BAHIR DAR UNIVERSITY

COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

GRADUATE PROGRAM

CHARACTERIZATION OF SHEEP FATTENING AT SMALL HOLDER LEVEL IN DIFFERENT AGRO-ECOLOGICAL ZONES OF ETHIOPIA – AMHARA REGION

M.Sc. Thesis

By

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June, 2016

Bahir Dar, Ethiopia

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Wisdom at the Source of the Blue Nile

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SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (M.SC.) IN ANIMAL PRODUCTION

June 2016

Bahir Dar, Ethiopia

ACKNOWLEDGMENT

ABBREVIATIONS

AEZ	Agro Ecological Zone
ARARI	Amhara Regional Agricultural Research Institute
BoARD	Bureau of Agriculture for Rural Development
CSA	Central Statistical Agency
DA	Development Agent
DAGRIS	Domestic Animal Genetic Resources Information System
EARO	Ethiopian Agricultural Research Organization
ESGPIP	Ethiopian Sheep And Goat Productivity Improvement Project
ICARDA	International Center for Agricultural Research in Dry Areas
ILRI	International Livestock Research Institute
IPMS	Improving Productivity and Market Success
SNNPR	Southern Nation Nationalities and Peoples Region

ABSTRACT

The purpose of the study was to characterize sheep fattening production system at small holder level in rural areas of Ethiopia, based on different agro-ecological zones (AEZs). 108 small holder sheep fatteners were selected by random sampling out of Amhara region. Therefore, three AEZs within Amhara region made a total of 12 study areas, each with about 36 respondents who were selected purposively, based on the relevant activity and accessibility to transportation. The collected data from the questionnaire was analyzed based on software, SPSS. The result of the region showed that the sheep fattening practice in general, in different AEZs, was found relatively more defined in the highlands, than in the mid lands and the low lands, respectively. Better market demand, shorter distance to health center, qualitatively and quantitatively feed resources availability, higher net profit gain, relatively better market value chain were scored in the highlands than the rest, followed by mid land and the least score in low lands. The high temperatures in the lowlands influenced health problem which ultimately resulted in low production. Even so, the fattening production system is semi- intensive even in better scoring areas and declines to extensive in most cases. But in fulfilling the constraints of each AEZ would enable them to have optimum and relatively, similar production potential. Besides, using appropriate breeds, market chains, distribution of industrial by-products and promotion of loans supported with agricultural inputs would encourage the small holder farmers to engage in sheep fattening, consistently.

Keywords: Sheep fattening, agro-ecology, rural smallholder

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Chapter 1: INTRODUCTION

1.1.   General Introduction

In developing countries, livestock production is mostly subsistence oriented and fulfills multiple functions (Gemeda *et al*., 2010). Rearing of sheep and goats plays an important role in the economy in general and sustainable livelihood of poor people of rain fed agro-ecosystem in particular, because of inherent risk involved in the crop farming due to uncertainty of rainfall and occurrence of recurrent droughts (Misra, 2005). Majority of Ethiopia's livestock production is focused in the highlands due to availability of crop residues and (Abegaz *et al.,* 2008) less risk of disease (Knips, 2004). Besides, 98% of the population lives in rural areas and about 25.5 million Sheep population is estimated (CSA, 2013).

Sheep are an important component of the livestock subsector, and sources of cash income; smallholder keepers contribute a quarter of the domestic meat consumption; about half of the domestic wool requirements; 40% of fresh skins and 92% of the semi-processed skin and hide export trade and an estimated 1,078,000 sheep and 1,128,000 goats are used annually for domestic consumption in different farming systems and agro-ecological zones of Ethiopia (Hirpa and Abebe, 2007; Legesse, 2008).

Sheep fattening requires low initial start-up costs to engage in production (Miklyaev and Jenkins, 2012). Animals which are to be sold during peak demand periods may have some supplemental feeding, but this traditionally, includes only surplus grains and leftover household food. Forages, grains and concentrates could be used to increase animals' weight and therefore the price they will sell for (Shapiro *et al.,* 1992).

Livestock production systems are identified on the basis of contribution of the livestock sector to the total household revenue (income and food), type and level of crop agriculture practiced, types of livestock species kept, and mobility and duration of movement (Abegaz *et al*., 2010) but sheep fattening production system, has not yet, been studied and characterized. Therefore, the study mainly proposed to characterize the sheep fattening system under smallholder farmers based on different agro ecological zones of Ethiopia. The result would be expected to show variation and similarities among regions and within a region and a good knowledge of their characteristics and strength and weaknesses at farm level and within the framework of the overall farming sector.

1.2 Statement of the problem

Sheep fattening system in Ethiopia has not been identified though it has been the leading potential next to crop production. Sheep fattening at smallholder level, lacks uniformity, low production and/or reproduction and far more away from exportation. Therefore, characterization of the potential area and identifying the variation among the available resources under agro-ecological zones would give better profile as an input for development strategies.

Most of the small ruminant population of Ethiopia is kept by smallholder farmers and small ruminant production in the country is traditional (EARO, 2001a). Encouraging small ruminants production on a large scale among the farmers will enhance the supply of adequate animal protein for the people (rural and urban) and even surplus for export to neighboring countries since their capita consumption of sheep and goat meat (kg/person /year) in Ethiopia is 8 kg while the global average is 38kg (104g/day), (Negassa and Jabbar, 2008). Although, Ethiopia is strategically situated in the horn of Africa, the share of export to the Middle East market has been declining in recent years while exporting countries have been taking an increasingly larger share of the rapidly expanding market for live animals and meat (Jabbar *et al.*, 2007). Annual off-take rate of sheep is estimated 33% (EPA, 2002) with av. carcass wt. of about 10 kg. This underutilization could be mainly from the lack of unclear system of production. Therefore, characterizing the production system based on AEZ would simplify the complex factors that hinder mutton production in the country and would magnify the fattening production system. The result of the study would be reference for organizations and institutions and would set priorities and shortcomings of farmers'.

1.3. Objectives

1. To characterize sheep fattening system at small holder level in different agro ecological zones.

2. To evaluate performance of sheep fattening in small holder rural farms.

Chapter 2. LITERATURE REVIEW

2.1. Livestock production system in Ethiopia

There are a number of ways to classify production systems. In Ethiopia, sheep and goat production systems were classified using criteria that included degree of integration with crop production and contribution to livelihood, level of input and intensity of production,

agro-ecology, length of growing period and relation to land and type of commodity to be produced (Abegaz *et al.,*2008).

