR	-	-21.34	-15.91	-48.18

Δ NI = change in net income; Δ TVC = change in total variable cost; MRR = marginal rate of revenue.

At the end of the experiment, field day was arranged and farmers in the surrounding were invited to evaluate the performance of goats under the four treatment groups. According to farmers' evaluation, the performance of goat in the three supplemented groups as good, but farmers were impressed in the body condition of goat supplemented with cotton seed cake with wheat bran mixtures. This is because of goats which were supplemented with cotton seed cake with wheat bran mixture had better body conditions than other groups. Farmers have found this strategic supplementation as a very important means of maintaining their goat in good body condition. But from this finding we can conclude that, even though supplementation favor better growth rate and improved body condition it was not economically beneficial compared to unsupplemented groups.

5. SUMMARY AND CONCLUSION

The present study was done to characterize the production and marketing system and on-farm evaluation of the effect of supplementing different protein sources each in mixture with wheat bran (energy source) on the growth performance of grazing local Metema goats under farmers' management. This study was conducted in Metema District, North Gondar Zone, Amhara National Regional State.

The study on production systems was conducted by implementing single visit questionnaire based on survey of 135 respondents, and rapid market appraising was done for marketing studies. Following survey work, on-farm monitoring and feed trial were carried out. Records on birth weight, weaning weight, pre-weaning average daily gain and mature body weight were recorded from monitored flocks. Twenty intact male local goats were used for on-farm feed trial experiment to evaluate the growth performance of grazing goats supplemented with isonitrogenous protein sources.

In Metema district different livestock species were found, in which 99.3% of the households had goats. Goat types in Metema district are composed of entirely local breed type, which included goats locally called Hebesha, Gumuze, Rutana and mix of the three breed types. According to the respondents, the indigenous goat types dominantly (76.3%) found in Metema district were locally known as "*Habesha*", and probably the naming referred to the places from where the goat originated, the highland parts of the North Gondar and other parts of the Region. Moreover, Rutana and Gumuze goat types, which were believed to be originated from Sudan and Benshagul Gumuze National state were found in small proportions.

Goat were ranked as the first (76.8% in cotton based farming system and 62.6% sesame based farming system) important livestock species followed by cattle. The primary reason for keeping goat for the Metema goat owners was to generate income followed by meat consumption, saving and as a means of ceremony. The dominancy of Metema goat

population and their contribution to the family income than other farming systems makes the species of paramount importance in the livelihood of the community.

The average flock size was 20.04 ± 5.94 in cotton based farming system, 19.7 ± 6.93 in sesame based farming system with an overall mean of 19.7 ± 6.60 . The major feed resources were natural pasture, crop residues, crop aftermath and hay, and farmers do not provide supplementary feed to goats. Feed resource was not a limiting factor for goat production in the area. The main water sources were rivers and wells and watering frequency was mostly once a day in the wet season and twice a day in the dry season. Enclosures near the fence or a separate hut for goats with a suspended wooden floor shelter were the two main methods of housing. Kids and adults are housed in isolation and joined only during the morning and evening hours. Most of the respondents (46.7 percent) herded goats separately, 30 percent practiced no herding and goat and sheep together was herded in the remaining households.

Breeding system was entirely natural mating using local bucks available in the area. Uncontrolled mating within the household's flock was predominant (on average 96.6% for cotton based farming systems and 98% for sesame based farming systems). On all the farms, the flocks consisted of goats of all ages and they were kept as a single flock. The buck is running continuously with the does. According to farmers' report, the overall average age at puberty in males was 7.4 ± 1.95 and 8.2 ± 1.64 months in females. Age at first kidding and kidding interval were 13.6 ± 2.44 months and 8.4 ± 1.37 months, respectively. In Metema area, pasteurellosis, PPR, and CCPP in that order were the most common diseases of goat. Disease, labour shortage, and theft were the most pertinent constraints for goat production in that order for farmers.

There is neither regular market information on prices and supplies nor grades and standards. Agreement on price is reached by a long bargaining between a seller and a buyer. Animals are sold on a per head basis.

