
ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

INSTITUTE OF REGIONAL AND LOCAL DEVELOPMENT STUDIES

# ADOPTION OF FORAGE INNOVATION IN SMALLHOLDER FARMING SYSTEMS: A *CASE STUDY IN KALU WOREDA OF SOUTH WOLLO ZONE*, ETHIOPIA

YIMAM DAMTIE ALI

JUNE, 2008

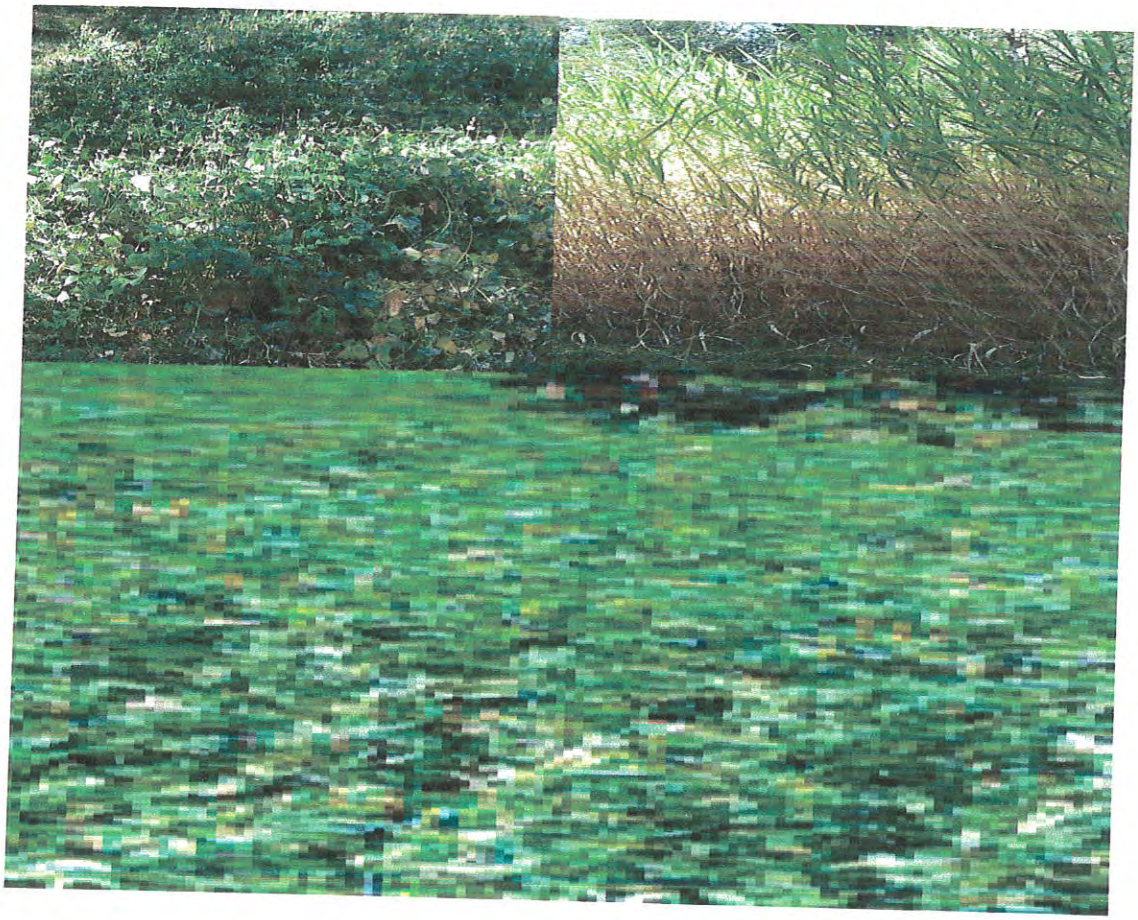
ADDIS ABABA

ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

INSTITUTE OF REGIONAL AND LOCAL DEVELOPMENT STUDIES

# ADOPTION OF FORAGE INNOVATION IN SMALLHOLDER FARMING SYSTEMS: A *CASE STUDY IN KALU WOREDA OF SOUTH WOLLO ZONE*, ETHIOPIA



YIMAM DAMTIE

JUNE, 2008

# ADDIS ABABA UNIVERSITY

## COLLEGE OF DEVELOPMENT STUDIES

## INSTITUTE OF REGIONAL AND LOCAL DEVELOPMENT STUDIES

**ADOPTION OF FORAGE INNOVATION IN SMALLHOLDER FARMING SYSTEMS: A *CASE STUDY IN KALU WOREDA OF SOUTH WOLLO ZONE*, ETHIOPIA**

**A Thesis Submitted to Institute of Regional and Local Development Studies of Addis Ababa University in Partial Fulfillment of the Requirement for the Degree of Master of Arts in Regional and Local Development Studies**

**BY**

**YIMAM DAMTIE ALI**

**Approved by**

| **Board of Examiners** | **Signature** |
|---|---|
| 1 Woldeab Teshome<br>**Chairperson** | |
| 2 **Dr. Workneh Negatu**<br>**Advisor** | |
| 3 **Dr. Belay Simane**<br>**External Examiner** | |
| 4 **Dr. Woldeamlak Bewket**<br>**Internal Examiner** | |

## TABLE OF CONTENTS

**Contents** **Pages**

# ACKNOWLEDGEMENT

Though the final errors, omissions and outcome rest on the author, numerous suggestions and comments have been taken into account in the process of writing this thesis. First and foremost, I would like to express my extreme gratitude and indebtedness to my thesis advisor Dr. Workneh Negatu. His guidance and support has nurtured me well in this undertaking and his frank suggestions and advices provided me with newly-opened avenues for independent thought and wisdom.

My sincere thanks go to staff members and development agents of *Kalu Woreda* Agriculture and Rural Development Offices for their provision of relevant information for the work and facilitating the data collection process. Mainly Ato Hussein Ibrahim, expert in the *Woreda* office, deserves appreciation for his cooperativeness in arranging the contacts with development agents.

Organizations and institutions who contribute for the successful completion of the work in one way or another, please I extended my unreserved gratitude to you all. Especially, the staff members in the libraries of Ethiopian Agricultural Research Organization and International Livestock Research Institute for allowing me to access their libraries and providing the relevant materials for the study.

I am highly indebted to my parents, sisters and brothers for their support throughout my entire life. I am very grateful to my friend Jemila Hassen for her support in writing the thesis and her encouragement in the overall step of my study. Sister Aregash Mengesha and Ato Abdu Ahmed, it was very difficult for me to finalize my study here in Addis Ababa University if your sisterly and brotherly guidance and support was not added.

Finally, I would like to thank all the farmers who have given me genuine and valuable information at the time of data collection.

# LIST OF TABLES

**Tables** **Pages**

## LIST OF BOXES



## LIST OF PICTURES



## LIST OF MAP



## LIST OF CHARTS



## FIGURES



## LIST OF ANNEXES

# ACRONYMS

| | |
|---|---|
| ADLI | Agricultural Development Led Industrialization |
| AEZ | Agro-Ecological Zone |
| AI | Artificial Insemination |
| CIMMYT | International Maize and Wheat Improvement Center |
| DAs | Development Agents |
| EARO | Ethiopian Agricultural Research Organization |
| EEA | Ethiopian Economic Association |
| FAO | Food and Agricultural Organization of the United Nation |
| FGDs | Focus Group Discussions |
| FSR | Farming System Research |
| GDP | Gross Domestic Product |
| Ha | Hectare |
| HHH | Household Head |
| HYVs | High Yielding Varieties |
| IAR | Institute of Agricultural Research |
| IFAD | International Fund for Agricultural Development |
| ILRI | International Livestock Research Institute |
| KAP | Knowledge, Attitude and Practice |
| KIDs | Key informant Discussions |
| KM | Kilo Meter |
| M.a.s.l | Meter above Sea Level |
| MDGs | Millennium Development Goals |
| MFIs | Micro-Finance Institutions |
| MoFED | Ministry of Finance and Economic Development |
| NARS | Ethiopian National Agricultural Research System |
| NGOs | Non-Government Organizations |
| PA | Peasant Associations |
| PADETES | Participatory Demonstration and Training System |
| PLA | Participatory Learning and Action |
| PRA | Participatory Rural Appraisal |
| SD | Standard Deviation |
| Sig | Significance |
| SPSS | Statistical Package for Social Scientists |
| TLU | Tropical Livestock Unit |
| WOAgRD | *Woreda* Office of Agriculture and Rural Development |
| $X^2$ | Chi-square |

# *GLOSSARY*

| | |
|---|---|
| ***Belg*** | Minor season for crop production which gets from rain January to March |
| ***Birr*** | Ethiopia currency (9.50 birr = 1USD, February, 2008) |
| ***Chat*** | *Chata edulis,* a kind of tree with green stimulant leaves and used as cash crop |
| ***Debbo*** | Labor arrangement where other community members assist a household for free with only food and drinks |
| ***Dega*** | Highland agro-climate condition |
| ***Iddir*** | Local institution where the community members have common norms and regulations, and is particularly for funeral ceremony |
| ***Karmiya*** | By-products left in farm lands after major crops are collected |
| ***Kebele*** | Peasant association, lowest administrative unit |
| ***Kolla*** | Lowland agro-climate condition |
| ***Meher*** | Major season for crop production which gets rain from end of June to half of September |
| ***Mu'ateto*** | Weeds gathered from major crop land which over planted to be used as feed for animals |
| ***Teff*** | *Cragostis tef,* a cereal, traditionally grown in Ethiopia used as major component of *enjera* ( a kind of large cake used as major food in country) |
| ***Timad*** | Unit of measurement for land where 1 timad is 0.25 hectare |
| ***Woreda*** | District, lower government administration unit |
| ***Woyna Dega*** | Middle agro-climate condition |
| ***Yewber sar*** | Grasses at or in the boundaries of farm lands used as grazing land |
| ***Yigashibal*** | Vegetative nature of herb legumes and grasses |

ABSRACT

*Livestock development and production is constrained and challenged by recurrent feed shortage. Forage innovation is proposed to minimize feed shortage for the livestock sector and it is also recommended to control soil erosion and land degradation. Even if the level of adoption is limited, the introduction of the innovation is not a recent phenomenon in the country. The main emphasis of this study is to assess major feed resources and to identify determinant factors, constraints and challenges of adoption of forage innovation in smallholder farming systems. Kalu is one of the districts where smallholder farming system is practiced. It is one of the 15 administrative districts in South Wollo Zone of Amhara Regional State.*

*In the study, analysis was made using primary data collected from 120 sample households selected through systematic random sampling from purposively selected six Kebeles. Structured questionnaire was used to collect data. The data collected from the sample households using structured questionnaire was supplemented by data collected from key informants and focus group discussants. Descriptive statistics and statistical analysis (chi-square and t-tests) were used to describe the sample households' socio- economic, institutional and adoption characteristics; and to test statistical significance of variables that influence the households' adoption decisions. In addition to the statistical tests a logit model was employed to identify determinant factors in adoption of forage innovation.*

*The major feed resources identified were crop residues, weeds, aftermath and grazing pastures. The smallholders manage and control feed resources through collecting and piling crop residues and hays.*

*Forage adoption is started 25 years before in the district. The land allocated and the priority given to grow forage species is limited. The adoption decision is mainly constrained and challenged by uncontrolled grazing and water shortage. Labor shortage, land shortage, literacy level, market access, credit delivery, and forage seed have limited impact to challenge and constrain adoption of forage innovation.*

*The logit result shows that from different factors hypothesized to determine adoption of forage innovation, dairy production, beef fattening, contact with extension agents, forage related training, inviting farmers to grow forage species, distance from towns, water and free grazing are found to be significant. The use of cross-bred cows in the dairy production activities has positive and determinant effect on adoption of the technology so that the shift to improved- bred should be a sustainable endeavor. The result also has implication for policy makers, researchers, policy implementers and non- governmental agencies to take their parts in minimizing the constraints and in enhancing the potential for adoption of forage innovation so that the productivity of the livestock sector is increasing.*

# 1. INTRODUCTION

## 1.1 BACKGROUND

Ethiopia, one of the largest populated countries in Africa, is expected to have a human population of about 130 million by the year 2030 (Alemneh, 2003). It is reported that of the total population in the country, 85 percent lives in the rural areas mainly engaged in the agricultural sector. Agriculture remains the mainstay of the country's economy. It contributes 46 percent to gross domestic product (GDP) and 85 percent to export commodities; it also supports the agriculture-based industrial sectors, which encompasses about 70 percent of large and medium scale industries (Setotaw, 2007).

Livestock is an important sector of agriculture in Ethiopia. Ethiopia has the largest livestock population in Africa. The livestock sub sector contributes about 18 percent to the total gross domestic product, 40 percent of the agricultural GDP and 19 percent of the national export earnings (Setotaw, 2007). Moreover, the sector contributes a lot in the manure production, fuel for fire, means of transportation and animal traction particularly in the rural part of the country, which is often very difficult to include these contributions to the total GDP. Although the livestock sector of Ethiopia is great in size with significant potential contribution to economic and social development and growth, its current contribution is much below expectation and fails to meet the demand for livestock services and products.

In a country which follows agricultural development-led industrialization (ADLI) strategy, contribution of the livestock sector can be enhanced through livestock development. The Ethiopia's five year plan (2005/06-2009/10) of accelerated and sustained development to end poverty has depicted that during the plan period, total meat production is projected to be increased by 48 per cent (from 566,000 ton in 2005/06 to 837,000

ton in 2009/10) while the production of milk is projected to be increased by 85 percent from 1,831,000 to 3,391,000 ton during the same period (MoFED, 2006)

In the development endeavor of the livestock production technological innovation is one of the crucial issues. Innovation conceptually improves production and consumption in order to satisfy the human needs. Innovation leads to change in aggregate level of production and consumption through a combination of factors of production. The change can be expressed both in terms of quality and quantity measurements. Accordingly Rogers (1962) in Gezahegn (1999) considered innovation as any idea perceived by the potential adopters as new. Basically, in Ethiopia agricultural innovation was made in 1953 when the college of agriculture was established at Alemaya and took over the national responsibility of research ,training and extension (Gezahegn,1999; EEA, 2005).The period onwards, innovation trials have been conducted by different institutions on crop production, livestock production and forestry development among others.

Forage development and production is one of the agricultural innovations in Ethiopia with the aim of improving the feed problems of cattle, small ruminants, equines and camels. The strategic plan of the country has given due emphasis to animal feed and it is identified that animal feed is one of the inputs that ranks top in determining livestock production. During the plan period, various strategies such as forage production and supply, expansion of improved pasture, improvement of crop residues are considered to address the problem of feed availability and quality (MoFED, 2006).