Based on the study by Abegaz *et al.,* (2008), three major and two minor production systems are described. The major production systems are:

- Highland sheep–barley system
- Mixed crop–livestock system
- Pastoral and agro-pastoral production systems

The other production systems that are not currently practiced widely but have a future are:

- Ranching
- Urban and peri-urban (landless) sheep and goat production system

2.2. Geographic distribution of sheep breeds in Ethiopia

Though livestock is a part of production systems prevailing in the country, different species of livestock may be more concentrated in some regions or *woredas* than others. Such distribution has implications for marketing as animals have to be moved from production areas to principal domestic consumption centers, processing centers and export outlets. An estimated 70-75% of Ethiopia's livestock population is concentrated in the highlands (Hawando, 2000).

Sheep breed distribution in EthiopiaSystematic characterization of breeds is still incomplete in Ethiopia. Based on detailed phenotypic and genotypic classification, DAGRIS (Domestic Animal Genetic Resources Information System) identified six sheep breeds named; Afar, Dangla, Horro, Menz, Black Headed and Bonga (Jabbar *et al.*, 2007).

Based on the study by Mohammad Jabbar *et al.*(2007) the highest numbers of cattle and shoats were to be found along a north–south transect covering parts of the central highlands of Tigray, Amhara and Oromia regions, and the transect that connects Nazret (Adama) and Dire Dawa. Conversely, very low livestock numbers occurred in pastoral areas like Afar, Ogaden, and Boran; this would be normally expected.

2.3. Sheep fattening constraints in Ethiopia

2.3.1. Feed

Natural grazing and crop residues are base feed resources in Ethiopia. There is a strong seasonality in supply and quality of feeds. Grazing areas have continuously declined due to increased areas of cultivation. Concentrate feeds are little used due to shortage of surplus over requirements for human consumption, since feed shortage is a critical issue and there is inadequate feeding and poor feed quality, the available feed only satisfies about 58% of the requirements (Kosgey *et al*., 2008).

Based on the study by Mikhail and Glenn, (2012), high prices of commercial feed products along with the low scale of the activity do not allow the feeding scheme based on the highly nutrition commercial feed products rather it was based on the free grazing feeding scheme with a limited quantity of supplementary feed. In line with this Misra (2005) stated Sheep farmers obtain forage from a combination of crop residues, private land and common gazing land. Thus, a sheep rarer obtains benefits from both common lands and framers' field. Based on the study by shigdaf, *et al*. (2012), in north western part of Amhara major constraints to sheep production were feed shortage (44%), disease (28%), labour shortage (15%) and drought (13%).Back yard fodder development (Oats, Rhodes, Virus free Napier and desho grasses and some legumes cow and pigeon peas, vetch, lablab), for fattening was also introduced. Use of crop residues was encouraged together with chopping of stover and treatment of the straw with urea. Use of locally available by-products from agro- processing (wheat bran, rice bran, *atella*) and commercially available concentrate (cotton meal, noug cake) was stimulated. To stimulate production of fodder (for fattening), from sloping grazing areas and bottomlands, grasses and leguminous fodder species and more controlled management of such areas, was encouraged. In some areas, these supplement roughage was introduced in Miesso and Alaba as a survival or an emergency feed and as a strategic feed reserve.

2.3.2. Market

Lack of Market, fluctuating price and occasional practice (Kocho and Geta, 2011), long market channel and market information are market constraints of sheep fattening. African farmers often fatten a few sheep to sell during feasts and holidays when prices are relatively high (Shapiro *et al.,* 1992). According to FAO (2004), the total annual meat production of

Ethiopia comes from cattle (63%), sheep (25%) and goats (12%) respectively. Based on the experience of IPMS project in Metema, Fogera, Bure and Miesso, farmers "bulked" their animals for marketing by either renting a truck to transport to distant market and/ or to assign one farmer to sell animals on behalf of the others. There is also an illegal exportation to neighboring countries, then exported to overseas (BoARD, 2005).

2.3.3. Animal Health

Animal health service is mostly provided by the government, and is often limited to vaccination and general disease control. Involvement of the private sector is limited to provision of drugs and treatment of sick animals. Only 27% of cattle are vaccinated and less than 10% of sick animals receive treatment indicating limited public veterinary practice.

2.3.4. Mortality

About one half of all lambs born die and an annual mortality in all classes of stock averages 23% for sheep in central high-lands. Lamb survivability in the village condition is one of the main factors that adversely affecting lamb production and it will remains the major form of productive wastage resulting into sizable economic loses in sheep farming unless there is an intervention to curb the problems (Abassa,1995). In the traditional flocks an estimated 10 to 50% of lambs die annually before weaning (Mugerewa *et. al,* 1994). Lambs born in land scarce areas had a low survival rate than lambs born in land available area.

2.4. Factors affecting sheep fattening at rural level

Due to feed shortage and lack of range lands, farmers shift from large to small ruminants. International market demand for Ethiopian small ruminants is increasing (Hipra and Abebe, 2008). International as well as local demand increases in mutton. (Legesse *et al*., 2008). This demand encouraged adding value and fattening animals (Kocho and Geta, 2011). As a result, investment increases, such as, construction of modern abattoirs in Bahrdar and Kombolcha (Ayalew, 2010).

The proximity of Ethiopia to consumers in Middle Eastern countries and their taste preference for our indigenous animals are advantageous for the Ethiopian meat export market. However, the international market for meat is becoming increasingly competitive and meat traders must adopt improved practices in production, processing and packaging of meat to maintain and grow market share (Sebsibe, 2006).

The IPMS project collaborated with partner research institution to test the introduction of improved local sheep breeds in particular Washera sheep in Fogera (with ARARI) and Bonga sheep in Goma .The Washera sheep in Gojjam highlands, whose lambs weigh 2.8 kg at birth, grow to 14.4 kg after 3 months and reach 21 kg by 6 months age. It is promising even with the indigenous breeds to promote fattening.

Chapter 3. MATERIALS AND METHODS

3.1. Materials

Primary data (questionnaire), DAs (development agents), diary, computer, internet, phone, Camera, A4 sized paper, pen and pencil.