The study result revealed that the over all mean of weight of kids at birth was 2.28 ± 0.04 . Type of birth, sex and parity exert effects on birth weight. Kids born single had heavier weight at birth than twins (2.72 vs 2.25) and male kids were heavier than females (2.36 vs 2.20). The overall mean weaning weight was 12.73 ± 0.13 , kg for Metema goats and the pre-weaning growth rate of kids was found to be 115.74 ± 1.55 g/day. The study also revealed that the over all mature body weight for Metema goat was 32.96 ± 0.61 kg and sex and age exert effects on mature body weight. Males body weight was 33.99 kg which was significantly ($p < 0.05$) higher than their female (31.92 kg) contemporaries. Live weight significantly (at least $p < 0.05$) increased from goat having 1 pairs of permanent incisors (PPI) to 3 PPI and then showed a decreasing trend though not significant.

The result of feeding trial revealed that, diet had effect ($P < 0.01$) on final BW in that supplemented goats had higher final body weight. The partial budget analysis indicated that yearling Metema local goats supplemented for 90 days with 300g/head/day of Noug seedcake, cotton seedcake and sesame seedcake and all with wheat bran mixtures was showed a good net profit. Although, Feed supplement of NSC, CSC, and SSC and their mixture with WB was showed good net profit of yearling goats but was not found to be economically feasible compared to the unsupplemented groups.

5.1. Conclusion

From this study it could be concluded that the general production system and goat management system in the study areas was similar to other Northwestern highland areas in Gondar and was characterized by mixed crop-livestock production system. Goat production in Metema area was characterized by small scale subsistence oriented production system. Goats play an important role in the livelihoods of people in the study area, and they have potential for greater contribution through better health management and genetic improvement. Given the highly unfavorable production condition (difficulties in managing disease and shortage of labour), adaptive traits are very important in the harsh production environment. On the other hand, although the provision of pasture

during the wet season and during the dry season is much better than other parts of the zone, the limited health service systems of animals resulted in high parasite and disease challenges. In such circumstances, animals adapted to the area are thought to perform better than those which are found from other parts of the zone.

From the reproductive and productive performance for the Metema goat in flocks from the traditional production systems, it would appear that the reproductive performance of Metema goats is higher than others reports on local goat breeds in Ethiopia. The present results show that Metema goats have a high growth potential to produce meat for rural and urban families. The birth weights observed and high growth rates of the kids are good indicators of their potential under semi-arid conditions in Metema.

5.2. Recommendations

The following sets of recommendations were forwarded from the results of the study

- More emphasis needs to be placed on the improvement of Metema goats due to their significant contribution to the family income and food and their ability to survive and reproduce in the extreme environments
- To reduce loss due to disease there should be an urgent attention by development actors and partners to strengthen veterinary services including training, credit facilities, and formation of farmers cooperative to facilitate drugs supply and distribution.
- To give curative treatments the proposed diseases should be confirmed through identification and diagnosis.
- Goat are crucial in the livelihood of the smallholder farmers so that taking this into consideration the extension and institutional systems are mandated to commit in alleviating the widespread barriers hindering the performance of flocks and the producers could benefit from the flocks they keep.
- Inputs and improved technologies relevant to the smallholder need to be delivered.

- Marketing intervention of equipping marketing infrastructures and delivery of market and price information for efficient marketing must requires to encouraging producers and traders.
- To increase the validity of conclusion based on-farm feeding trial, it is important to under take well planned on station study to predict the biological and economical potential of the feed technology for yearling goat in Metema condition.
- The fattening potential and meat quality of Metema goat recognized by the owners need further performance and carcass evaluation under feed lot condition.

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7. APPENDIX

Appendix table 1. Population trends of major livestock species as reported by respondent households in Metema Woreda

	Cotton based farming	Sesame based farming	over all
Species	%	%	%
cattle			
increasing	88.9	85.6	85.9
decreasing	6.7	12.2	11.1
constant	4.4	2.2	3
sheep			
increasing	93.3	93.3	94.1
decreasing	5.6	5.6	5.2
constant	1.1	1.1	0.7
goat			
increasing	93.3	90	87.4
decreasing	2.2	2.1	9.6
constant	4.4	7.8	3
equine			
increasing	24.4	18.9	20.7
decreasing	-	-	-
constant	75.6	81.1	79.3

Appendix table 2. ANOVA for the effect of sex, age group, parity and type of birth on kid birth weight in Metema Woreda