Generally, for a sector which dominates the livelihood and day to day affairs of the majority of the population of a nation, improvement in the productivity arena through improved systems and technologies is essential. It is expounded that the agricultural sector is the dominant sector in Ethiopia where the majority lives in the

rural parts. Hence, it is this sector which absolutely demanding changes in the production system. The improvement may not be started at a single shot rather the components of the sector are to be supplied with the case wise improved technologies. The livestock sector, one of the basic sub sectors in agriculture, has to be changed so that the productivity enhanced over periods. No doubt the sub sector encompasses lots of subclasses which the improvement of one may induce change in the other. Among the improvements critically essential in the livestock sector is the feed resource for the livestock population so that forage innovations are the quest of the time.

*Kalu*, the study *Woreda* /District is one of the districts in which smallholder farming systems is dominant. Mixed (crop-livestock) farming system is operating by the smallholder farmers. Feed shortage is one of the major constraints in the livestock production sector. Forage technology dissemination has been started 25 years before with the then dairy production cooperatives (WOAgRD, personal contact). And yet the adoption and sustainable growing of the technology requires more to be done and identifying the factors that constrain the adoption decisions is important.

## 1.2. PROBLEM STATEMENT AND JUSTIFICATION

The significant part of farming systems Ethiopia uses natural pasture as sources of feed. It is estimated that about 90 percent of the total animal feed is obtained from unimproved pasture, range lands and fallow (AACM, 1984: a in Tilahun, 1995). Crop residues and byproducts of agricultural processing are also identified as assuming increasing importance in many densely- populated areas of Ethiopian highlands (Tilahun *et al.*, 2005).

Alemneh (2003) after stating past efforts in the livestock production improvement as focusing on promoting veterinary services which is important, emphasized that the major factor resulting in low productivity of Ethiopian livestock sector is the serious shortage of feed. He added that livestock feed is mainly depended on natural pastures that are low yielding; and these grazing areas are shrinking due to the expansion of cultivated lands.

For sustainable livestock and crop production in Ethiopia, dynamic change is required in the livestock management systems. The key components of these changes are shift towards more intensive and improved feeding systems, which encompass cut-and-carry feeding, and a gradual shift away from uncontrolled grazing (Alemayehu, 1997). The use of forage innovations particularly, woody leguminous species in agro-forestry, as alley cropping or coppice browse is one of the key element to establishing sustainable agricultural system in the country. It is also identified that improved livestock feed and forage production is crucial for both food security and prevention of natural resource degradation (Alemneh, 2003). Moreover, the intensive use of forage innovations and conservation of the output is fundamental in alleviating the shortage of animal feed in the long dry seasons of the country.

The introduction of forage technologies is not the recent phenomenon in Ethiopia. It lasts at least for decades. National and international agencies such as the International Livestock Research Institute (ILRI) have developed several feed production and utilization technologies and strategies to address the problems of inadequate supply and poor quality of feeds (Gebremedhin *et al.*, 2003). Among the most notable government strategies regarding livestock improvement, the National Livestock Development Programme (NLDP) can also be mentioned. NLDP consolidates and expands the result obtained from the Fourth Livestock Development Project, particularly in the area of forage development and seed production that are

suitable to local conditions (NLDP, 1997 in Alemneh, 2003). The programme has come up with modified forage development strategies for different agro- ecological zones and farming systems that could also be used by other development agencies involved in natural resource management.

The adoption of these technologies, however, is low and reported as slow in its progress. For example, according to Gebremedhin *et al.* (2003), despite evidences of high returns where the technologies have been extended by extension and development agencies, the level of adoption of the technologies has been slow. Moreover, most of the studies (Alemayehu, 1997; Giller, 2001; Alemneh, 2003; Peters and Lascano, 2003 in Mapiye *et al.*, 2006) concentrated on forage species diversity development; and benefits of the technology to livestock production improvement and to minimize natural resource degradation. Limited investigations (Darnhofer, 1997; Gebremedihin *et al.*, 2003)) are conducted to assess the level of adoption of the technology and to identify factors that influence the adoption of forage innovations in the country. These studies on the production of specified forage species and factors that affect the adoption decisions gave emphasis to areas where dairy production is intensified and regional research institutions are adjacent. Hence, the most used sources and evidences to see the limitedness of level of adoption of the technology remained at report levels; particularly in the *Woreda* Offices of Agriculture and Rural Development, which lack detail investigations of the factors that determine the adoption decisions. Above all, the factors that affect the adoption of the technology may differ based on the socio- economic, institutional and biophysical conditions of each agro-ecological zone. Therefore, these facts call for investigations to identify the factors that constrain or enhance adoption decision; and assess the state of adoption of the technology in the development endeavor of *Kalu Woreda*.

## 1.3. RESEARCH OBJECTIVES AND HYPOTHESIS

### 1. 3.1. Objective

#### 1.3.1.1. General objective

The overall aim of this study is to identify determinant factors, constraints and challenges of forage technology adoption in smallholder farming systems.

#### 1.3.1.2. Specific objectives

The specific objectives of the study are:

- To assess major feed resources and feed resource management practices used by the smallholder farmers.
- To assess the state of forage innovation development and use in *Kalu Woreda*.
- To identify the factors affecting the adoption of forage technology.
- To investigate constraints and challenges of forage development and production in the smallholder farming systems.

### 1.3.2. Hypothesis

It is obvious that technological innovations in the resource scarce world are indispensable. The development and food self - sufficiency actions of nations, especially agriculture-based developing countries require agricultural innovations. It is also expected that diffusion and adoption of technology in the right path is essential which actually is not an easy task. It will be challenged by a lot of related, combined or individual factors. With regard to growing of forage innovations, the hypothesis can be stated as follows.

Socio-economic, institutional and biophysical factors affect the adoption of forage innovation in *Kalu Woreda*.

## 1.4 SIGNIFICANCE OF THE STUDY

Forage innovation is not a new phenomenon in Ethiopia. The technology lasts for decades. But its adoption is very limited at national level so that it demands investigations to find out the major constraints and challenges in the adoption process. Hence, the outcome of this study will help researchers, policy makers, and policy implementers to be enriched with the prevailing information about the states of adoption of forage technology. Moreover, it is supposed to find out factors affecting the adoption of the technology in smallholder farms for which policy promotions are to be undertaken by concerned bodies, such as *Woreda* experts, DAs, NGOs, regional bureaus, and other governmental agencies.

## 1.5 SCOPE OF THE STUDY

This study is conducted on adoption of forage innovation in smallholder farming systems. It is to identify major feed resources and to assess the state of adoption of forage innovation. Factors and constraints that influence the adoption decision are the major areas of emphasis.

## 1.6 LIMITATION OF THE STUDY

Some farmers were not able to identify land allocated to forage production. This hampered the need to see the intensity of adoption based on land allocated to the technology as a ratio of total land available.

Financial constraints forced the data collection procedures to be based on only six selected *Kebeles*.

## 1.7 ORGANIZATION OF THE THESIS

The thesis is organized into six chapters. The first chapter is introduction which has six subsections. Background, problem statement, objectives, research question and hypothesis, significance of the study, the scope of the study, and limitation of the study are part of the introduction section. Chapter two holds the review of related literatures and conceptual framework. The Third chapter is about description of the study

area. Chapter four describes the methodology in which model specification and definition of variables are included. The fifth chapter is all about results and discussion in which basic socio-economic, institutional and biophysical factors are described. The last chapter briefly presents summary of major findings, conclusion and recommendations of the study.

# 2. Review of Related Literature and Conceptual Framework

## 2.1 Benefits and Challenges of Livestock Sector

The world community has agreed to cut global poverty in half by 2015. An estimated 75 per cent of the poor live in rural areas, and 600 million of these people keep livestock (IFAD, 2004). Livestock related livelihoods must therefore be a key focus of any effort to achieve this ambitious goal.

The global livestock sector is undertaking rapid transformation. Growing urbanization and rising income are creating a dramatic increase in demand for meat and milk in the developing world. These trends are being reinforced by the shifting role of livestock in several parts of the developing world from multipurpose to single commodity livelihoods. Thus the increasing demand and changing structure of the sector offer opportunities for economic growth of the smallholder, but at the same time present a significant danger that the poor will be crowded out, environment eroded and global food security jeopardized (de Haan *et al*, 2001). This implies the increase in demand for livestock products poses both challenges and opportunities for the reduction of poverty among poor households with a good potential in livestock production.

Livestock development has there been assigned the dual role of satisfying the rapidly rising demand of the expanding global demand for meat and milk and helping to meet the MDGs in poverty reduction (IFAD, 2004).

The same report also shows sale and consumption of animal products can decrease the vulnerability of households to seasonal food and income deprivation. Keeping livestock can also shield households from shocks such as from drought and natural disasters. Animal ownership may raise the ability of the households and individuals to meet social obligations and enhance cultural identity. Livestock is also the key source of collateral for the poor and enable many households to obtain access to capital and business loan. Thus livestock is an important capital asset, which, with careful tending, can propel households out of

abject poverty and into the benefits of market economies. Any attempt to address poverty must be based on a solid understanding of the case and consequences of poverty. The underlying causes of poverty in livestock related livelihoods may differ according to local conditions and production systems. Livelihoods are deteriorating in many production systems. This is due to the shrinking farm size, deforestation and erosion, declining soil fertility and in heavily populated areas, the degradation of water and land (IFAD, 2004)

FAO (2002a) disclosed that as population grow , many livestock –based systems are coming under pressure .The run for arable land, for example, in the east African highlands is leaving millions of households with little land to survive and sedentary farms on arable land are rapidly marginalizing livestock population throughout Africa and central Asia.

Therefore, taking into consideration the benefits and related challenges in the development of the livestock sector, it demands to react so as to minimize the constraints on livestock production and to get the proper benefit.

## 2.2 Feed Resources and Management Practices

Availability and quality of feed resources is one of the basic requirements in the livestock development movement of a nation. Historical perspectives shows that feed resources were not as such considerable challenges in the development of the livestock sector. Naturally available grazing lands were sufficient to make use of the expected result of the livestock sector. But in today's largely populated world, it is becoming difficult to rear a single animal as it was even a century before.

Phengsavanh *et al.* (2000) described the change in feed practices particularly associated with increase in population and the challenges resulted over periods in getting feed for livestock. Moreover, the writers mentioned some actions taken by the farming units in alleviating the problems.

*... in the past, the traditional system of long rotations (>15 years fallow) resulted in forest fallows, which supported efficient nutrient cycling and sustainable land use. With increasing populations, however, fallow periods are becoming very short in most areas (often no more than 3–5 years) and the resulting fallow vegetation is shrubby. In some places, free grazing is banned or limited to particular areas, and commonly farmers devote a lot of labor to building fences each year. Loss of traditional grazing land to protected/planted forests or cropping resulting in feed shortages in the wet season (when this land is normally used for grazing). Insufficient feed in the dry season is also challenging. It is common to meet farmers who spend 1–3 hours each day cutting grass for their animals. These problems are motivating many farmers to experiment with better management of their livestock, including the use of planted forages as a supplement to the diminishing traditional feed resources.*

The reduction in the performance of the livestock sector shows escalating and studies regarding the role of the livestock sector come up with contributable findings in association with feed. According to Elliott and Folkersten (1961), in Zambia, for instance, the long dry seasons are characterized by live-weight loss patterns, typical in tropical livestock production systems. They have added that

*...cattle and goats are the major species of domestic livestock. They rely on natural pasture during the wet and early dry seasons and crop residues for the remainder of the dry season (goats should benefit from the browse flush before the arrival of the rains). When the rain cease the quantity and quality of grazing falls rapidly; so that winter grazing is fibrous and low in crude protein.*

It implies that as the grazing fails, accepted practice is to redress the deficit with crop residues. With the dominant role of crop residues in dry season feeding, especially towards the end of the season, the

farmer needs to know the options for: storage; supplementation; modification of the residues; and management of his animals.

The potential for increasing digestibility and intake of fibrous residues through treatment with alkali has been widely researched and comprehensively reviewed (Sundstol and Owen, 1984). Urea treatment is of most practical significance in the tropics, acting both as an alkali and a source of supplementary N to materials inherently low in crude protein. However, its uptake at farm level has been slow due to different reasons, among which is cost acquisition (Smith *et al.*, 1989).

Similar studies were under taken to state the existing feed resources and research solutions for the prevailing shortages over periods. (McIntire *et al*, 1992) had reported that inadequate nutrition and feeding are the major constraints to livestock production in Sub-Saharan Africa. Feeds (usually based on fodder and grass) are unavailable in sufficient quantities due to fluctuating weather condition or are available but of such poor quality that they do not provide adequate nutrition. These constraints result in low milk and meat yields, high mortality of young stock, longer inter-calving intervals and low animal weights.

Hove *et al.* (2003) identified that the productivity of livestock in Zimbabwe and other tropical countries is constrained by the lack of adequate good quality fodder, especially during the dry season. Native pasture and crop residues, the major feed resources in the smallholder livestock production systems in Zimbabwe, have insufficient nutritional value to support acceptable levels of livestock production. The most limiting nutrient is protein, and it is necessary to feed protein supplements to all classes of livestock to reduce losses in productivity. In the smallholder dairy sector, protein supplements are required throughout the year. Studies assessing the performance of cows in smallholder dairy schemes concluded that shortages of both protein- and energy-rich feeds were major constraints to the productivity of animals in this sector (Dube, 1995 and Mupeta, 1995 in Hove *et al*, 2003). The options undertaken were:

*While farmers successfully grow grasses [Napier grass (Pennisetum purpureum), Bana Cynodon spp., Chloris gayana] and ensile maize as sources of energy, they still buy protein concentrates to meet the protein requirements of their cows. The use of purchased concentrates adversely affects profitability of the dairy enterprise. The Zimbabwe Government, through the Dairy Development Programme (DDP), encourages farmers to grow protein banks of both herbaceous and tree legumes on their farms. Herbaceous legumes like Macroptilium atropurpureum, Stylosanthes guianensis and Chamaecrista rotundifolia have been grown with limited success; these legumes have not been productive and have failed to persist under the low levels of management that exist on smallholder farms(Hove et al,2003:279).*

By the same token, Smith (2000) wrote that dry season nutritional stress is a major constraint to ruminant livestock production in most part of Africa. After the rains finish, quantity and quality of grazing fall rapidly, leaving cereal crop residues as the major feed resource. These residues are low in N and high in crude fiber characteristics which restrict intake and digestibility, so that underfeeding results.

Lapar and Ehui (2003) also identified that many smallholder farmers attribute poor animal performance to an insufficient quantity of good-quality feed; in particular, scarcity of feed during the dry season and limited size of grazing areas.