3.2. Study Area

Ethiopia is divided into 32 agro-ecological zones (AEZs) delineated by biophysical conditions (MoA, 2000) which are significantly influenced by altitude, which ranges from -155 to +4,000 meters above sea level. Rainfall also varies temporally resulting in incidents of drought every 4-5 years (Osman and Sauerborn, 2008).The Amhara National Regional State (ANRS) is one of the nine regional states of the Federal Democratic Republic of Ethiopia (FDRE). In geographic terms, the ANRS is located between $9^0 21^'$ to $14^0 0^'$ North latitude and $36^0 20^'$ and $40^0 20^'$ East longitude. The total area of the Amhara region is estimated to be 170,752 square kilometers. The region shares borders with Tigray, Afar and Oromia and Benishangul and the Sudan Republic in North, East, South and West, respectively. The region is divided in to 11 administrative zones including Bahir Dar special administration and 114 Woredas**.** Sample data was collected in Amhara region of three woredas; in 12 regions representing three AEZs based on traditional classification 2000m-3000m above sea level was the highland, 1500- 2000m midland and was the lowland (Mengistu, 2006). The low lands (500-1500 meters above sea level) cover mainly the north western part of the region bordering the Sudan and the eastern parts bordering the Afar region. These areas are largely plain and constitute big part of the northern and eastern part of the region. The highland areas are rugged and mountainous with peaks rising up to 4620

masl at Rasdashen (the highest peak in Ethiopia). In terms of the traditional agro-ecological classification, the region is composed of Bereha 3% (below 500 masl), Kolla 22% (500-1500 masl), 44% Woinadega (1500-2300 masl), 27% Dega (2300-3000 masl), 3.6% Wurch (3000-3700 masl) and 0.4% high Wurch (above 3700 masl). The recorded annual mean temperature of the region ranges from 12.4 or in Mehal Meda (Dega) to 27.8 ^{o}C in Metema (Arid Kolla) (CSA, 1996). The mean annual rainfall recorded in the region is in the range of 598.3 mm (Lalibela) and 1692 mm (Chagni) 3-25 years average. The North- Western and North-Eastern parts of the region along the boundary with the Sudan, Tigray and Afar regions receive the lowest amount of rainfall, which is less than 700 mm. The region receives the highest percentage (80%) of the total rainfall in the country (BoARD, 2002). The highest rainfall occurs in "Meher" season which starts in mid-June and ends in early September. The land use pattern of the region is 28.2% arable land, 30% pastoral land, 2.1% forest land 12.6% bush land, 7.2% settlement, 3.8% water bodies and 16.2% is unusable land (PEDB, 1999).

The multitude of agro-ecological zones (AEZs) is traditionally classified into five categories with traditional names assigned to each zone, based on altitude and temperature: Bereha (desert), kola (low land), Weinadega (mid land), Dega (High land) and Wurch (frost).

Table 3.1. Traditional Ethiopian agro- ecological zones

Zone	Altitude(m)	Mean Rainfall (mm)	Temperature (°C)
Bereha (dry-hot)	500-1,500	<900	>22
Weinadega (dry- warm)	1,500-2,500	<900	18-20
Erteb Kola (sub-moist warm)	500-1,500	900-1,000	18-24
Weinadega (sub-moist cool)	1,500-2,500	900-1,000	18-20
ErtebWeinadega (moist- cool)	1,500-2,500	>1,000	18-20
Dega (cold)	2,500-3,500	900-1,000	14-18
Ertebdega (moist cold)	2,500-3,500	>1,000	10-14
Wurch (very cold or alpine)	>3,500	>1,000	<10

Source; MOA 2002
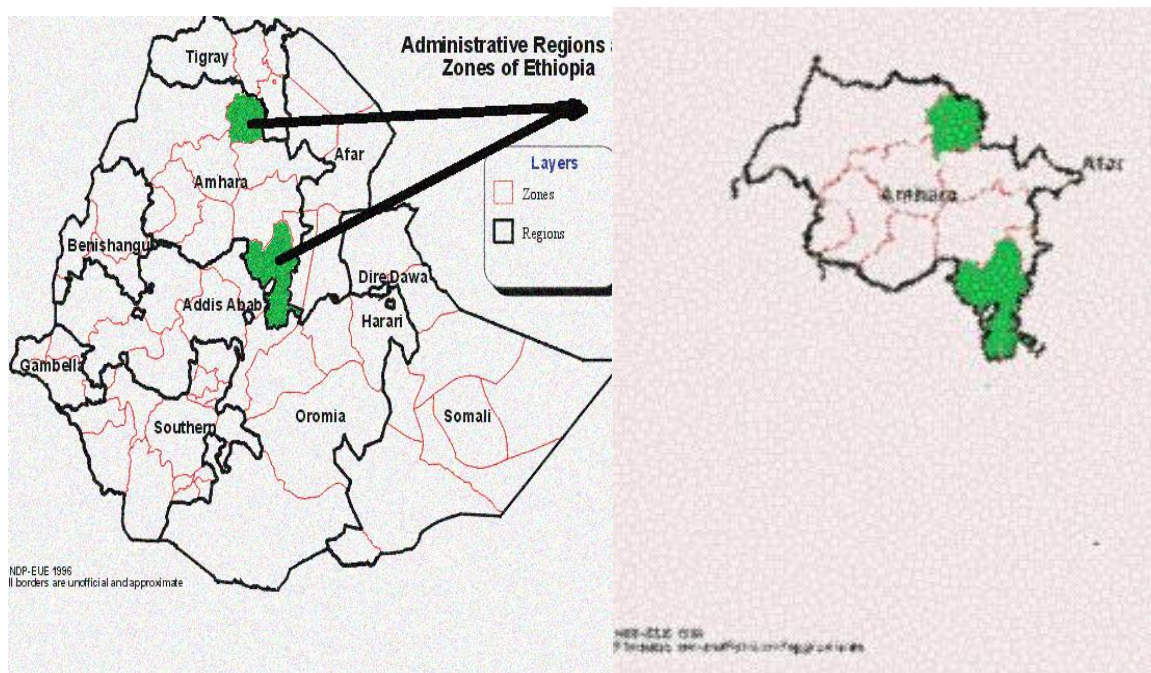
Source: MOA, 2000

Figure 3.1. Map of Ethiopia showing study areas in Amhara region.

Abergele: Altitude level of 1340-2200 m above sea level, north east of Bahir Dar, 350-700 mm rain fall range.

Tekeze low land sorghum and goat (TSG) livelihood zone has poor soil fertility and unusually short rain season not more than July and August, 864mm but satisfactory for a low land. The worst in Amhara prone to rain failure is this area. Main crops are sorghum, teff and haricot beans, and cereals are often quick varieties. Niger and Sesame cake are grown for cash. Small stock especially goats are numerous. Peak market demand of small ruminants is September to December and April to June. Four main destination markets for small ruminants are Mekele, Gonder, Bahir Dar and Sudan.