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	0.60881910	0.60881910	5.56	0.0207
Parity	3	3.04197197	1.01399066	9.25	<.0001
Type of birth	2	10.11496280	5.05748140	46.15	<.0001

Appendix table 3. ANOVA for the for the effect of sex, age group, parity and type of birth of weaning weight of kids in Metema Woreda

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	16.08966774	16.08966774	14.86	0.0002
Parity	3	33.30228982	11.10076327	10.25	<.0001
Type of birth	2	21.95713270	10.97856635	10.14	0.0001

Appendix table 4. ANOVA for the effect of sex, age group, parity and type of birth of pre weaning average daily gain of kids in Metema Woreda

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	1476.375958	1476.375958	10.00	0.0023
Parity	3	1951.611712	650.537237	4.41	0.0067
Type of birth	2	541.417973	270.708986	1.83	0.1673

Appendix table table 5. ANOVA for the effect of sex, age group and sex by age group for live body weight in Metema Woreda

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	165.109768	165.109768	7.13	0.0085
Age group	3	1104.011190	368.003730	15.89	<.0001
Sex*age group	3	47.162283	15.720761	0.68	0.5665

Appendix table 6. ANOVA for initial weight yearling male goats in Metema Woreda

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	3	0.95000000	0.31666667	1.15	0.3683
Block	4	91.80000000	22.95000000	83.45	<.0001

Appendix table 7. ANOVA for final weight yearling male goats in Metema Woreda

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	3	26.03350000	8.67783333	11.98	0.0006
Block	4	72.27800000	18.06950000	24.94	<.0001

Appendix table 8. ANOVA for average daily gain weight yearling male goats in Metema Woreda

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Treatment	3	2865.864198	955.288066	11.37	0.0008
Block	4	477.530864	119.382716	1.42	0.2858

Appendix table 9. Vernacular name, species of animals affected, clinical symptoms and veterinary equivalent of goat diseases in Metema Woreda

Local name	Species affected	Clinical signs	Veterinary equivalent	Period of occurrence
Tifina	goats, sheep	Coughs, a discharge from the nose, distressed breathing, become weak and tired and have a high fever.	Contagious Caprine Pleuropneumonia (CCPP)	Year round
Wara	goats	Intense irritation with the animal scratching and chewing creating skin lesions that can become ugly.	Lice and mites(mange)	Oct-May
kofele	goats, sheep	Loss of appetite, distressed breathing fever, a watery discharge from the nose and eyes, increased salivation, small red patches (on skin, around mouth, on the head, under the tail and between the legs). The patches become swellings under the skin. Then they become blisters that break and become open sores that soon develop scabs..	Sheep & goat pox	Dry season
Kizen	goats, sheep	Diarrhoea , high fever, loss of appetite and sudden death. Cough and have distressed breathing that increases in intensity.	Ovine pasteurellosis	Dry season(Jan-Apr)
Embeke	Goats and sheep	Nasal discharge, wounds in the mouth, diarrhea and fever.	Peste des petits ruminants (PPR)	Feb-May
ferkek	goats and sheep	Sore of leg and hoof, fluffing of hoof	Foot root	Jun-Sep

Adopted from Deberbehan Research Center Diagnostic survey 2003

Appendix table 10. Birth data record sheet for on-farm monitoring of Metema goats at Metema woreda

Woreda _____ Kebele _____ Got (Site) _____
 Owners Name _____

DID	BD	Dam dentition	Parity	TB	KID	sex	KBW	KBC	remark

DID=dam ID, BD= birth date (dd/mm/yy), , TB=type of birth, KID= kid ID, KBW=kid birth weight and KBC= kid body condition at birth.

Appendix table 11. Fortnight BW record sheet for on-farm monitoring of Metema goats at Metema woreda

Woreda _____ Kebele _____ Got (Site) _____
 Owners Name _____

Kids			birth		DID	BW						Remark
ID	breed	sex	date	weight		D15	D30	D45	D60	D75	D90	

DID=dam ID, D15= BW at day 15, D30= BW at day 30 and so

Appendix Table 12. live body weight at a given age by dentition class record sheet for on-farm monitoring of Metema goats at Metema woreda

Woreda _____ Kebele _____ Got (Site) _____
 Owners Name _____

ID	sex	breed	Wight	age	parity	Remark

ID= Id number