Other writers (Baur *et al.*, 2003) in the field strengthened the ideas of previous authors that the general absence of good quality feed during the long dry season is a major constraint faced by livestock producers particularly in the arid and semiarid areas of West Africa. According to these authors, research efforts are being undertaken to match seasonal fluctuations in feed supplies with constant requirements.

> ... *the promotion of packages which combine various feed resources such as forage legumes, fodder trees, cottonseed cake and agro-industrial byproducts to supplement grazing and to provide adequate feed supplies throughout the year are becoming area of emphasis (Baur et al., 2003)*

It is also added that in mixed farming systems where crop production and animal husbandry are closely integrated, the availability of aftermath and crop residues, especially during and after harvest, provide cheap sources of feed for livestock. According to Baur *et al.* (2003) in Mali, for example, the use of cottonseed cake as livestock feed has long been encouraged in the semi-arid and sub humid zones.

## 2.3 Livestock Development and Feed Resource in Ethiopia

It is often reported that Ethiopia has the largest livestock population in Africa. Recent data showed that there are 41 million heads of cattle, 25 million of sheep, 23 million of goats, 41 million of chicken, 5.7 million of equines and 2.3 million camels distributed in all administrative regions (CSA, 2004 in EEA, 2005).

Livestock production is an integral part of the subsistence crop-livestock systems of Ethiopian agriculture. It is used not only as a source of draught power, manure and transport to support the crop sector but it is also a source of cash, nutrition and asset for the rural communities. It is considered as a mobile bank that could be hired, shared, inherited and contracted by rural households (Tilahun *et al.*, 2005).

MoFED (2006) in its plan for accelerated and sustained development to end poverty under livestock sub-section stated that in Ethiopia, by far the largest proportion of the crops produced utilizes livestock inputs in terms of traction power. This plan report also mentioned that in rural Ethiopia, lack of plough oxen has direct impact on the size of land to be put under cultivation and is considered as a very strong indicator of welfare among rural households. In areas where mixed farming (crops and livestock production), are jointly

undertaken, farmers use livestock for coping with adverse situations during crises of crop failure by selling animal products. The report also emphasized that although livestock's contributions to facilitate the crop sector and to increase nations GDP have been recognized all along, livestock productivity in Ethiopia is declining to a level that may affect sustainability of crop-livestock systems.

Studies show that despite the attempts to improve agricultural productivity through research and development interventions in the last few decades, the major research and development investments have been concentrating on the crop sector with little attention to livestock related challenges. For instance, according to Tilahun *et al.* (2005) crop breeders have been attempted to increase cereal yield for the last 30 years with little attention to crop residue, which is the major source of animal feed in Ethiopia.

Shortage of feed resources becomes challenging in Ethiopia due to reasons associated with expansion of the crop production in major part of the nation including the once pastoralist areas. The shift from grazing livestock in fields to stall feeding is advocating particularly by natural resource specialists. The shortage of feed resources is pronounced in the long dry season in most part of the nation. Tilahun *et al.* (2005) after an investigation on the major feed resources in the highlands of Ethiopia reported that feed shortage is critical during the dry season and described that situation of feed resources in the study areas as follows:

> *Most of the feed in the Ethiopian highlands is obtained from the natural pasture and crop residues. Feeds are in abundance from December to February, and rationing starts afterwards. Quality feed is usually allotted to draught oxen, mainly in the peak farming months, when land preparation and planting operations are commonly practiced. In the months of May and June, when there is almost no green feed, but a very high demand for draught power, crop residues is the major feed source. Crop residue from pulses is considered as quality feed resource and it is fed mainly to oxen and milking cows in mixture*

*with straw from cereals. Crop residues from the cereal fields are low in metabolisable energy and protein content (Tilahun et al., 2005).*

This study also shared with the ideas of *McIntire et al.* (1992), Dube (1995), Mupeta (1995) and Smith (2000) that dry season feed stress is also constraining the livestock development in Ethiopia. Moreover, it is implied that the feed resources are becoming crop residues which actually considered as feeds lacking major nutrients.

It is not surprising even to find decline in the livestock population of the country as the biased to cereal crop and cash crops persists over periods. There has been an increased investment in small scale irrigation in Ethiopia, especially in valley bottoms, mainly for production of vegetables, fruits and other high value products. There are visible trade-offs and complementary effects between the crop and the livestock sector in the existing and newly built irrigation schemes. A recent study conducted by IFAD (2004) indicated that there is a decline in the number of livestock per area with the expansion of irrigation across regions regardless of agro ecology, but there is also an increase in number of draught oxen. Tilahun *et al.* (2005) identified that feed shortage was apparent between the months of April and June. The decline in grazing area due to conversion of dry season fallow lands to vegetable fields and increase in area enclosure in the hilly landscapes accompanied by frequent drought caused serious feed shortage which has enormously contributed to the reduction of cows, sheep and goats.

Benin *et al.* (2003) also reported that increased irrigation was associated with a reduction in ownership of livestock but with increased adoption of technologies that enhance productivity in the Amhara region. Similarly communities, in Gedemmso, Oromia, which used to be a pastoralist area up to 1990, have been converted to a crop-livestock system with significant reduction in stock (Tilahun *et al.*, 2005). Area enclosure as a means to rehabilitate the landscape has been integrated in some regions, particularly in Tigray and

Amhara highlands. The protected areas above the enclosures are not open for livestock grazing; hence there is a limitation on free livestock movement with a shift towards partial stall feeding (ibid).

In theory, according to Tilahun *et al.* (2005) the expansion of the potential irrigated area should allow farmers to produce more biomass all year round, partly as crop residues and partly by growing grasses on strips, borders and hilly patches. However, the by-products produced from the vegetable fields are not used as feed source as livestock are not accustomed to this type of feed. Another challenge is that farmers are not allowed to produce fodder from irrigated land due to local laws that give priority to food crops.

The Ethiopian government after recognizing the shortage of animal feed, in terms of quality and quantity, as currently one of the major constraints that ranks top in determining livestock production, designed various strategies such as forage production and supply, expansion of improved pasture, development of animal feed, improvement of the quality of crop residue, bush clearing, and water development (MoFED, 2006).

Like other parts of the country, smallholder farmers in *Kalu* district rear livestock in their mixed farming system. Oxen are used as major draught power. Livestock is the households' social security, proud and means of financing their children at school. The district is rich in livestock resources. But the productivity of the sector is low for different reasons mentioned in a report of the *Woreda* office. The report includes the change of grazing land to farm land, the existence of challenging free grazing, less use of highbred livestock, and livestock related diseases as some of the reasons for low productivity (WOAgRD). According to the same report the district is working to end free grazing and to expand the practice of growing forage innovation by the smallholder farmers. Moreover, the report described that the productivity of the sector would have to be increased so that in addition to feed resources provisions for the livestock population, the use of agricultural commercialization through market oriented livestock production is in operation.

## 2.4 Adoption of Innovations

The view that an innovation is something newly developed appears to dominate in adoption and diffusion literatures. As Taddesse (1996), quoting Friedman (1973), Pederson (1972) and Eders (1980), stated the definition of innovation as a new product, technique, organization or idea introduced into any social system for positive change. However, as it is done by most of related empirical studies the more simplified definition of Rogers (1983) is applied for the definition of innovation.

> *An innovation is described to be an idea, object, method or practice that is perceived as new by the individual or members of the social system (Rogers, 1983).*

The point of consideration for adoption of innovations comes from different disciplines and areas of studies. Politicians, policy makers, economic planners, commercial agents, extension workers, health workers and even priests etc. want their new ideas and products be accepted; be spread to all members of the public to which they are addressed and be adopted in the short time possible (Tadesse, 1996).

Adoption of innovations in agriculture has also attracted considerable attention among development scholars (Feder *et al*, 1982, Rogers, 1983; Sunding and Zilberman, 1999; Doss, 2003; Cramb, 2003) because the majority of the population of the developing countries derives its livelihood from agricultural production and new technologies apparently offer opportunities to increase production and income substantially.

However, there is often a significant interval between the time an innovation is developed and available in the market and the time it is used widely by producers (Sunding and Zilberman, 1999). The introduction of many new technologies has met with only partial success as measured by observed rate of adoptions. The diffusion of innovations does not move at the speed politicians, policy makers and other category of the population wish. A long time may elapse before a new idea or a product is widely diffused and adopted

(Tadesse, 1996). As pointed out by Feder *et al.* (1982) the conventional wisdom for the partial success of adoption of those technologies is that they are constrained by involving factors such as lack of credit, limited access to information, aversion to risk, inadequate farm size, labor shortage, insufficient human capital, chaotic supply of complementary inputs (such as seed, chemicals, and water) and inappropriate transportation infrastructure among others. Due to these or other reason sometimes the technology may fail or perhaps rejected, even if it has an evident advantage for the ultimate target.

## 2.5 Evolution of Adoption and Diffusion Studies

The first adoption and diffusion study seems to have been conducted in the early 20th century. However, the concept goes as far back as 1891, when it receives a great deal of attention by students of communication and agricultural extension in the U.S. (Harvey, 1969 in Tadesse, 1996). The first concrete step toward a scientific conceptualization of the study of adoption-diffusion, however, apparently started with a French sociologist, Gabriel Tarde, who published his first book 'Law of imitation', in 1903, where his observation of the now confirmed "S" shape trend in the rate of adoption of innovation was for the first time described. Although his view did not immediately gained attention, after about decades American scholars began studying adoption and diffusion around Tarde's law of imitation (Rogers, 1983).

More important, however, is the diffusion study movement started by European anthropologists at about the same time or a little later. These anthropologists worked on one general notion of the concept of diffusion, which was directly picked up in the early 1920s by American anthropologists, who developed it further (ibid). The same study also identified the importance of diffusion has thus been brought to the attention of other social scientists, and the foundation for the tradition of research on adoption and diffusion has been laid. Many scholars then picked up and pursued adoption and diffusion studies in their own specialized fields with out any interchange with other research traditions. Disciplines that have contributed to the development

Doss (2003) by considering a series of technology adoption studies carried out by the International Maize and Wheat Improvement Center (CIMMYT) in collaboration with national agricultural research Systems in Eastern Africa tried to show the complexity of facts in defining adoption. He stated the difficulty in defining adoption as follows.

> *Defining adoption may be complicated by the complexity of defining the technology being adopted. For the adoption of improved seeds, the CIMMYT studies used several definitions ranging from farmers using a variety that was originally an "improved" hybrid but has been repeatedly recycled (for example, many farmers in the Tanzania samples had recycled hybrid seed for 12 years or more), to farmers following extension service recommendations of using only new certified seed (as in the Kenyan studies). Since the definition of adoption encompasses a wide range of dissimilar practices, the results from these studies are not comparable. Studies should state explicitly how terms are used. Given the complexity of adoption measures and the potential value of having compatible measures of technology adoption across studies, it would be valuable for CIMMYT— perhaps in conjunction with other institutions—to take a leadership role in developing a scheme for defining adoption that could be used in adoption studies (Doss, 2003).*

For the purpose of this study some modification of the definitions given would have been applied. Adoption is the practice of growing forage innovation by the smallholders in the prevailing mixed farming system. The smallholder farmer is considered as adopter when forage species is growing in his/her farm. The farmer may practice the technology as inter-cropping (mixing with other crops), live fence or as erosion controls among others; the crux of the matter for the definition of adoption, however, is whether the farmer decided the practice of growing forage innovation and use it as feed resource.

## 2.7 Stages in the Process of Adoption

In the previous 30-40 years, tremendous efforts have been made by the Ethiopian agricultural Research Systems to disseminate agricultural technologies to end-users by way of on-farm verification, pre-extension demonstration, popularization, and training and extension publications (Agajie *et al.*, 2007). However, it is reported that the impact of these extension efforts remained below expectation. One of the major factors for the low impact was lack of efficient dissemination pathways in the process of dissemination of the innovation (Abera and Beyene, 1997 in Agajie *et al.*, 2007).

Rogers (1962) while defining adoption as a mental process reported that an individual passes from hearing about an innovation to its adoption that follows awareness, interest, evaluation, trial, and adoption stages. This five-stage model is called "the innovation-diffusion model". Here diffusion is defined in relation to the spread of an innovation at the aggregate level viewed over time. It is the cumulative process of adoption measured in successive time periods in five categories: innovators, early adopters, early majority, late majority and laggards.

Stages in the process of adoption have three major distinctive features: the knowledge stage, the attitude stage and the practice stage (Rogers, 1983).The process of behavioral change in adoption starts with awareness level on the part of the potential adopter. Whether it becomes a rumor or news, whether the potential adopter learns it from the extension agents, or search it for intentionally, the existence of the innovation must be known first before any adoption learning takes place.

After knowledge acquisition, the second stage in the process of adoption is the formation of attitude. Many diffusion scholars, including the followers of KAP model believe that when an individual has learned some aspects of the attributes of an innovation he/she forms certain inner feeling toward it. Accordingly he sets his/ her mind in the direction of adoption or rejection (Tadesse, 1996).

Practice is an overt behavior of applying the knowledge, skills and interest developed in the early two stages and making full use of the innovation. For David *et al.* (2006) however, adoption is a learning process with two distinct aspects. One is the collection, integration and evaluation of new information to allow better decisions about the innovation. The other aspect is improvement in the landholder's skills in applying the innovation to their own situation. Most farming innovations require a certain level of knowledge and skill, and added attitude to apply them in practice and there can be a wealth of choices in the method of implementation (e.g. timing, sequencing, intensity, scale). Through learning-by-doing, as well as by reading, listening and watching, the necessary skills can be established and enhanced (ibid).

This dynamic learning process as a stage of adoption has thus been broken down into stages or phases in a number of different (though similar) ways. One typical description of the sequence can be listed as follows (David *et al.*, 2006).

1. Awareness of the problem or opportunity.
2. Non-trial evaluation.
3. Trial evaluation.
4. Adoption.
5. Review and modification.
6. Non-adoption or dis-adoption.

Prior to trialing, the landholder's assessment of a technology or practice relies strongly on information from outsiders. At this stage, social and information networks would be important influences on the decision to proceed to trial, but after trialing has commenced, personal experience is likely to be the main influence on further decisions (Dong and Saha 1998 and Marsh *et al.* 2000 in David *et al.*, 2006).

The process of adoption is perceived differently by different scholars. It is in fact a continuous process in which any other logical categories of stages can be made. The crux of the matter, however; is there are some stages which the process of adoption can pass through and majority of the differences are a matter of details and briefing the categories. This study give due emphasis to the adoption/practice stage with given assumptions that the smallholder farmers know the technology at least through DAs and feel that forage innovation is essential for the livestock development endeavour.

## 2.8 Agricultural Innovation and Development in Ethiopia

In agriculture led economy, ensuring a flourishing agricultural economy is crucial for reducing poverty, ensuring food security, and managing natural resources in a sustainable manner. Farmers need appropriate technology, improved skills and timely information to ensure the development of the agriculture sector and meet the demand out of it.