North east woinadega: mixed cereal zone is characterized by a dry, Woinedega (Mid land) agro-ecology, with rugged topography. Barley, sorghum, teff and wheat are main crops but the area is known for its low fertility. Faba bean lentil and Oil seeds are grown for sale. Shoat and cattle sells are the main cash income for the middle and better-off households. Grazing is free on communal lands but scarce.

Debre Birhan: 120 kms north east of Addis Ababa, situated at the enteral highland of north Shewa with an average elevation of 2,714. The people are highlanders. The region has two

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rainy seasons, *meher* and *belg,* that lasts from *June* to September and between January and April, respectively. A household largely depends on small ruminants.

3.3. Methodology

Both primary and secondary data's were collected using semi-structured questionnaire. A total of 108 respondents were asked to fill a questionnaire in Amhara region with about 11 chapters that constitute questions regarding background, ownership, importance of fattening, farming resources, features of the sheep used for fattening, feed resources and feeding strategy, finishing, health, marketing, trends and restrictions and economics of fattening. The secondary data were also concentrated mainly on fattening farmers' population, distribution, agro-climatic information, and the attention of the woreda and NGOs towards fattening.

Out of Amhara region, 108 small holder fatteners were selected by random sampling. Each region was assessed according to its agro-ecological zones (AEZs); therefore, three AEZs per region make a total of 12 study areas, each with about 36 respondents who were selected based the woreda information on the population potential, agro ecology, fattening practices, ease of access to villages and transportation access.

Respondents were selected with the help of the woreda DAs, by experience of the farmer in sheep fattening, age variation and if found women headed member. An interview was made to a total of 108 farmers, each zone with 36 respondents, with an average interview time of 1.55 hours.

The semi-structured questionnaire was designed to obtain information mainly on the purpose of engaging in sheep fattening, period of sales of the animals, type and cost of feed inputs, average market prices of the animals, feeding strategy, benefits derived from fattening and the system of their production. Therefore, the questionnaire will comprise about 137 items, grouped into the following sections: Importance of fattening, water source and watering system, farming resources, selection of sheep fattening, feed resources and feeding strategy, finishing, health and marketing information.

Table 3.2. The study area according to their agro-ecologies

Region	Area (woreda)	Kebeles	Agro-ecology
Amhara	Debrebrhan	Moretna Jeru, Qeyt, Sayadebrna Wayu	High land
	Abergele	Abergelle, Tsana, Arsgie	Low land
	Dehana	Amdeworq, Chilla, Qewzba	Mid land

3.4. Data management and analysis

Data was filled in a Microsoft excel spread sheet from the questionnaire and analyzed using an SPSS (Statistical Package for Social sciences). To present the results; descriptive statistics, Chi-square, using Keendell Wallace comparison and average mean and t- square testes were also used for single parameters.

Chapter 4. RESULTS AND DISCUSSSION

4.1. Household characteristics, importance and farming resources of fattening

In the highlands and lowlands 100% and in the midlands 97.2% of the respondents were Ethiopian Orthodox Church followers. The most frequent family size of household in the highland 6 (27.8%), in the lowland 5(27.8%) and mid land 6 and 8 (19.4% each) but the range of the size of the households was 1-11. In rural small holder household heads 52.9% of the illiterate respondents were from highland, 23.5% each from the low lands and mid lands and there is no significant difference in education level among AEZs (p > 0.05). Only 5.6 % of the total respondents were female headed family. The main source of income of the fatteners in the low land and the mid land was crop production and labor with an average 8.4% and 5.6%, respectively. But in the highlands crop production and fattening holds 69.4%. Statistically, in the highlands 86.1%, low land 83.33 and mid land 80.6% of the respondents had never taken any training concerning sheep fattening. An overall age interval was from 23 - 70 years age old. There is no significant difference (p > 0.05) among AEZs in age difference (p=0.875). The highest frequency (11.1%) in which fatteners engage in

fattening was at the age of 26. Young fatteners were expected to be in highland than the rest of the agro- ecological zones (AEZs).

The reason for the age difference in fatteners among AEZs could be due to the availability of market and feed resources in the highland, besides there is infrastructure availability around the capital city where the highland sites were taken as representative. Whereas, in the mid and low lands, the youth had no land availability and there was relatively, low feed resources as the temperature increases with decreasing altitude. Therefore, youths rely on labor as a source of income and only elders are available sticking on their small holding with small number of sheep under traditional fattening with scarce or no additional supplementation. Illiteracy could mainly be due to the harsh condition of the low land, there has been a problem in distribution of infrastructure and skilled human resources. The variation in training was from the lack of training institutions follow up and consistency in providing relevant training to the right farmer. Besides, there could be lack of records of fatteners at *kebele*, *woreda* and zone level.

Table 4.1. Household size of sheep fatteners in different AEZs.

Respondents' Characteristics		Agro-ecology					
		Highland		Midland		Lowland	
		N	%	N	%	N	%
Religion	Orthodox	36	100	35	97.2	36	100
	Muslim	0	0	1	2.8	0	0
	Catholic	0	0	0	0	0	0
	Protestant	0	0	0	0	0	0
	Total	36	100	36	100	36	100
Sex	Female	1	2.8	0	0	5	13.9
	Male	35	97.2	36	100	31	84.1
	Total	36	100	36	100	36	100
Marital Status	Single	1	2.8	0	0	0	0
	Widowed	1	2.8	0	0	0	0
	Custom Married	33	91.7	35	97.2	34	94.4
	Civil married	0	0	1	2.8	0	0
	Divorced	1	2.8	0	0	2	5.6
	Total	100	100.0	36	100	36	100
Educational level	Illiterate	9	25	4	11.1	4	11.1
	Literate	9	25	8	22.2	5	13..9
	Primary	16	44.4	20	55.6	23	63.9
	Secondary	2	5.6	4	11.1	3	8.3
	Diploma	0	0	0	0	1	2.8
	Total	36	100.0	36	100.0	36	100.0

Table 4. 2. Average mean of age and household size of respondents

Respondents' Characteristics	Mean ± MSD						P-value
	N	Highland	N	Midland	N	Lowland	
Age	36	38.97± 1.77	36	36.03± 2.66	36	34.5± 1.64	0.304
Household size	36	5.67± .3	36	6.36± .34	36	5.42± .31	0.094

The experience in fattening in the highlands had no labor experience. Whereas, in the high lands fattening experience was observed in the range of 4-6 years. Years of experience in fattening were highly frequent at 5 years in the highlands (16.7%), 4 years in low lands (25%) and 6 years in the mid lands (27.8%). The variation was seen on the labor work as an alternative job was common in mid and low land areas. The farming system was mixed type with 100% in the low lands and 83.3% in both the highland and mid lands, with no significant difference ($p > 0.05$) was observed among them. Farming was the primary job of household heads in almost all AEZs in above 90% of the respondents, each.

In the highlands, the lack of rangeland enforced farmers to hold small number of animals and they were, relatively, business oriented. Whereas, in the mid and low lands, the trend of, the size of animals, increased as the availability of range land was obvious to increase. Adaptation and suitability to AEZs created variation, in species possession difference, so that the availability of horses, oxen and sheep were mainly common in the highlands and mid lands than the low lands, and the possession of goats donkeys and cows was significantly the highest ($p < 0.05$) in the lowlands than the rest. The species availability variation could, mainly, be due to the availability of range land in the low lands, the use of draft for ploughing in the highlands and climatic condition (temperature). The common experience of ownership of animals was mutual between husband and wife under, married status in all AEZs. As far as, rural small holder farming is concerned, source of sheep was mainly from own farm. Husband domination in farming activities such as, to buy and sell the fattened sheep, and housing, was mainly influenced by the social culture towards gender discrimination in job classification. Therefore, the fate of female was mainly restricted in cleaning, watering and some house activities. Children in family have the obvious role of herding above 90% of the respondents, and the involvement of children on farming was highest in the lowlands than the rest. This was due to, mainly the grazing culture of the areas.

Table 4.3. Sheep ownership of respondents

Respondents Characteristics		Mean ± MSD						P-value
		N	Highland	N	Midland	N	Lowland	
Year of experience		36	7.78± 0.91	36	6.31± 0.45	36	34.5± 1.64	0.01
Sheep owned		36	12.17± 1	36	9.78± 0.71	36	7.61± 0.66	0.001
< 6 months	Male	36	2.17±0.41	36	0.5±0.14	36	0.47±0.24	0.0001
	Female	36	0.97± 0.18	36	0.72± 0.15	36	0.17± 0.06	0.0001
6-9 months	Male	36	2.00± 0.33	36	0.67±0.14	36	1.00±0.59	0.052
	Female	36	0.56±0.14	36	0.14±0.07	36	1.84±1.11	0.17
9-12 months	Male	36	2.03±0.33	36	2.78±0.24	36	2.06±0.28	0.12
	Female	36	0.69±0.19	36	0.22±0.09	36	0.31±0.13	0.053
12-24 months	Male	36	0.92± 0.19	36	1.75± 0.27	36	1.28± 0.26	0.06
	Female	36	1.14+.23	36	0.78+.14	36	0.72± 0.14	0.19
>24 months	Male	36	0.31± 0.18	36	0.06±0.04	36	0.22±0.098	0.06
	Female	36	1.58± 0.34	36	2.56± 0.33	36	1.61± 0.2	0.032

The purpose of sheep fattening was mainly for sale in the highland areas. In the other AEZs, it was traditionally linked with other activities such as slaughtering of well fattened sheep for religious and cultural ceremonies, in places where there was no banking system, use them as saving mechanism, besides, the lowland has been vulnerable to drought and that occurrence was mainly the lack of feed (due to poor soil moisture), intermittent rain and high evapotranspiration would increase the risk of mortality, as a result small ruminants have been used as an insurance against crop failure and death of large ruminants. In the mid land and low lands, the diversity of the purpose of fattening increases, as an altitude of AEZ decreases, respectively. The purpose of sheep fattening to exchange for cattle was common in the highlands than the rest AEZs. This was an indication of the lack of capital of the fatteners in the feed potential area. Fatteners prefer to fatten large ruminants than small ruminants in areas where high feed resource available, good market demand and good road accessibility.

Fattening was an important source of income, and it had additional benefits, mainly of dung and wool, with promising trend. Family experience and advice by friends were the two common driving forces that encouraged farmers to get involved into fattening business. Duration of fattening depends mainly on the availability of feed and market in the study areas and majority in the midland and lowlands, the respondents were not regularly fattening

in cycling and duration. While in the low lands, duration of fattening was limited by market day. This could mainly be due to the traditional way of fattening in the low lands which was mainly based on grazing. Land possession in individual level, in the mid and low land could relatively be larger but the potential was lower. The result of the data might not give the real picture of the respondents' land possession. This could mainly be from the fear of exposure to extra land revenue. Housing for fattening sheep differs among AEZs and this could be due to the climate difference and resource availability for house construction. In the highlands the housing was based on wood, mad and with a window. In the mid land majority have partially stone built houses and in the low land the animals were kept along with other animals and the housing system also constructed mainly on partially built open sided shade roof with wood and straw. In some places in the highland and mid lands, corrugated iron was also used. Feeding the animals was responsibility of the households but mainly of husband and wife and similar response was among AEZs.

At small holder fattening in rural areas, labor hiring is not common practice. But in the lowlands, there was a monthly salary for a shepherd during grazing seasons. One hundred birr per family was the familiar salary offered for grazing small ruminants per month. Labor scarcity occurred during summer and spring seasons for the field work was common practice of all farmers, students as well as wives in all AEZs. This happened due to the labor demanding work in the field of every farmer. The subsector also provides year round employment for a significant part of the rural population, which would perhaps remain unemployed otherwise (MEDaC, 1999). Availability of tap water and electricity is almost related to road accessibility. The more the areas away from road the less available the tap water availability. Watering trough was mainly made of Plastic Jerrica in all zones but there were also metal buckets in hot areas to accelerate them as coolers. The advantages of using Jerrica was its light weight and its availability at fair price and in lowlands, it resists corrosion unlike metal but easily pierced and broken and easily kicked by an animal. Road accessibility was available in areas where there was a concentrated fattening farmer which was in highlands. Whereas, in the mid and low lands the road accessibility was poor and farmers were complaining to have road access for better market opportunity.

Table 4.3. Fattening cycles among AEZs.

AEZs		Mean $\pm$ MSE	
		Cycles of fattening	Fattening per cycle
Highland	36	2.097$\pm$0.56	4.486$\pm$0.1006
Mid Land	36	1.583$\pm$.0833	5.111$\pm$0.1632
Low land	36	1.194$\pm$0.0669	5.681$\pm$0.1038
Total	108	1.625$\pm$0.0539	5.093$\pm$0.0861

The average water availability was 1 kms in the highlands and higher in the other AEZs. The lowest distance in the highlands could be due to the water demand and scarcity in hot areas, than the cold areas (highlands). Except watering and housing were dominated by female and male, respectively, other farm activities were mostly done by all family members.