The earliest attempt to bring about change in the agricultural sector through research and extension was started in 1953 when the college of agriculture established at Alemaya and took over the national responsibility of research, training and extension (EEA, 2005). The college opened up the research avenue by conducting adaptive and basic research on biological (improved varieties, breeds, etc) and/or agronomic practices. The college was successful in generating improved technologies in the field of crops: maize, wheat, pulses, and in horticultural crops.

Major structural change has been undertaken in 1963 and consequently the extension wing of the college was transferred to the Ministry of Agriculture. Later on in 1966, the Institute of Agricultural Research (IAR) was established by law to coordinate the research programs and conduct research at national level. The establishment of the IAR resulted in strengthening the research dimension by opening up new areas of research direction in collaboration with the college of agriculture at Alemaya. IAR opened research centers

at various parts of the country and streamlined major research priorities for the major crops (Gezahegn, 1999).

In view of the numerous institutions conducting research to generate innovations, duplication of efforts and misuse of the various scarce resources were inevitable. The research endeavors in the various public institutions were virtually uncoordinated and therefore remained at large fragmented (Gezahegn, 1999). The absence of clear cut national research policy to guide the system of governance coordination and follow up and monitoring at a regional and national level, created conflict of interest and stress among the various national institutes (Goshu, 1994). Consequently, most of the research programs lack scientific depth and continuity. Most of the research projects terminated before completion because of high turnover of qualified senior staff. This gap remained for many years to be a major drawback of the Ethiopian National research Agricultural System (NARS). To overcome the draw back of the previous system and to co-ordinate and effectively guide the research programs in the country, an autonomous organization known as Ethiopian Agricultural Research Organization (EARO) was established by law in June 1997 (Gezahegn, 1999; EEA,2005).

Ethiopian Agricultural Research Organization (EARO) is now the main agricultural research entity in Ethiopia and is mandated to coordinate the agricultural research activities of the federal and regional research centers and the higher learning institutions. Its mandate encompasses agricultural researches in crops, livestock, fisheries, forestry, and other natural resources. EARO falls under the administrative responsibility of the Ministry of Agriculture and Rural development and, as of 2000, organized its research through 5 research directorates, 3 research coordination offices, 40 programs, and 106 projects (Nienke and Menelik, 2003 in EEA, 2005).

Most of the research orientations in the country concentrated in some selected areas. Crop researches took more than half of the research outputs with little emphases on other areas. A report on detailed information of the number of researchers working in specific commodities and thematic areas showed that more than half of the 691 full time equivalent researchers are engaged in crop research. Livestock accounted only for 18 percent, while forestry and post harvest research accounted for 7 percent (ASTI, 2003 in EEA, 2005). Moreover, a recent assessment of research outputs indicates that a large number of improved crop varieties have been released. Similarly, technologies in farm implements, soil and water conservation, livestock breeds, and forage species have been developed and released.

Table 2.1 Agricultural research output in Ethiopia

| Types of technology developed, tested and released | Number |
|---|---|
| Crop varieties | 390 |
| Farm implements | 25 |
| Soil and water conservation | 16 |
| Livestock breeds | 10 |
| Forage species | 17 |

Source: EEA (2005) quoted from Tesfaye and Senait (2003).

When the technology generation of the country is considered, in the early 1980s, IAR adopted Farming System Research (FSR) approach in generating, verifying and transfer of innovation. The FSR system is more of farmers participatory approach and gained popularity in the 1980s when it was realized that the adoption of High Yielding Varieties (HYVs) alone would not realize the potential yield gain (Lele,1996). Hence, the FSR approach was integrated to Ethiopian agricultural research system with the broad objectives of understanding existing practice, identifying farmers' priorities, needs and constraints and to identify a targeted homogenous recommendation domain (Gezahegn, 1999).

A donor supported project, the Sasakawa Global 2000 has initiated an extension strategy in 1993, which was later known as Participatory Demonstration and Training System (PADETES). With more emphasis on packages, extended use of fertilizer, improved seeds particularly of crop grain, demonstration of agronomical practices like row planting, and technical advices were promoted (MoA, 1994c in EEA, 2005). Starting 1995 the approach was further promoted as a major extension management system in Regional states. The core features of PADETES include clear objectives and implementation strategies, selecting technologies suitable to a specific AEZ, use of wide range of communication methods and media, emphasis on participation through a large number of demonstration plots on farmers' fields, providing inputs through credit under local government, collateral arrangement, and systematic inclusion of women and the youth (Habtemariam, 2005).

PADETES pushed technologies to farmers. The planning was central, top down and supply driven, with little attention to market demands and farmers' needs. For any program to be successful and sustainable, the information and technologies provided to the farmers should be demand-driven (EEA/EEPRI, 2006). The same report pointed out that though its name calls for participation, in reality PADETES lacked elements to be participatory.

## 2.9. Adoption of Agricultural Innovations and Factors Affecting the Decisions

The adoption of agricultural innovations is affected by a set of factors which may be combined or individual in nature. The factors can be seen from different attributes such as farmers' attributes, farm attributes and technological attributes among others (Kaliba *et al.*, 1998). These attributes encompasses the nature of the technology, the characteristics of farmers and institutional or policy related factors in one way or another. Adoption studies conducted in different disciplines came up with distinguished nature of factors impeding or enhancing the adoption of innovations with particular focus on developing countries.

Zekarias and Admasu (2007) after surveying adoption of coffee production technologies reported that access to extension is systematically associated with the adoption of improved coffee. Those farmers who had major extension contact were more likely to adopt the improved variety as compared to those who have less access for the extension service. The authors also identified that access to credit is vital to purchase essential external inputs, which are required by a given technology. According to this study, shortage of credit, unfavorable repayment conditions, and too bureaucratic procedures associated to credit in the area hinder adoption of technologies.

It is also reported in the same study that access to training, distance from the nearest development centers and markets were the affecting factors the adoption of the technology. Those who had more training were more likely to adopt the improved technology as compared those who had less access to training. Moreover, those farmers who are nearer to the development centers and markets were found to adopt the technology better than those who are far away from the development centers and markets.

A study by Hailu *et al.* (2007) in Northern and Western Shewa zones of Oromiya found that pattern and sequence of adoption of improved *teff* and wheat is affected by the educational level and age of farmers. Full adopters were significantly the most educated and the youngest.

Setotaw and Abate (2007) in adoption study of improved Durum wheat technologies found that resource endowment, extension visit and participation field days positively influenced adoption of improved varieties.

John *et al.* (2007) in a study of technology use and participation of female and male headed households in agricultural research and extension pointed out that economic factors such as farm size and area of land rented significantly influenced the use of land saving technologies. These authors also identified that the use of extension services is significant contributor to adoption of technologies. Associated with credit

services, it is identified that short lived and non comprehensive nature of existing credit scheme; shortage of input credit, problems in repayment and interest rate and related appraisal requirements of agricultural enterprises for borrowing badly hurt the adoption of the technologies.

Adoption of innovations is negatively affected by farm size and favored by risk tolerance (Yaron *et al.*, 1992 in Zekarias and Admasu, 2007). The study also noted that extension service and educational level of the farmer has no impact on the adoption of innovation in the area which can be associated to the insignificant variability of the education or the extension practices among the beneficiaries. Moreover, the same study indicated that market outlet matters in adopting innovations.

A study by Chandra and Sigh (1992) in India pointed out that among various determinants of adoption, profitability of the technology, credit orientation attitude towards highbred varieties, risk preference, and age of farmers contribute significantly to the adoption of new technology package. The findings of the same study also indicated that the level of adoption was positively associated with area of land under cultivation.

Asfaw *et al.* (1997) cited in Zekarias and Admasu 2007 in Boka area of Ethiopia found that the adoption of improved maize variety is significantly influenced by extension service while the use of fertilizers is significantly related to the provision of credit and level of education of the farmers. However, the technology of row planting is found to be positively related to the farmer's formal education and oxen ownership.

Tesfaye *et al.* (2001) in a study on the adoption of high yielding maize technologies in the major maize growing regions of Ethiopia investigated and documented the level of adoption and the factors that affect the adoption process of improved maize varieties. Among these factor distance to the nearest market center, access to credit, access to extension information, livestock unit, farm size and use of chemical fertilizer are found to significantly affect adoption of improved maize varieties.

A study by Steinbach (1997) for alternatives to crop residues as feed resources in mixed farming system indicated factors affecting integration of forage legumes into subsistence farming systems. The factors are available arable land per capita, number of crops that can be grown per year, market access to animal products, labor availability, and farmers' perceptions of the risks and rewards of investing in their livestock enterprises. Tenkir (2001) also reported that farmers with more cattle were more likely to adopt agricultural innovations. He also identified that the probability of adoption of different technologies was influenced by farm related training while educational level does not affect adoption decisions.

Wanyama *et al.* (2003) after assessing factors influencing adoption of pastures and fodders among of smallholders subsistence farmers pointed out that the major factors influencing adoption of forage technologies in the soil management project were farmers participation in on- farm trials, age of farmers, education of farmers and farm experience. The same study concluded that at a given type of cattle, good forage types and good farming systems; operational project policies that would result in greater contact with extension/research staff and more farmer participation in on-farm trials or demonstrations are likely to increase adoption of forage components.

The findings of Wortman and Kurungu (2000) on adoption of legumes for soil improvement and forage by smallholder farms in Africa identified that age and education have no significance influence on adoption of forage species while dairy cows, extension services, and uncontrolled grazing have significantly affected adoption decision of the farming units.

According to Lapar and Ehui (2003) credit service and educational level of the household head have significant and positive influence on adoption of improved forage components while livestock size has no significant impact, land size has also shown the less likely of adoption effect.

Mwngi and Wambugu (2003) had emphasized that adoption of any technology is enhanced when farmers can see the benefits. Their result indicated that visits to research center or to other farmers' fields will help the households to visualize the potential of the technology. Moreover, Gebremedihin *et al.* (2003) in a study on factors determining adoption of improved forage in the highlands of Ethiopian reported that family size affects the adoption decision while age has no significance influence on the same.

## 2.10 Potential for and Constraints to Forage Adoption

Advances in biological technology in livestock systems have been induced primarily by improving the yield of animal products per unit of feed or per unit of breeding stock (Hayami and Ruttan, 1985). Development and diffusion of improved feeding and supplementary feeding technologies are critical for improving livestock productivity. Forages play an important role in sustaining livelihoods of small- and medium-scale farmers in the tropics, mainly as a result of their contribution to economic and environmental sustainability (Peters and Lascano, 2003 in Mapiye *et al.*, 2006). Legumes play a vital role in the improvement of tropical pastures, largely due to their ability to fix atmospheric nitrogen. Apart from the direct contribution to livestock production, particularly in intensive systems such as dairy, through the provision of protein-rich fodder, legumes can improve the productivity of rangelands by increasing the amount of nitrogen available for uptake by associated grasses (Giller, 2001).

The study by Mapiye *et al.*(2006) in Zimbabwe identified that the major constraints to adoption of forage and browse legumes were shortage of inputs, low yield and lack of persistence of legumes and lack of fencing material, lack of capital, lack of knowledge, shortage of labor and shortage of land.

Moffat and Austin (2003) in their study on forage demand and constraints to adoption of forage technologies by livestock keepers in Malawi reported the following major constraints.

- Grazing is a customary right with everybody having free access to grazing areas;

- Improved pastures are expensive to establish, maintenance requires regular applications of fertilizer and fencing may be necessary to control grazing;
- The average land holding in some areas in Malawi is small and does not allow the farmer to establish a significant area of pasture on his own land, unless it can provide him with a greater return than crop production;
- Prices of seed (when available) and other planting materials are high;
- Pasture research results have not been brought to the point of application, even though considerable research on pastures has been conducted in the country;
- Attitudes of livestock farmers towards forage hinder adoption of forage technologies in Malawi. Farmers consider pasture and forage as weeds rather than crops, and tend to consider weeds and pasture species as one; and there is a lack of appreciation of the value of forage. Many livestock farmers do not consider forage as a valuable crop; accordingly, they would rather take care of a maize crop than a pasture crop.

Unlike residues management, and hay and silage making, adoption of forage grasses and legumes often involves the introduction of a new crop into the farming system. Success of the introduction depends on how well new crop fits into the existing system (Gebremedhin *et al.*, 2003). Their study shows degree of crop-livestock integrations, the functioning of forage and livestock product markets and the extent of participation of forage growers, and household resource availability are important factors for successful introduction of forage crops.

The potential for forage adoption is limited under subsistence oriented livestock production as the economic incentives are low (Gebremedhin *et al.*, 2003). The adoption of forage can be high under-market oriented livestock production, such as dairying with cross-bred or improved breeds, and fattening of large and small ruminants. According to data collected from Holeta area from 1993 to 1997, forage production is much more

the variables. Moreover, the interaction between the factors is represented with the expected contribution of one over the other in the respective arrowed lines.