4.2. Features of the sheep used for fattening

It is rare to use sheep used for fattening from the market only since there were no commercial fatteners among respondents. The breed of sheep for fattening was mostly local breeds in which farmers do have their own words for it. Their preference to the breed was mingled with individual performance of the sheep. But in the midland areas, introduced breeds of farta by ministry of agriculture made a change to have mixed breed which had better performance than the local breeds. Whereas, the other AEZs have local breeds of their own which were highly preferred by fatteners as well as consumers and this was a perception from "I like what I know". The dominant perception of farmers in using aged animals for fattening was mainly derived from the perception of fattening in large proportion along with the deposition of fat. And in the bought animals for fattening, they are available in the market with cheap price, for a reason of culling.

In most cases, farmers were not familiar with SI units and were reluctant to give an estimated initial weight but among the responded, the average weight was less than 20kg. And the reason for preferring less than 20kg weight was simply to have gain weight fast was the dominant answer. Almost all farmers (99%) in all AEZs fatten different breeds, different sexes and different weights at the same time. Number of animals fattened per cycle for weaners and male sheep up to 12- 15 in number were the dominant among other age stratum.

Weight of sheep for weaners was less than 16 kg and less than 20 kg. Male were the dominant among them.

There were common factors like the lack of money, labor and market which were dominant in all AEZs that hindered sheep fattening production. In the lowlands, water was the most critical constraint that hindered sheep fattening, as sheep were not tolerant to thirst followed by feed shortage. Almost all the respondents above 90% in both the high land and mid land use castration prior to fattening except in some areas of the lowland (80%). In some parts of the low lands, no access of health centers or covers large areas. The reason for castration was mainly for better ADG and to make the sheep docile or either of them.

4.3. Feeding strategy and feed availability

Hay is the staple feed that is used in all AEZs with no significant difference ($p>0.05$). The use of industrial by-products such as wheat bran are used only in the mid land area though there is no significant difference ($p< 0.05$) from the other AEZs.

Lowlanders where known for their grazing dependence. It has been a recent experience due to lack of range land that farmers used to preserve post-harvest by products. In the study 100% of the respondents in all AEZs preserve hay as a staple. Wheat bran also is available around the cities in the highlands but fatteners in the rural highlands were not the beneficiaries of the products even in the mid lands. The only users of it were the lowlanders. This could mainly be due to the other feed shortage in the area especially dry season. No green feed is available, like the other ecological zones.

Table 4.4. Stover staple feed in different AEZs of Amhara.

Agro-ecology		Crop residue name		
		Sorghum Stover	Wheat Stover	Total
Highland	N	0[a]	36[b]	36
	% within AEZ	0%	100%	100%
Mid land	N	20[a]	16[a]	36
	% within AEZ	55.6%	44.4%	100%
Low land	N	36[a]	0[b]	36
	% within AEZ	100%	0%	100%

Subscripts with the same letter denote that there is no sig. difference at 0.05 level.

Barley Stover is the common crop residue in the highlands and is highly significant (p < 0.05) in availability and usage which is 85.7% of the total feeds (sorghum husk and sorghum stover) than the rest of AEZs. In the low lands there is barley stover and sorghum stover difference (p < 0.05).

Almost all fatteners graze (95%) their animals except in the highlands in which feed availability were better. In the highlands, better accessibility of feed was present including industrial by-products in the market. In the low lands the feed accessibility was mainly limited by the low production of the land. But experiences up to date show that collective action for communal grazing land management can contribute to the sustainable use of the resources (Berhanu Gebremedhin *et al.,* 2004). Curbing the free and uncontrolled grazing system, and introducing improved forage species, and cut and carry systems are other potential options that could contribute to the alleviation of the feed shortage problem, especially in the highlands of the country. As a result the farm by products, mainly sorghum stalk, husk and rangeland were the main feed bases. The major feed resources in the country are crop residues and natural pasture, with agro-industrial by-products and manufactured feed contributing much less (Berhanu Gebremedhin *et al.*, 2009). The source of feed in rural small holder fatteners was mainly from their own farm. Zinash and Seyoum (1991) reported that about 70% of crop residues in the highlands are used as animal feed. In the lowlands of the country natural pasture is the major source of feed. There are no reliable estimates of the animal feed resources in Ethiopia (EARO 2003). Different defense mechanisms were taken to tackle the feed shortage of feed and the common experience was feed conservation in advance. Above 99% of this mechanism was common in all AEZs. In the highlands, about 80% of the respondents had the experience of using concentrates (industrial byproducts and legumes leftovers). In non-conventional feeds, almost 99% of the farmers use *Attela* of *tella*, in all AEZs. *Atella* of liquors is specific concentrate to the highlands; it is about 75% of the respondents use on it. The reason for peculiarity of *Attela* of liquor was due to the potential of the area in cereals such barley. It was purchased for 5 birr per Jerrica. The common experience in almost all (99%) of the respondents in all AEZs was that they used home food leftovers as a concentrate for their animals. In finalizing fattening the common experience of fatteners was to fulfill the demand of the consumer. But the knowledge of identifying the actual weight of the fattened sheep had no determined mechanism except guessing or estimation. An exaggerated age above 36 months could be regarded as fatigue meat by consumer. Therefore, age also had remarkable amount (40%) of the respondents.

Table 4.3. The use of bran as an animal feed for fattening in AEZs.

AEZ		By-product concentrate name				Total
		No bran	Any bran	Millet bran	Wheat bran	
Highland	N	0^a	0^a	0^a	36^b	36
	%within AEZ	0%	0%	0%	100%	100%
Mid land	N	1^a	34^a	1^a	0^b	36
	%within AEZ	2.8%	94.4%	2.8%	0%	100%
Low land	N	$0^{a,b}$	36^b	$0^{a,b}$	0^a	36
	%within AEZ	0%	100%	0%	0%	100%

Subscripts with the same letter denote that there is no sig. difference at 0.05 level.

More than 90% of the respondents had the ability to guess the fattening practice limiting the months of fattening. Since the initial fattening age was common among AEZs, the determined month of fattening also additional experience among AEZs holding above 90 % of the respondents.

Table 4.4. Crop residues as an input in all AEZs.