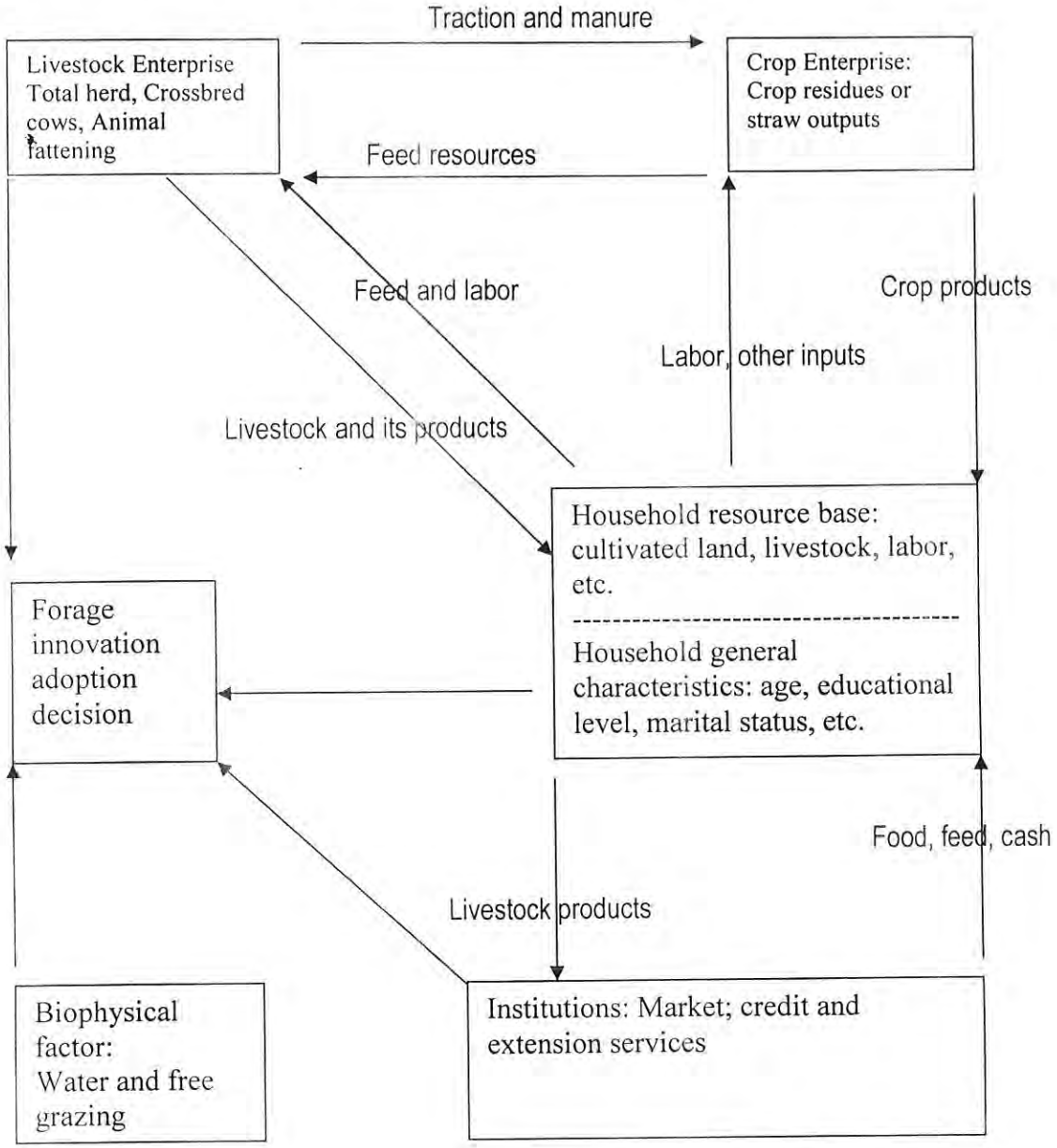


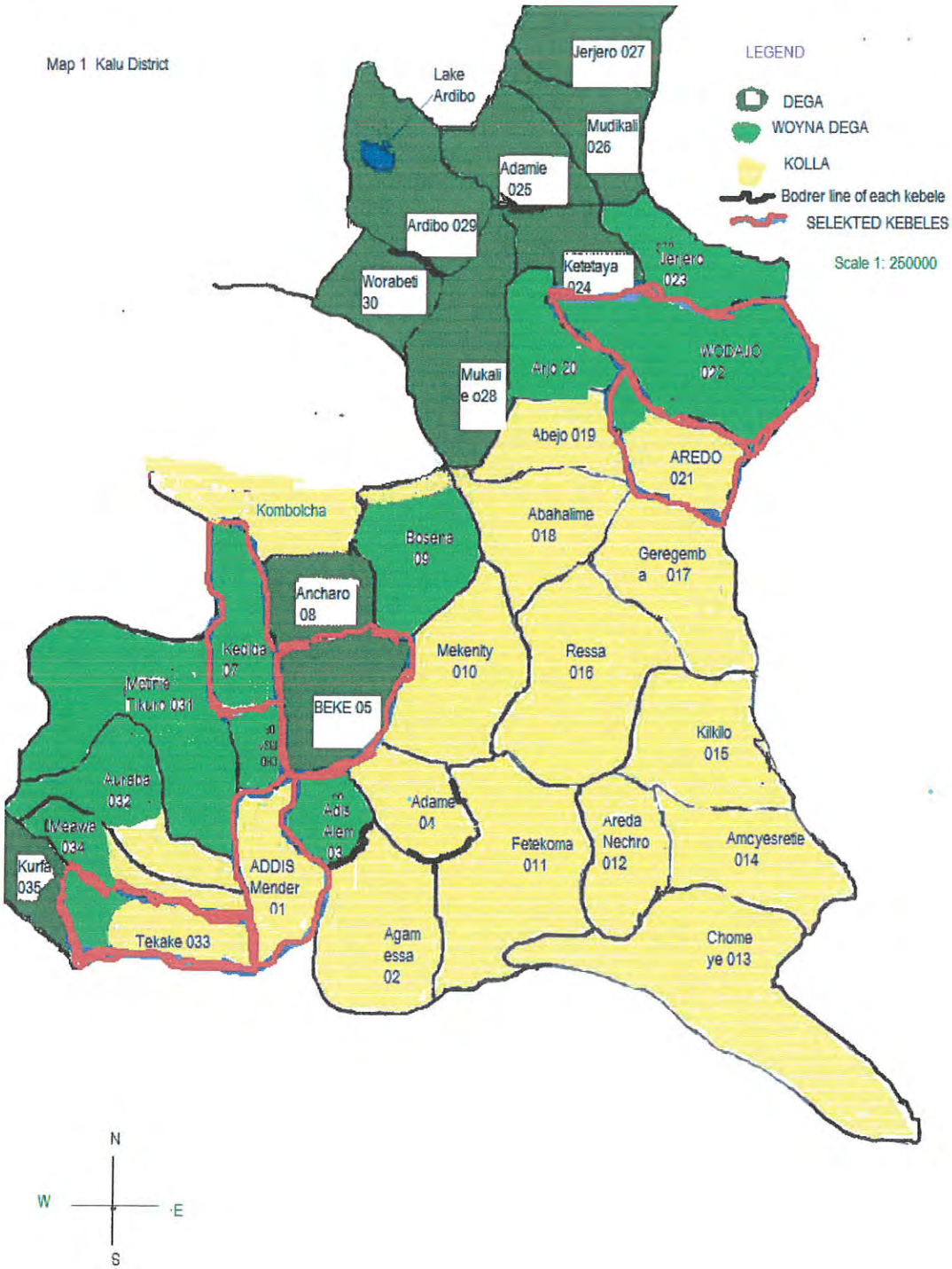

Figure 2.1 Factors that affect adoption of forage innovation, modified from Gebremedhin (2003) crop-livestock integration figure

# 3. STUDY AREA DESCRIPTION

The physical and socio-economic description of the study area is presented under this section.

## 3.1 Geographic Location

The study was conducted in *Kalu Woreda*. The *Woreda* is one of the 15 administrative districts in south Wollo Zone, Amhara Regional State. Its administrative office is found in *Kombolcha* town around 380 km from Addis Ababa. There are 30 rural and 4 urban *Kebeles* in the district. The total area is about 90,701 ha. Geographically the *Woreda* is bounded by *Bati* woreda in the east; *Dessie Zuria*, *Worebabo* and Tehuledere *Woredas* in the North; *Dewacheffe* and *Argoba Woredas* in the South and *Dessie Zuria* and *Albuko Woredas* in the west. This location is described based on the WOAgRD report for the fiscal year 2006/07. The map of the district, taken form the report of the WOAgRD is shown below.


Map 1 Kalu District
LEGEND
DEGA
WOYNA DEGA
KOLLA
Bodrer line of each kebele
SELEKTED KEBELES
Scale 1: 250000
Lake Ardibo
Jerjero 027
Mudikali 026
Adamie 025
Ardibo 029
Ketetaya 024
Jerjero 023
Worabeti 30
Mukali e o28
Arjo 20
WODAJO 022
Abejo 019
AREDO 021
Kombolcha
Bosera 09
Abahalime 018
Geregemb a 017
Ancharo 08
Kebida 07
Mekenity 010
Ressa 016
BEKE 05
Kilkilo 015
Areda Nechro 012
Amcyesretie 014
Fetekoma 011
Adame 04
ADDIS Mender 01
Agam essa 02
Chome ye 013
Tekake 033
N
W
E
S

## 3.2 Topography and Climate

The topographic feature of the study area includes only 20.9 percent plain with a slope ranging from 0 to 15 percent. The remaining part of the District is reported to be slope of 15 to 50 percent. The topography shows most of the area is not conducive for farming (cultivated land) and soil erosion is challenging. The altitude ranges from 1400 to 2800 m.a.s.l. As a result of this wide range of altitude, the study area holds the different traditional climate zones of Ethiopia. About 43 percent *Kolla*, 38 percent *Woyna Dega* and 19 percent *Dega* climate conditions covers the *Woreda* (WOAgRD).

The mean annual rainfall ranges from 700 to 900 mm. There is bimodal rain in the district. For *Belg* production season the rain starts in the month of January and ends in March. The summer months (June-August) are the second and major raining months for *Meher* production. However, according to WOAgRD, the *Woreda* is challenged due to irregularities of the raining seasons, in timing and volume, and is becoming one of the drought prone areas in the zone. The rest months (April to June and October to December) are dry seasons in the study area (WOAgRD).

## 3.3 Water and Forest Resource

The district holds 28 small and 4 medium rivers, 106 springs; and there is underground water used for irrigation purpose around *Chefa*. The water resource enables the *Woreda* to develop about 2703 hectares of land through irrigation. Moreover, reports in the *Woreda* office showed the potential of the water resource to expand irrigated land by additional 1797 hectares of land.

The forest coverage in the *Woreda* accounts only to 5 percent. According to WOAgRD most of the trees under this coverage are newly planted.

## 3.4 Demographic Characteristics

The report (2006/07) in the WOAgRD shows a total population size of about 205,287. About 37,821 male headed households and 7483 female headed households are found in the district. The overall population density shows 181.6 persons per square km.

## 3.5 Economic Conditions

The Woreda is primarily agriculture based. Mixed farming (crop-livestock production) system is practicing.

### 3.5.1 Crop-production

The farming system is dominated by subsistence small scale agriculture. Rain-fed agriculture is dominant to produce crops. The climate condition varies over periods which deteriorate crop productivity in the *Woreda*. Even at times enough raining is recorded, the product on small size of land holding per household cannot feed the households in particular and the population of the *Woreda* at large.

The *Woreda* is working to improve the productivity through improving soil fertility and enhancing the natural resource management system through water and soil conservations. Moreover, to enable the smallholder farmers produce more than once in a year different irrigation schemes are opening under the Woreda office effort. Among the activities under this section, 1314 small scale irrigation channels using small and medium rivers, ground water and springs are operating.

The commonly produced crops include sorghum, *teff*, maize, wheat, chick pea and millets at large and other crops like oats, oil seeds and pulses, vegetable, *chat* and spices are also produced.

### 3.5.2 Livestock production

The livestock population, according to 2006/07 farm survey report, reported in terms of total livestock number, is about 372,331. The cattle population accounts to 100,381, sheep 23,729, goats 38,594, equines

12,012 (11,123 donkeys, 254 horses, and 634 mules) and camels of about 1865. Moreover, there are about 193,750 chicken recorded in the WOAgRD reports. About 5,537 hives which include traditional hives of 4601, in transition to modern of 248 and modern hives of 688 bees are recorded in the *Woreda*.

The numbers shows the existence of large livestock population in the district. However, the same report described low productivity of the sector. The reasons mentioned for the low productivity were uncontrolled grazing, feed resource shortage, lack of intensive use of improved breeds and animal disease among others.

## 3.6 Infrastructure

### 3.6.1 Road and Telephone

The road outlet in the Woreda encompasses 45kms of all-weather roads and 250kms of off-season weather roads with a total of about 295kms road networks. The rural and urban Kebeles are channeled through these roads. Moreover, 9 rural *Kebele* offices have telephone services.

### 3.6.2 Education and Health Centers

The *Woreda* has reported 21 first cycle (1-4 grades), 21 second cycle (5-8 grades) and 2 high schools. There are health centers which include both governmental and private centers. In the *Woreda* about 16 governmental health posts, about 7 private clinics and 6 pharmacy centers are found. With regard to veterinary services about, 7 animal clinics are available in the *Woreda* (WOAgRD).

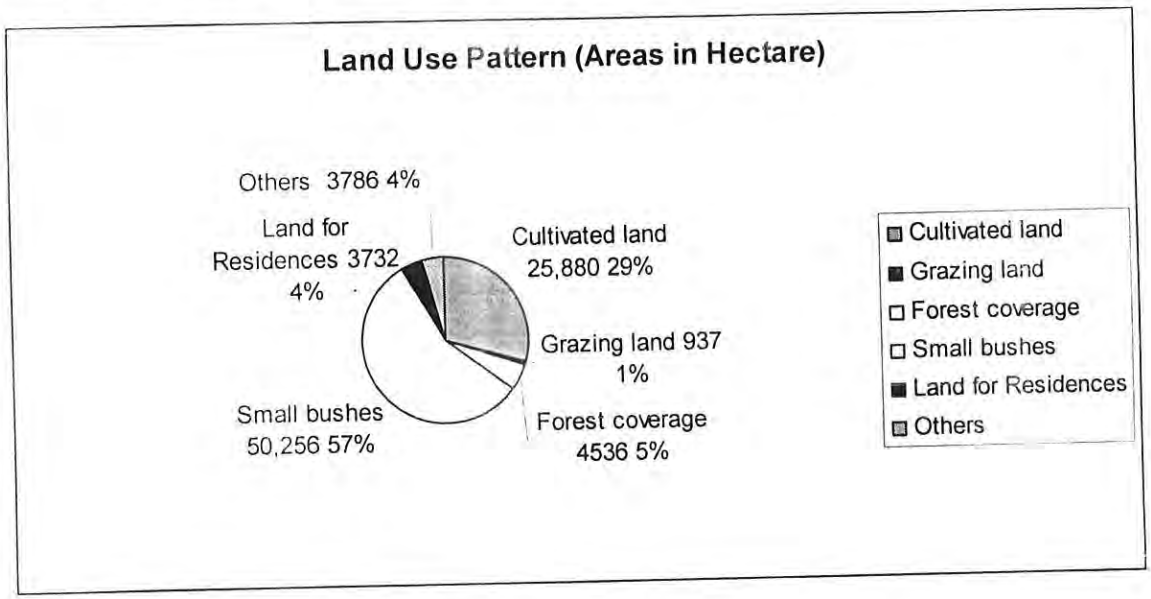
### 3.6.3 Training and Nursery centers

The *Woreda* has 22 farmers training centers. There are about 1755 nursery centers. 1 model nursery center which run under the Woreda office's control; 15 and 1739 nursery centers are owned by associations and by farmer privately in a respective manner.

### 3.7 Land Use Pattern

The land use pattern comprises of cultivated land, grazing land, land under forest, small bushes and land for residences with respective areas presented in hectare. Chart 3.1 revealed the size of each category of land use and the percentages from the total land available.

Chart 3.1 Land Use Pattern (in Hectares and Percentages)




*Source*: Pamphlet prepared by the WOAgRD, 2006/07

The chart depicts that about 29 percent of the total land is used as cultivated land. Grazing land accounts only for one percent. The largest part of the available land is covered under small bushes which accounts to 57 percent.

# 4. METHODOLOGY

## 4.1. Study Design

Study design may vary depending on the purpose, objectives and nature of the research. Survey design which is mostly used in social science researches was applied under this study. Survey design may be cross-sectional surveys and longitudinal surveys. Cross-sectional survey was used with some consideration in notion of change over time. Yeraswork Admassie (undated) stated the designs as follows.

> *The cross-sectional survey is the most frequently used study design. This is because of its one time data collection and analysis which in turn makes it time-saving and cost effective. It is therefore highly efficient. However, researchers often are interested in answering research questions involving processes or the notion of change over time, which is an aspect that is probably handled through longitudinal surveys. To gain from the better of the two methods then (i.e. the efficiency of cross sectional survey and special advantage of the longitudinal surveys) certain devices are employed in a cross-sectional survey for approximating study of process of changes.*

This study therefore, is primarily designed to undertake a cross-sectional survey of forage technology adoption in *Kalu Woreda*. Under this study the researcher made an initial contact with the *Woreda* administrators so that they enabled him to identify the appropriate *Kebele* office sites. After the office sites were identified, the researcher second contact was with the administrators and development agents who highlighted about the respondents. Once the researcher has identified who and where the sample households were found interviews were through trained enumerators. The enumerators were at least Diploma holders in agriculture. A sample size of 120 households heads from six *Kebeles* were used for the survey. Key informant discussion with the development agents and *Woreda* experts had been undertaken.

Moreover, six focus group discussions with member size of 7 – 8 were conducted. At least one and half hours per *Kebele* had been elapsed to conduct the focus group discussions. This was to strengthen and to gather more explanation for the data collected under other methods. While administering interviews and discussions with KIDs and FGDs, recording the responses manually or through electronic means like video was used.

## 4.2. Population and Sample

### 4.2.1. Population

The study was conducted in Kalu *Woreda*. The *Woreda* has a total number of 30 rural and 4 urban *Kebeles*. A report for fiscal year 2006/07 in the WOAgRD shows a total population of about 205,287. About 37,821 male headed households and 7483 female headed households are found in the district. The study used six Kebeles which have a total household size of about 8,359.

### 4.2.2. Sampling Frame and Design

The sampling framework used was list of households recoded for property tax purpose by the *Kebele* officials. A two-stage sampling technique was employed in the design procedure. The first stage involved the purposive selection of *Kebeles* and in the second stage households were enlisted alphabetically from which sample was selected using systematic random sampling.

### 4.2.3. Sample Size

The determination of simple size is influenced by the variability of the population, cost and time availability. This study used the statistical method to determine sample size. The total sample size was determined using the following formula (Cochran, 1977 and Kinfe, 2002 in Dagnew, 2006).

a) $n_0 = \frac{z^2pq}{d^2}$ b) $n = \frac{n_0}{1 + \frac{n_0 - 1}{N}}$

Where: $n_o$ – is the desired sample size when the population is greater than 10,000

n- is number of sample size when population is less than 10,000

z-is 95% confidence limit i.e., 1.96

p- is 0.1 ( proportion of the population to be included in the sample, i.e.,10%)

q – is 1-p, i.e., 1 - 0.10= 0.90

N- is total number of population

d- is margin of error or degree of accuracy desired usually at 0.05

The method resulted in a sample size of about 130. However, a valid sample size of 120 households was entered in the analysis from all the six *Kebeles*. The remaining sample is accounted to be invalid because some of the required variables were missed by the enumerator at the start of data collection and it was difficult to get the farmers for the second time. The number of households in each *Kebele* was determined by proportion to the population size. Moreover, the six FDGs were having members of 7-8 each. The members of the FGDs were both female and male household heads. Due to small number of female household heads in the respective *Kebeles* a maximum of three females were among the discussants. Moreover, the researcher believed that sex does not matter as far as the possibility of potential, in terms of awareness, farmers to discuss with is accessed. These discussants were selected by the help of DAs. Three *Woreda* experts and six DAs, those in the livestock and natural resource management sections, were interviewed and discussions were conducted by the researcher.

## 4.3. Data Collection

### 4.3.1. Data Source

Both primary and secondary data sources were used in this study. The primary data sources were household heads, *Woreda* experts, and development agents (DAs). The diversification of respondents was

believed to triangulate the information obtained and to increase the validity and reliability of the data. Moreover, secondary data sources including reports and pamphlets were used.

### 4.3.2. Data Types

This study used both qualitative and quantitative data types. The qualitative data were information from focus group discussions, key informant interviews and responses from structured questionnaires which could not be quantified numerically. The quantitative data used were number of livestock owned, family size, farm size, frequency of extension workers contact and others which could be quantified numerically.

### 4.3.3. Data Collection Techniques

There are a number of data collection techniques to be used in any scientific inquiry. But the study under discussion used focus group discussions, key informant discussions and sample survey with structured interview using structured questionnaires. Structured interview was used because the households under study were considered as uneducated. Any difficulty from the respondent's side can be elaborated because the interviewers are to read questions and record the data. Moreover, the method allows the interviewers to overcome resistance from respondents and create chance of restructuring the questions based on the respondents feeling, minimize the rate of missing returns and non-responses. The questions prepared were both closed ended and open ended ones.

As far as the focus group is concerned, the research used this method of data collection as supplementary to the other methods. Under this method the researcher got explanation for information, enable to check and verify data gathered through other methods. The method is useful to gather data from a relatively wider population within a limited period of time.

$= B_0 + B_1X_1 + B_2X_2 + ... + BnXn$ ---------- (1)

Where $B_0$ is the constant and there are 'n' independent (X) variables with $B_1$, $B_2$, ..., Bn coefficient used to predict the log odds, and prob represents probability.

To simplify the procedure, let $Z = B_0 + B_1X_1$ , for one independent variable X.

(a) If $X_1$ is binary (0, 1) variable, then $Z = X_0$ (that is constant for the '0' group on $X_1$ and equals the constant plus the coefficient for the '1' group.

(b) If continuous variable Z equals constant plus the B coefficient times the value of $X_1$.

Hence for single independent model the probability of adoption, prob(adop), can be rewritten as:

$Prob(adop) = e^{(Bo+B1X1)} / 1 + e^{(Bo+B1X1)}$ ----------(2)

Then dividing equation (2) by $e^{Bo+B1X1}$, $Prob(adop) = 1/ 1 + e^{(Bo+B1X1)}$ ----------(3)

For more than one independent variable, the model can be generalized as:

$Prob(adop) = e^Z / 1 + e^Z$ ----------(4)

Dividing equation (4) by numerator, $Prob(adop) = 1/1 + e^{-Z}$ ----------(5)

Once equation (1) is computed, it is applied to compute the probability of adoption, Prob(adop), by inserting the Z values in (5)

Since it is easier (Gardson, 2008) to think of odds rather than log odds the odds ratio can be written as follows from equation (1)

$Prob(adop)/ prob(non\text{-}adop) = e^{B0 + B1X1 + B2X2 + ..... + BnXn}$ ---------- (6)

The logistic coefficient is the change in the log odds associated with a one unit change in the independent variable. The e raised to the power of B (odds ratio), written as Exp(B) in SPSS output, is the factor by which the odds change when the $i^{th}$ independent variable increases by one unit. The coefficients vary between plus and minus infinity, with 0 indicating the given explanatory variable does not affect the logit;

and positive or negative *B* coefficients indicate the explanatory variable increases or decreases the logit of the dependent.

### 4.5 Definition and Measurement of Hypothesized Variables

Usually study variable are categorized as dependent and independent variables. There are also intervening variables which will affect the actual relationship between the dependent and independent variables. Adoption of forage innovation is the dependent variable for this study. The independent (factor) variables included in the analysis are described as follows.

- **Adoption decision**

Adoption decision was considered as growing or not growing of forage innovation by the smallholder farmers. A household was considered as adopter if improved forage species is grown on his farm land. This includes households that interrupted the protection and management of the technology due to different reasons but the species is still in their farm lands. On the contrary, a household was categorized as non-adopter if no attempt was undertaken to grow the innovation. The decision to grow forage or reject was dichotomized as Yes =1, for a farmer who has the species on the farm; and No = 0, for a farmer with no species on farms.

From practical and statistical point of view, it is difficult to include all factors that influence the decision to adopt innovation. Based on correlation analysis, therefore, a limited number of factors are selected to estimate the adoption decision. Spearman's correlation analysis was performed for several variables. As a rule of thumb if correlation coefficient between two variables is greater than or equal to 0.6, only one of the variables is included in the logistic regression (Moock, 1981 in Yohannes *et al.*, 2007). 17 variables were selected to investigate the decision regarding adoption of forage innovation. The correlation matrix of the variables included in the model is Annex 1.

- **Educational level of the household head**

Education enhances decision making efficiency and thereby helps to improve ability required to make innovative decisions. Hence, level of education was assumed to increase the probability of adoption of forage innovation. The educational level of the household head categorized as illiterate and literate. The dummy was presented as *EDUCHHH*= 0 for illiterate household head and *EDUCHHH* =1 for literate.

- **Family size**

Lager family size was supposed to result in larger labor supply and it was expected to increase the chance of adoption. The particular emphasis associated with family size is the prevalence of working age group in the household. But for this study, total family size was assumed to influence adoption of forage innovation; because in most cases children (above 5 years) and old aged members in rural areas are assumed to be involved in herd-keeping. Family size used as a continuous variable with representation of *FAMSIZE* in the model.

- **Age of household head**

Older household heads were assumed be reluctant to adopt innovations due to their apathy for use of external inputs at later ages. Hence, under this study older age was considered to have negative influence on probability of adoption. It is a continuous variable entered in the model as *AGEHHH*.

- **Access to credit facility**

Financial resource is required to buy forage seeds, to hire labor or to buy livestock. Farmers may be unable to raise sufficient fund to invest in the innovation because of limited access to credit or temporary cash flow problem. This is to imply that there is likely of increase in adoption of innovation when credit service is available. Hence, the chance of adoption of the technology would be increased with the credit taking habit of the households. The study considered credit availability in the form of whether the household had taken

credit or not in the past five years. If credit was taken by the household the dummy would be *CREDIT*(Yes)= 1 or *CREDIT(No)* = 0, for the household who did not take any credit over the last five years.

- **Farm size**

The amount of *timad* of land owned by a household, with a given priority for livestock development and crop production in a mixed farming system, was assumed to influence the adoption of forage technology. It is obvious that some forage technologies are competitive to the crop production. Hence, farmers with larger farm size were assumed to adopt more likely than the farmers with small land holding size. Farm size measured in *timad* was used as a continuous variable with representation of *FARMSIZE* in the model.

- **Access to market places**

Market access is required to buy agricultural inputs and to sell farm produces. Hence, it is expected that access to market centers would increase the probability of adoption. For this study market access was seen in terms of availability of town market and respective minimum distances measured in km. Distance is a continuous variable represented as *DISTTOMARKET* in the model.

- **Livestock size**

Forage innovation is mostly used for the livestock development and production. The larger the livestock size in a household the more the need for larger feed resources. Households with larger livestock size were expected to adopt forage innovation than the small size owners. It is a continuous variable used as *LIVESTOCKSIZE* in the model.

- **Intensifications in the livestock sector**

Intensification of livestock production can drive the demand for forage development and productions. This study assumed that the practice of smallholder farmers in dairy production and animal fattening would increase the probability of adopting forage technology. Farmers practice in dairy production and animal fattening were represented by dummy variables *DAIRYPROD(Yes)* =1 and *BEEFFATTEN(YES)* =1 for

farmers engaged in the practices, and *DAIRYPROD(No)* = 0 and *BEEFFATTEN((No)* = 0 for those not practicing in dairy production and animal fattening respectively.

- **Access to extension services**

Extension contact is essential in technology dissemination. This study assumed that contact with extension workers and minimum distance between offices of DAs and village of the household was supposed to increase the probability of growing improved forage species. The farmers contact with extension agents was used with a dummy variable *CONTAEXT(Yes) =1* for the groups with extension contacts and *CONTAEXT(No) =0* for farmers not having any contact with extension agents. The variable distance to the offices of DAs from a village of a farmer is continuous variable shown in the model as *DISTDAS*.

- **Visit to demonstration plots**

Visits to research center or to other farmers' fields will help the households to visualize the potential benefits of the technology. Farmers with experience of attaining demonstration days and visiting demonstration plots could increase the likely of adopting innovations. Under this study, farmers who had visited demonstration plots were included in the model with dummy *DEMONST(Yes)= 1* and *DEMONST(NO) = 0* for farmers not visited demonstration plots in the last five years.

- **Training of forage related activities**

Training of forage related activities particularly technical trainings such as how to plant, cut and feed, and conserve etc. have potency of increasing the probability of adoption. Under this study farmers who have taken training were assumed to adopt the technology and were included in the model as dummy variable with *TRAINFORAGE (Yes) =1* and those not trained about the innovation as *TRAINFORAGE (No) = 0*.

- **Asking /Inviting farmers to grow forage**

The farmers are assumed to be inspired for motivating them to grow forage technology. Direct asking households to practice growing the forage would likely increase the probability of adoption. This study

considered farmers who had been called for growing forage innovation with dummy *CALLFORAGEDEVT (Yes) =1* and those had not been invited as *CALLFORAGEDEVT (No) =0*.

- **Water Availability**

Biological innovations such as forage require water to give the expected benefit for intended sector. Water availability was assumed to increase the probability of adoption of forage innovation. This study emphasized on whether there is water shortage in the study area which constrained the practice of growing forage species. The farmers with the shortage of water to grow forage were included in the model as *WATERSHORT (Yes) =1* and those who did not faced water shortage as *WATERSHORT (NO) =0*

- **Forage seed Supply**

The availability of planting martial such as forage seed is essential for possible adoption of the innovation. Hence, this study assumed that the probability of adoption of forage innovation will be enhanced with enough supply of forage seed. The farmers challenged by shortage of forage seed were represented with dummy *SEEDSHORT(Yes) =1*, and farmers with no short of supply *SEEDSHORT(No) =0* .

- **Uncontrolled grazing (Free grazing)**

Farming system is not free of disturbances of different kind such as free grazing and requirement of fencing material for the same, diseases and termites. This study considered the existence of disturbances which negatively affects the probability of adoption of forage technology. For the farmers free grazing as major constraint to grow forage, the dummy *FREEGRAZE(Yes) =1* and for farmers free grazing is not a problem *FREEGRAZE(No)=0* is included in the model.