AEZ		crop residue			
		Barley stover	sorghum husk	sorghum stover	Total
Highland	N	36_a	0_b	0_b	36
	% within AEZ	100.0%	0.0%	0.0%	100.0%
Midland	N	0_a	$0_{a,b}$	36_b	36
	% within AEZ	0.0%	0.0%	100.0%	100.0%
Lowland	N				
	% within AEZ				

Finally, the fattened animal would have market value difference among AEZs. The highest price valued at highlands reached up to 3000 birr. In the mid land from 2000-2500, whereas, in the low lands 2000 and less. Husband was the dominant (99%) decision maker in almost all the activities mentioned and this was common occurrence among all AEZs. This had cultural and natural values endowed experience.

Table 4.8. Non-conventional feed usage

AEZ		Nonconventional feed		Total (%)
		No usage	*Attelaareqie*	
Highland	N	36	36	36
	% within AEZ	0%	100%	100
Midland	N	0	36	100
	% within AEZ	0%	100%	100
Lowland	N	15	21	36
	% within AEZ	41.7%	59.3%	100

4.4. Health, market and economics of sheep fattening

The effect of agro- ecology caused the differences in disease occurrence was accountable. Based on the respondents' observation and experiences, considerable amount of loss and threat has been accompanying the fattening practice though the distribution of clinics, availability of skilled man power and drugs are in access better than before.

The main constraints in sheep fattening prioritized by the selected respondents were explained in Table 6 below. The most challenging parameter in the highlands was disease by about 44.4%. In the mid lands the foremost challenging among constraints was market problem. Whereas, in the lowlands the most challenging was road accessibility. In an overall choice road accessibility was the most preferred among the constraints.

Table 4.5. Challenges in sheep fattening.

Challenges	%	AEZs						Total%	Rank
		High land%	R1	Mid land %	R2	Low land%	R3		
Feed	AEZ	13.9	3	33.3	2	2.8	2	16.7	3
Labour	AEZ	2.8	5	0.0	5	0.0	3	0.9	5
Water	AEZ	5.6	4	0.0		0.0	3	1.9	4
Market	AEZ	16.7	2	36.1	1	0.0	3	17.6	2
Disease	AEZ	44.4	1	5.6	4	0.0	3	16.7	3
Road	AEZ	16.7	2	25.0	3	97.2	1	46.3	1

Though there is no significant difference (p<0.05) in the net price among sheep fatteners in the AEZs, the highest net income was achieved in the highlands (1138.81±46.401). The profit achieved in the highlands was mainly due to the short fattening duration and three cycles per year's fattening practice. Market access and feed availability in the area also increased the net profit of the fatteners in a way that different abattoirs, butcher men and restaurants created a continuous market demand with a low priced feed. Whereas, in the mid and low lands, fattening related business had a market demand problem beyond the lack of natural resources availability and the concentration of human population was lower than the highland areas. The concentration of feed processing industries in the urban highlands also had an impact in providing feed to landless youth fatteners.

Table 4. 6. Net profit of sheep at the end of fattening.

AEZs	N	Mean± SE of net profit
Highland	36	1138.81±46.401
Mid land	36	793.14±65.356
Low land	36	803.61±63.499

The additional opportunity of utilizing wool in the highlands was not part of the respondents. Though the sheep breeds had wool and there was blanket industry in Debre Birhan, no single respondent had the clue to use of it as a by-product. Generally, the study is in line with the study by Gebremedhin *et al.* (2007) that the problems in livestock sector are compounded by inefficiencies in the input (feed, genetic material and veterinary services) and output (livestock and livestock products) marketing, including poor market infrastructure, lack of marketing support services and limited market information. And free grazing feeding scheme with a limited quantity of supplementary feed also the recommended practice to be studied in the rural smallholder sheep fattening system by Miklyaev and Jenkins (2012).

Chapter 5. CONCLUSION AND RECOMMENDATION

From the above results, it can be concluded that the small holder fattening practice in Amhara region of three different agro-ecological zones (AEZs) had shown significant differences (p < 0.05) in majority of the parameters. The most suitable AEZ, in terms of the cumulative result of the parameters, was the highland area, which had better input and output

results than the rest. The concentration of the population in the highlands had also created suitable market demand and created pressure over the distribution of infrastructure.

The sheep fattening production system of the highlands has a semi intensive production system in which fatteners solely produce for market purpose and the fattening system were relatively commercialized. Whereas, in the low lands and mid lands the production system were mainly based on grazing and was not market oriented. This was mainly due to the distant market places, water points as well as grazing areas that lead the sheep to emaciation and develop poor quality meat.

As far as the nature of the three AEZs has been suitable for sheep fattening production, fulfilling the prioritized demand of the fatteners would enable them as profitable as that of the highland. Like market chains, distribution of industrial by-products, minimizing water point and range land distance, provision of medicine (quality as well as quantity) and promotion of loans supported with agricultural inputs would encourage the small holder farmers to engage in sheep fattening consistently.

The AEZ differences, inevitably, create natural difference therefore improved breed of sheep should also be selected as per the ecology so that better utilization could be achieved.

System of production should also be modified according to the availability of the resources based on AEZs that in the low lands, grazing and its management should be encouraged.

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Appendix

Appendix 1. Educational level of respondents in different AEZs.

AEZs		Educ Level					Educ Level
		Illiterate	Informal	Primary	Secondary	Collage	
Highland	Count	9_a	$9_{a,\,b}$	16_b	$2_{a,\,b}$	$0_{a,\,b}$	36
	% within AEZ	25.0%	25.0%	44.4%	5.6%	0.0%	100.0%
Mid land	Count	4_a	8_a	20_a	4_a	0_a	36
	% within AEZ	11.1%	22.2%	55.6%	11.1%	0.0%	100.0%
Low land	Count	4_a	5_a	23_a	3_a	1_a	36
	% within AEZ	11.1%	13.9%	63.9%	8.3%	2.8%	100.0%

Each subscript letter denotes a subset of educ. Level categories whose column proportions do not differ significantly from each other at the .05 level.

Appendix 2. Marketing related sheep fattening data based on agro ecology.

Parameter	High land	value	Mid land	value	Low land	value	P value
Local market dist.	1 km	50%	1 km	30.6%	10km	27.8%	Sig.
Sold price	2000	55.6%	1500	50%	1500	94.4%	Sig.
Who sales sheep	Husband	94.4%	Husband	100%	Husband	94.4%	N.S.
Transportation	Trekking	83.3%	Trekking	97.2%	Trekking	100%	N.S.
Market info source	Market day	86.1%	Market day	91.7%	Market day	%	N.S.
Local market dist.	1 km	50%	1 km	30.6%	10km	27.8%	Sig.
Sold price	2000	55.6%	1500	50%	1500	94.4%	Sig.
Who sales sheep	Husband	94.4%	Husband	100%	Husband	94.4%	N.S.
Transportation	Trekking	83.3%	Trekking	97.2%	Trekking	100%	N.S.
Market info source	Market day	86.1%	Market day	91.7%	Market day	%	N.S.
Local market dist.	1 km	50%	1 km	30.6%	10km	27.8%	Sig.