**Table 4.1 Summary of Variables Included in the Logit Model**

| Variable | Code | Type | Definition | Hypothesis |
|---|---|---|---|---|
| Growing forage species@ | *FORAGE* | Dummy | 0= No and 1= Yes | |
| Age of the household head | *AGEHHH* | continuous | Age in years | Negative |
| Educational level of household head | *EDUCHHH* | Dummy | 0= illiterates and 1= literates | Positive |
| Family size | *FAMSIZE* | continuous | Total members of the family | Positive |
| Farm size | *FARMSIZE* | continuous | Total land in *timad* | Positive |
| Practice in beef fattening | *BEEFFATTEN* | Dummy | 0= No and 1= Yes | Positive |
| Practice in dairy production | *DAIRYPROD* | Dummy | 0= No and 1= Yes | Positive |
| Distance from town market | *DISTTOMARKET* | continuous | Minimum distance traveled in km | Negative |
| Contact with extension workers | *CONTAEXT* | Dummy | 0= No and 1= Yes | Positive |
| Distance from DAs office | *DISDAS* | continuous | Distance between village and office (km) | Negative |
| Training of forage related activities | *TRAINFORAGE* | Dummy | 0= No and 1= Yes | Positive |
| Visits to demonstration plots | *DEMONST* | Dummy | 0= No and 1= Yes | Positive |
| Asking farmers to grow forage | *CALLFORAGEDVET* | Dummy | 0= No and 1= Yes | Positive |
| Shortage of Water | *WATERSHORT* | Dummy | 0= No and 1= Yes | Negative |
| Forage seed supply shortage | *SEEDSHORT* | Dummy | 0= No and 1= Yes | Negative |
| Free grazing | *FREEGRAZE* | Dummy | 0= No and 1= Yes | Negative |
| Livestock size | *LIVESTOCKSIZE* | continuous | Total livestock unit | Positive |
| Access to credit | *CREDIT* | Dummy | 0= No and 1= Yes | Positive |

@ Dependent Variable

# 5. RESULTS AND DISCUSSION

Under results and discussions section of the thesis, basic socio- economic characteristics of household heads, feed resource and feed resource management practices, institutional arrangements, the state of adoption of forage innovation and the challenges and constraints of adopting the technology are described. Moreover, factor that determine the adoption decision of the innovation at household level are identified.

## 5.1 Background and Demographic Characteristics of Sample Households

Background and demographic characteristics considered in this investigation encompass the socio-demographic features such as age, sex, educational level, and marital status of the household heads; family size and members of the sample households.

### 5.1.1 Background Information of Household Heads

This study is based on 120 sample household heads. The questionnaire survey resulted in an average age of about 44 years for the household heads. The majority of the respondents are in the active work force category; because about 95 percent of the respondents are in the age category of 23 to 65. As it is indicated in Table 5.1, about 90.8 percent of the respondents are males and 9.2 percent are females. The majority (67.5%) of the household heads can at least read and write; rest (32.5%) of the respondents cannot read and write. The same table also shows that almost 97 percent of the household heads get married with 3.3 percent and 4.2 percent divorced and widowed respectively.

**Table 5.1 Background Information of Household Heads**

| Background Information | | Frequency | Percent |
|---|---|---|---|
| Educational level | Illiterate | 39 | 32.5 |
| | Read and write only | 42 | 35.0 |
| | Elementary (1-6 grade) | 28 | 23.3 |
| | Junior secondary (7-8 grade) | 6 | 5.0 |
| | Senior secondary(9-12 grade) | 5 | 4.2 |
| | Total | **120** | **100.0** |
| Marital status | Single | 4 | 3.3 |
| | Married | 107 | 89.2 |
| | Divorced | 4 | 3.3 |
| | Widowed | 5 | 4.2 |
| | Total | **120** | **100.0** |
| Sex of the Respondents | Male | 109 | 90.8 |
| | Female | 11 | 9.2 |
| | Total | **120** | **100.0** |

*Source: Field survey, 2008*

## 5.1.2 Demographic Characteristics of Sample Households

The questionnaire survey in *Kalu* shows that the average family size is about 6 with nearly equal numbers of males and females in the overall ages. The age groups below 15 years and above 65 years (which is mostly termed as the dependent groups) accounts for about 47.9 percent of the family members in the sample households. The active age group accounts to 52.1 percent. There is an average of 2.99 active work forces and an average of 2.77 dependents per household (Table 5.2).

**Table 5.2 Family Size and Members in the Sample Households**

| Family Composition | Mean | Std. Deviation | Percent |
|---|---|---|---|
| Number of male aged below 15 years | 1.19 | 1.023 | 20.70 |
| Number of female aged below 15 year | 1.45 | 1.028 | 25.10 |
| Number of male aged 15 to 64 year | 1.56 | 0.887 | 27.10 |
| Number of female aged15 to 64 years | 1.43 | 0.827 | 25.00 |
| Number of male aged above 65 year | 0.07 | 0.250 | 1.10 |
| Number of female aged above 65 year | 0.06 | 0.235 | 1.00 |
| **Total Family size** | **5.76** | **2.12** | **100.00** |

*Source: Field survey, 2008*

## 5.2 Economic Characteristics of Sample Households

As far as the economic characteristics of the sample households is concerned, the farming systems in the study area have farm land, labor and livestock as basic asset of the households.

### 5.2.1 Farm Land

The selected households in the study area have an average land size of 4.8 *timad* per household. The majority (83.3 %) of the sample households have 2-8 *timad* of land, of which about 57 percent households are in the category of 2-5 *timad* owners (Table 5.3).

**Table 5.3 Farm Land Owned by the Households**

| Land size in *timad** | | Frequency | Percent |
|---|---|---|---|
| Land size category | Size<=2 | 12 | 10.0 |
| | Size>2&<=5 | 68 | 56.7 |
| | Size>5&<=8 | 32 | 26.7 |
| | Size>8 | 8 | 6.7 |
| | Total | 120 | 100.0 |

*Source: Field survey, 2008* *1 *timad* = 0.25 hectare

Households in most cases allocate land for different crops such as sorghum, *teff*, fruit, and vegetables and for grazing land among others. This allocation is made actually based on the land size, the risk associated with the weather condition, the suitability of the land for the proposed purpose in terms of soil fertility and access to irrigation. Most (91.7%) of the farmers in the selected *Kebeles* also allocated their farm land for sorghum production, *teff* production, vegetable and fruit production, wheat production, oil and pulse productions. Most farmers are accustomed to use their land for the purpose of sorghum production. *Teff* production is the second most important crop in terms of the number of producers and plot size after sorghum. The land allocated for forage production is the smallest for most of the households. The questionnaire survey result shows that of the total adopters who know the land allocated for forage production, about 57 percent allocated less than 0.5 *timad* of land and about 87 percent less than or equal to one *timad*. Moreover, as it is shown in Table 5.4, the average land size allocated for forage production is only about 0.86 *timad* of land.

**Table 5.4 Allocation of Farm Land for Different Cropping and Grazing Systems (in *timad*) 2006/07 Seasons**

| cultivar | N*** | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| *Teff* | 80 | 0.50 | 6.00 | 1.8813 | 1.15079 |
| Wheat | 14 | 0.50 | 3.00 | 1.5000 | 0.73380 |
| Sorghum | 106 | 1.00 | 6.00 | 2.2995 | 0.97898 |
| Fruit trees | 29 | 0.25 | 4.00 | 1.0479 | 0.78907 |
| Vegetable | 19 | 0.50 | 2.00 | 1.1053 | 0.51583 |
| Grazing land | 52* | 0.08 | 4.00 | 1.0996 | 0.89202 |
| Forage Production | 53** | 0.08 | 5.00 | 0.8550 | 0.97570 |
| Pulse and oil seed | 22 | 0.20 | 2.00 | 0.8591 | 0.64543 |
| Other Crops | 37 | 0.20 | 3.00 | 1.0581 | 0.79656 |

*Source: Field survey, 2008*

** The farmer who allocated land for grazing accounts to about 68, but 16 farmers do not know the size allocated for.*

***The farmers who grow forage species accounts for 73, but 20 farmers can not identify the land size allocated.*

**** N is number of respondents who allocated land for the respective cultivars*

Currently there seems to exist a trend of shifting grazing land to cultivated farm land. This is supposed to decrease the grazing land of the smallholder farmers and will have an increasing impact on the size of the cultivated land. The smallholders in the selected area hold the cultivated land unchanged over the last five years (66.7%). From the total sample smallholders 43.3 percent of households do not have any gazing land. About 60 percent of the owners of grazing land hold constantly unchanged over the last five year (Table 5.5). Some farmers mentioned that the increase in grazing land is resulted from of distribution of communal grazing land for private use. Some farmers in the study area have been distributed grazing lands to be kept and used through cut-and-carry system under the households' control. Whereas the indicated decrease in grazing land is attributed to erratic run-off which made the land useless and some farmers distribute land to married sons.

**Table 5.5 Trends of Cultivated Land and Grazing Land over Last the Five Years**

| Descriptions | | Frequency | Percent |
|---|---|---|---|
| The trend of the cultivated land over the last five years | Decreasing | 28 | 23.3 |
| | Constant | 80 | 66.7 |
| | Increasing | 12 | 10.0 |
| **Total** | | **120** | **100.0** |
| The trend of your own grazing land over the last five years | Decreasing | 13 | 10.8 |
| | Constant | 40 | 33.3 |
| | Increasing | 15 | 12.5 |
| | Total | 68 | 56.7 |
| | NAP | 52 | 43.3 |
| **Total** | | **120** | **100.0** |

*Source: Field survey, 2008 NAP= not applicable*

### 5.2.2 Labor

Labor availability is an economic factor of production that is considered as basic resource in the overall production process of the farming units. It refers to the fulltime farm workers and assisting labor forces.

With regard to the sample households of this study, the average fulltime workers are about 2 per household. About 65% of the household heads responded that they have two fulltime farm workers and almost in all (98.3%) of the households at least one fulltime farm worker is available. There are households (32.5%) in which children are not assisting in farming activities. The majority of the sample smallholders (76.7%) in the study area did not get assistance from relatives (Table 5.6).

**Table 5.6 Labor Availability**

| Number of fulltime and assistant workers per household* | | Frequency | Percent | Mean(SD) |
|---|---|---|---|---|
| Number of fulltime workers in a household | 0 | 2 | 1.7 | 1.88(0.762) |
| | 1 | 29 | 24.2 | |
| | 2 | 78 | 65.0 | |
| | 3 | 5 | 4.2 | |
| | 4 | 5 | 4.2 | |
| | 5 | 1 | 0.8 | |
| | Total | 120 | 100.0 | |
| Number of assistant children in a household | 0 | 39 | 32.5 | 1.15(1.090) |
| | 1 | 41 | 34.2 | |
| | 2 | 28 | 23.3 | |
| | 3 | 9 | 7.5 | |
| | 4 | 1 | 0.8 | |
| | 5 | 2 | 1.7 | |
| | Total | 120 | 100.0 | |
| Number of assistant relatives live in a household | 0 | 92 | 76.7 | 0.38(0.812) |
| | 1 | 15 | 12.5 | |
| | 2 | 10 | 8.3 | |
| | 3 | 1 | 0.8 | |
| | 4 | 2 | 1.7 | |
| | Total | 120 | 100.0 | |

Source: *Field survey, 2008*

* *Numbers 0 to 5 represent the number of fulltime workers and assistants in the households.*

The other issue with regard to labor availability is the involvement of women in the farming activities (plowing, harvesting, weeding, herd keeping etc.). As it is indicated in Table 5.7, women are greatly involved in selected farming activities in the study area. While they are largely engaged in herd keeping, weeding and harvesting activities they do not involve in plowing (only about 17.4 percent of the respondents mentioned that women involve in plowing activity).

**Table 5.7 Women's Involvement in Farming Activities**

| Women's involvement in farming activities | | Responses | |
|---|---|---|---|
| | | Yes | No |
| Are women involved in farming activities? | | 115(95.8) | 5(4.2) |
| Areas to be involved | ▪ plowing activities | 20(17.4) | 95(82.6) |
| | ▪ herd keeping activities | 109(94.8) | 6(5.2) |
| | ▪ harvesting activities | 106(92.2) | 9(7.8) |
| | ▪ weeding activities | 113 (98.3) | 2(1.7) |

*Source: Field survey, 2008* *Figures in bracket are percentages*

Labor available in a household including fulltime farm workers, the assistant children and relative living in the household may not be sufficient in peak labor demand periods. The solutions used to alleviate labor shortage include traditional labor exchange, hired labor and use of relatives in the peak seasons. The majority (85.8 %) of the sample household indicated that they face labor shortage in farming activities (Table 5.8).

**Table 5.8 Labor Shortage and Solutions used**

| Labor Shortage and solutions used | | | Frequency | Percent |
|---|---|---|---|---|
| Do you face labor shortage in farming activities? | | Yes | 103 | 85.8 |
| | | No | 17 | 14.2 |
| | | **Total** | **120** | **100.0** |
| Measures taken | ▪ Hired labor | Yes | 56 | 54.4 |
| | | No | 47 | 45.6 |
| | | **Total** | **103** | **100.0** |
| | ▪ Use traditional labor exchange *(debbo)* | Yes | 90 | 87.4 |
| | | No | 13 | 12.6 |
| | | **Total** | **103** | **100.0** |
| | ▪ Use relatives in peak labor demanding periods | Yes | 58 | 56.3 |
| | | No | 45 | 43.7 |
| | | **Total** | **103** | **100.0** |

*Source: Field survey, 2008*

It is also indicated that most (87.4%) of the households use traditional labor exchange to solve labor shortage. About 56.3 percent and 54.4 percent of the households also call relatives and use hired labor respectively (Table 5.8).

Associated with the economic characteristics of households, there is also non-farm income supplementing the farming systems. The rural farmers get income either from non-farm occupation such as wage labors, petty trades and handicrafts or migrant family members.

**Table 5.9 Non-farm Occupations**

| Descriptions | | Responses | |
|---|---|---|---|
| | | Yes | No |
| Do you have occupation other than farming? | | 74 (61.7) | 46 (38.3) |
| Non-farm areas | • Occupation in wage laborer | 36(48.6) | 38(51,4) |
| | • Occupation in petty trade | 26(35.1) | 48(64.9) |
| | • Occupation in handicraft | 21(28.4) | 53(71.6) |

*Source: Field survey, 2008* *Figures in brackets are percentages*

Table 5.9 indicates that about 61.7 percent of the sample household heads have non-farm occupations. About 48.5 percent, 35.1 percent and 28.4 percent of the household heads mentioned that they have non-farm occupation in wage labor, petty trade and handicraft respectively. The questionnaire survey also revealed that 104 (86.7%) of the households did not have family member living and working in other places.

### 5.2.3 Livestock Resources

Livestock resource is the other economic resource for the sample households. The households in the study area owned an average of 7.6 livestock unit excluding chickens. Cattle took the highest share of the total livestock population with an average of 4.16 TLU. The survey questionnaire result indicates that equines are kept by small number of households, only about 8.71 TLU are reared by the total sample households (Table 5.10).