Appendix 3. Farming resources analyzed data based on AEZs.

Parameter	Highland	value	Midland	value	Lowland	value	P- level (0.05%)
Sheep owned	Husband & wife	83.3%	Husband & wife	94.4%	Husband & wife	94.4%	0.047
Income % (fattening)	30% income	22%	31.6% income	22%	21% income	58.3%	0.006
Who purchases	Husband	88.9%	Husband	94.4%	Husband	94.4%	0.311
Land possession	8 timad	30.6%	8 timad	22.2%	4 timad	11.1%	0.001
Land less	0	30.6%	0	47.2%	0	86.1%	-
Grazing land	1 hectare	19.4 %	1 hectare	16.7	0	100%	0.011
Place of animals	Separate room	72.2%	Separate room	91.7%	Separate room	94.4%	0.033
Shed Ownership	Owned	97.2%	Owned	100%	Owned	100%	0.364
Windows	One	72.2%	One	91.7%	One	97.2%	0.022
Wall material	Wood	58.3%	Wood	75%	Wood	94.4%	0.033
Roof material	Wood	55.6%	Wood	77.8%	Wood	97.2%	0.001
Shed's floor	Mud	58.3%	Mud	97.2%	Mud	97.2%	0.001
Dung collection	Seven	77.8%	Seven	80.6%	Seven	94.4%	0.16
looks after fattening sheep	Husband	47.2%	Husband	52.8%	Husband	88.9%	Sig.
Purchase, feed	Husband	72.2%	Husband	63.9%	Husband	86.1%	N.S
Who feeds	Husband	50%	Husband	50%	Husband	86.1%	N.S
Health care	Husband	41.7%	Husband	50%	Husband	80.6%	Sig.
Clean shed	Husband	30.6%	Husband	47.2%	Husband	77.8%	Sig.
Months with labor shortage	Summer and Autumn	52.8%	Summer and Autumn	100%	Summer and Autumn	100%	Sig.
Watering trough	Plastic	77.8%	Plastic	97.2	Plastic	97.2%	Sig.
Road Access	Poor	72.2%	Poor	97.2%	Poor	100%	Sig.

Electricity	No	58.3%	No	97.2%	No	97.2%	Sig.
Cleaning activity	All family	22.2%	All family	22.2%	All family	25%	Sig.
Housing	Husband & boy	27.8%	Wife, boy, girl	30.6%	Husband &boy	30.6%	Sig.
Source of sheep	Owned & purchase	47.2%	Owned & purchase	58.3%	Owned & purchase	83.3%	N.S.
Breed	Pure	86.1%	Pure & mixed	52.8%	Pure & mixed	69.4%	Sig.
Fattening duration	24	97.2%	24	86.1%	24	97.2	N.S.
Herding activity	All family	25%	Husband & wife	25%	Both	25% (each)	0.001
Cleaning activity	All family	22.2%	Wife, son, labor	30.6%	Wife, son daughter	27.8%	0.003
Watering	wife	27.8%	Wife, son others	30.6%	Wife; Wife, son & dough.	27.8%	0.001
Housing activity	Husband & son	27.8%	Wife , son,	30.6%	Husband, son	30.6%	0.001

Appendix 4. Health related data on sheep fattening at different AEZs.

Parameters	Highland	Mid land	Low land	P value
Pneumonia	99%	80%	60%	
Foot and mouth soar	70%	70%	70%	-
Skin disease	50%	40%	25%	--
Heart water	30%	5%	0	
Anthrax	40%	15%	5%	-
Source of health info.	No response (60%)	No response (75.7 %)	No response (97.2%)	Sig.
Vet. service	Govt clinic (71.4%)	Govt clinic (91.9%)	Govt clinic (100%)	Sig.
Distance from vet.	1 km (54.3%)	1 km (51.4%)	1 km (55.6%)	N.S
Responsible to sick	1(45.7%)	1(73%)	1(91.7%)	Sig.
Therapy used	Yes (54.3%)	Yes (78.4%)	Yes (100%)	Sig.
Drug effectiveness	Yes (91.4%)	Yes (89.2%)	Yes (100%)	N.S.
Death of animals	No (85.7%)	No (94.6%)	No (100%)	Sig.
Vaccination usage	Yes (94.3%)	Yes (100%)	Yes (97.2%)	N.S.

Appendix 5.Trend of sheep fattening at different AEZs.

Parameter	High land	Mid land	Low land	p-value
N of Sheep initially	2 (63.9%)	2 (83.3%)	2 (83.3%)	N.S.
Currently fattening	6 (22.2%)	4 (27.8%)	3 (30.6%)	-
Trend in 5 years	Increasing (88.9%)	Increasing (94.4%)	Increasing (100%)	N.S.
Suggested ways	Treatment (27.8%)	Water (25%)	Water (72.2%)	Sig.
If in cooperative	No (97%)	No (100%)	No (100%)	N.S.
Would you like to	No (83.3%)	No (97.2%)	No (100%)	Sig.
Government's contribution	Grazing (50%)	Grazing (86.1%)	Grazing (100%)	Sig.
If loan beneficiary	No (72.2%)	No (91.7%)	No (100%)	Sig.
Objective of loan	Fertilizer (70%)	Fertilizer (70%)	Fertilizer (%)	Sig.

Appendix 6. Livestock possession in different AEZs.

Livestock species		Agro-ecology		
		Highland	Midland	Lowland
		total (n=)	Total (n=)	total (n=)
Cattle	%	14.0		1.4
	number*	336		46
	ave./HH*	3.8		0.5
Sheep	%	33.5		1.7
	number*	804		55
	ave./HH*	9.1		0.6
Goat	%	35.9		74.1
	number*	861		2460
	ave./HH*	9.8		26.7
Equine	%	8.5		0.4
	number*	204		15
	ave./HH*	2.3		0.2
Camel	%	0		7.8
	number*	0		258
	ave./HH*	0		2.8
Chicken	%	8.2		14.6
	number*	196		486
	ave./HH*	9		2.7