**Table 5.10 Size of Livestock in the Sample Households**

| Type of Livestock | Size in number | Mean | TLU* Equivalent |
|---|---|---|---|
| Ox | 181 | 1.15 | 181 |
| Cow | 163 | 1.36 | 163 |
| Calf | 126 | 1.05 | 63 |
| Heifer | 52 | 0.43 | 52 |
| Bull | 40 | 0.33 | 40 |
| Total cattle | **562** | **4.68** | **499** |
| Sheep | 119 | 0.99 | 11.9 |
| Goat | 193 | 1.61 | 19.3 |
| Total sheep and goats | **312** | **2.6** | **31.2** |
| Donkey | 12 | 0.10 | 8.04 |
| Mule | 1 | 0.01 | 0.67 |
| Horse | 0 | 0.00 | 0 |
| Total equines | **13** | **0.11** | **8.71** |
| Camel | 25 | 0.21 | 36.25 |
| Chicken | 903 | 7.53 | 4.515 |

*Source: Field survey, 2008*

**Conversion factors for TLU equivalent are: cattle =1.0 calf =0.5, sheep/goat =0.1, mule = 0. 67, donkey =0.65, horse = 0.67, camel = 1.45 and poultry =0 .005 (Ramakisha and Assefa, 2002 in Dagnew, 2006).*

### 5.2.3.1 Intensification in Livestock Resources

For effective use of the livestock resources, intensification of the sector supporting with available technologies is considered essential. Beef fattening, dairy production with cross-bred cows, and use of other technologies are required in the intensification processes. About 35 percent and 30 percent of the sample households rear cattle in stall feeding for beef fattening and milk production (Table 5.11). Technologies in the livestock development and production such as cross bred cows, improved forage (fodder), improved grazing management, health drugs, AI, highbred poultry production are used to improve productivity of the sector. It is indicated in Table 5.11 that most of (79.2%) of the sample households use at least one improved technology for the livestock resource development.

**Table 5.11 Technologies for Livestock Development and Production**

| Livestock intensification issues and technologies used | | Responses | |
|---|---|---|---|
| | | Yes | No |
| 1. Do you practice in animal fattening activities? | | 42(35.0) | 78(65.0) |
| 2. Do you practice in dairy production? | | 36 (30.0) | 84(70.0) |
| 3. Do you use Improved technology in livestock production? | | 95(79.2) | 25(20.8) |
| Improved Technologies | ▪ Cross bred cows | 23 (24.2) | 72 (75.8) |
| | ▪ Fodder trees (forage technology) | 73 (65,3) | 22 (34.7) |
| | ▪ Use of health drugs for animals | 60 (63.2) | 35 (36.8) |
| | ▪ Improved grazing management | 18 (18.9) | 57 (81.1) |
| | ▪ Poultry production with improved breeds | 21 (22.1) | 74 (77.9) |
| | ▪ Artificial insemination (AI) | 17 (17.9) | 78 (82.1) |

*Source: Field survey, 2008* *Number in brackets are percentages*

### 5.2.3.2 Major Constraints in the Livestock Development and Production

The livestock development and production is constrained by the presence of livestock disease, shortage of feed, water scarcity, lack of grazing land, etc. As it is indicated in Table 5.12, the selected households stated that feed shortage (70.5%), disease (60.5%) and lack of grazing land (51.3%) are the most challenging constraints of livestock development and production in the study area.

**Table 5.12 Major Constraint in Livestock Development and Production**

| Major constraint in livestock development and production | Responses | |
|---|---|---|
| | Yes | No |
| Disease | 72(60.5) | 47(39.5) |
| Feed shortage | 84(70.6) | 35(29.4) |
| Water shortage | 41(34.5) | 78(65.5) |
| Shortage of grazing land | 61(51.3) | 58(48.7) |
| Poor grazing land | 26(21.8) | 93(78.2) |
| Over grazing | 18(15.1) | 101(84.9) |
| Lack of veterinary service | 47(39.5) | 72(60.5) |

*Source: Field survey, 2008* *Numbers in brackets are percentages*

### 5.2.3.3 Feed Resource Management and Practice

In the livestock development and production, feed is instrumental asset of the sector. Feed resources include crop residues, weeds, grazing lands, industrial byproducts, etc. It is also crucial to manage and properly utilize the available feed resources. Feed shortage is critical problem in dry seasons so that feed resource management is practiced to preserve feed from surplus periods. Collecting and piling of crop residues and hays are commonly practiced options.

Most (95.7 %) of the sample households use crop residues as major feed resource (Table 5.13). It ranks first for 66.7 percent of household heads asked to rank crop residues in the dry season. The rank given to crop residues changed in the wet season, only 10 percent of the respondents gave the first rank. Crop residues are most used in the dry seasons, according to the smallholders, due to: 1) livestock preference

changed to wet feeds in the wet season, for most of crop residues are dried out, and 2) crop residues ends up in the dry season.

Weeds are among the most used feed resources in the wet seasons. As it is indicated in Table 5.13, most (90.8%) of the sample household heads mentioned that they use weeds to feed livestock. The smallholders were asked to rank the major feed resources. About 51.7 percent of respondents gave the first rank for weeds. By the same token about 98.1 percent of the household heads ranked weeds first to fourth for wet seasons. The farmers practice to use weeds as feed is associated with sorghum production. The sample household heads stated that they over sow sorghum seeds so that the unfitted ones are considered as weeds (locally termed as *mu'ateto)*.

Aftermath (*karmiya*) is another feed resource used by smallholder farmers in the study area. The majority (85.7%) of households use aftermath to feed livestock (Table 5.13). About 54.2 percent of the household heads gave the second and the third rank for aftermath in the dry season. Since aftermath is used immediately after harvesting of crops and little is left in the farm land, the farmers mentioned that it is used for limited periods. It is only 6.7 percent of the respondents that ranked aftermath as their first option.

The same table also revealed that grazing land is another source of feed in the study area. Both private and communal grazing lands are used by the smallholders. The majority (63 %) of the sample household heads used private grazing lands to feed livestock. About 58 percent of the respondents indicated that communal grazing lands are sources of feed. The private grazing land includes small grazing lands adjacent to and at the boundary (locally known as *yewober sar*) of farm land and communal grazing land allocated for private use.

Moreover, the smallholders also purchase feed resources. As it is indicated in Table 5.13, the majority (73.9%) of the households purchase hays, grasses and straws to feed their livestock. The use of industrial

by-products is limited. It is only 14.1 percent of respondents who indicated that industrial by-products are resource of feed. Forests, shrubs and bushes are not major feed resources in the selected area. It is only about 12 percent of the household heads that indicate forests, shrubs and bush are sources of feed (Table 5.13).

**Table 5.13 Major Feed Resources**

| Feed resources | Responses | |
|---|---|---|
| | Yes | No |
| Crop residues | 114 (95.5) | 5 (4.3) |
| Private grazing land | 75 (63.0) | 44 (37.0) |
| Aftermath | 102 (85.7) | 17 (14.3) |
| communal grazing land | 69 (58.0) | 50 (42.0) |
| Industrial byproducts | 18 (14.1) | 101(84.9) |
| Forests, shrubs and bushes | 14(11.8) | 105(88.2) |
| Weeds | 107(90.8) | 12(9.2) |
| Purchased hays, grasses and straws | 88(73.9) | 31(26.1) |

*Source: Field survey, 2008* *Figures in brackets are percentages*

The simple availability of feed resource is not sufficient; it requires proper management and control. Majority (96.7 %) of the sample households collect crop residues and make piles to manage and control feed resource. Moreover, about 77.1 percent of livestock owners in the sample households indicated that they collected hays for this year. But only about 25 percent the households with grazing land rotate livestock in grazing (Table 5.14).

**Table 5.14 Feed Resource Management Practices**

| Management Practices | Responses | |
|---|---|---|
| | Yes | No |
| Rotation system in grazing lands | 19(25.3) | 56(74.7) |
| Make Piles of crop residues | 116(96.7) | 4(3.3) |
| Hays collected current year | 91(77.1) | 28(22.9) |

*Source: Field survey, 2008* *Figures in brackets are percentages*

Even though the collection of crop residues and use of hays as means of managing and reserving feed stuff are usual practices, the household heads indicated that there is challenging feed shortage. For a question related to the shortage of feed over the last five years, about 77 (64.7%) respondents indicated the shortage the existence of feed shortage.

## 5.3 Institutional Characteristics of Sample Households

Institutional arrangements are required to the efficient utilization of resources and bring change in the rural development process. Some of the institutions considered in the study were extension service, credit and market institutions.

### 5.3.1 Credit Institutions and Service Delivery

As far as the credit taking habit of the smallholder farmers is concerned, the majority (82.5%) of the household heads had taken credit from different sources. For 67.7 percent of the sample households, government office (i.e., WOAgRD) is the major source of credit followed by local credit associations (Table 5.15). The households are not accustomed to take credit directly for forage development and production. For the majority of the farmers, forage development and production has no priority for credit. Moreover, forage seed is freely provided by the *Woreda* office.

**Table 5.15 Credit Services**

| Credit taking habit and credit sources | | Responses | |
|---|---|---|---|
| | | Yes | No |
| Have you ever taken credit? | | 99(82.5) | 21(17.5) |
| Sources of Credit | ▪ Government (WOAgRD) | 67(67.7) | 32(32.3) |
| | ▪ Neighboring farmers | 22(22.2) | 77(77.8) |
| | ▪ Local trader | 8(8.1) | 91(91.9) |
| | ▪ Credit association | 54(54.5) | 45(45.5) |
| | ▪ NGOs | 24(24.2) | 79(79.8) |
| | ▪ MFIs | 27(27.3) | 72(72.7) |
| | ▪ Relatives | 28(28.3) | 71(71.7) |

*Source: Field Survey, 2008 Figures in brackets are percentages*

### 5.3.2 Market Access of Households

The household heads mentioned that there is no as such pronounced shortage of market center to sale agricultural products. The farmers can sell agricultural produces in town, farm gate and local markets.

**Table 5.16 Market Access of Households**

| Market place of sale | Responses | |
|---|---|---|
| | Yes | No |
| Local market | 94(78.3) | 26(21.7) |
| Farm gate markets | 34(28.3) | 86(71.7) |
| Town markets | 100(83.3) | 20(16.7) |

*Source: Field Survey, 2008 Figures in brackets are percentages*

The sample households rely on town markets and local markets to sell agricultural produces in majority of the cases, 83.3 percent and 78.3 percent respectively. However, only about 28.3 percent of the respondents indicate that farm gate markets are used in selling agricultural products (Table 5.16). Some of the households mentioned that farm gate markets are used only if the farmer produces fruits and vegetables including sugar cane and sell feed resources.

### 5.3.3 Extension Services, Training and Contact Characteristics of the Household Heads

The frequency of extension contacts by the farmers with extension agents (DAs) and the average distance between the households' village and DAs offices were surveyed. Distance was analyzed by classifying into four categories (Annex.2).

**Table 5.17 Extension Contact Characteristics of the Household Heads**

| Number of contacts and distance from DAs office | Frequency | percent |
|---|---|---|
| Number of Contacts made with extension workers last year | | |
| o Once | 5 | 4.2 |
| o Twice | 11 | 9.2 |
| o Five times | 15 | 12.5 |
| o Ten times | 15 | 12.5 |
| o More than ten time | 63 | 52.8 |
| Total | 109 | 100.0 |

*Source: Field Survey, 2008*

There are some (9.2%) household heads that do not have any contact with extension agents. The majority (90.8%) of the sample smallholders, however, made contact(s) with extension workers. Moreover, about 53 percent of the households made more than ten contacts within a year. With regard to the distance between the home of a farmer and the office of development agents, the majority (88.3%) of the respondents are found at a distance less than or equal to five km.

**Table 5.18 Frequency Distribution of the Household Heads Trained Farm Related Activities**

| Descriptions | Responses | |
|---|---|---|
| | Yes | No |
| Have you ever taken training related farm activities? | 100 (83.3) | 20 (16.7) |
| o Fertilizer application | 29(29.0) | 71(71.1) |
| o Pesticides application | 67(67.0) | 33(33.0) |
| o Artificial Insemination | 31(31.0) | 69(69.0) |
| o Forage technology | 57(57.0) | 43(43.0) |
| o Feed resource management | 68 (68.0) | 32(32.0) |

*Source: Field survey, 2008* *Figures in the brackets are percentages*

About 83.3 percent of the household heads took training related to farm activities (Table 5.18). The sample household heads trained about how to use feed resources (68%), pesticides (67%), and forage technology (57%) in majority of the cases. About 92 percent trained farmers have got the training enough and more than enough (Annex.2).

## 5.4 Forage Technology Development and use

The start of adoption of improved forage technology lasts about quarter a century in the study area. An expert in the *Woreda* office disclosed that the adoption of forage technology was started in 1983. The innovation was in use when the dairy development cooperatives were functioning; and an extensive application was recorded in the year 1988 in some peasant associations. But the practice was interrupted together with the fall of the dairy development cooperatives. The revival of the adoption started for the second time in 1999. Now, the Woreda expert stressed, every *Kebele* is growing at least one species. According to the discussion results with experts in the *Woreda* office and DAs, lablab, pigeon pea, elephant grass, vetch, cow pea, *sesbania* and alfalfa are the most used types of forage species.

### 5.4.1 The State of Forage Technology Adoption

This section investigates the adoption characteristics of the sample households. The number of sample adopters, ways the innovation introduced, ways of establishment, ways of growing, most growing species, farmers observation and attitude for species grown, forage seed supply, and farmers use of the species are discussed.

The sample households are categorized as adopters and non-adopters based on their decision to grow or reject to grow forage species on their farms. The result of questionnaire survey shows that 73 (60.8%) of the sample households are adopters. The adopters are the households who are growing forage species on

their land. It includes farmers started the practice but interrupted management and protection of species for reasons such as uncontrolled grazing and lack of awareness.

The sample households mentioned that forage species are first introduced by the role of extension workers. The sample households stressed that the extension agents were forcing some farmers at initial times. Households who have better awareness to innovations such as fertilizer and crossbred cows were forced to grow forage species. But the sample households described that they know the benefit from neighboring farmers and trainings in later times.

As it depicted in Table 5.19, most (78.3 %) of the sample households were asked to grow forage species. The contribution of DAs is much greater (94.7 %) to call the farmers practice in growing the innovations. Introduction of forage innovation though participatory development is not practiced in the study area. The questionnaire survey result shows that farmers had not been asked to evaluate species they have adopted. Table 5.19 reveals that all the sample households were not part of species evaluation. Moreover, little demonstration work is done in the study area. It is only about 30 percent of the household heads who had visited demonstration plots.

**Table 5.19 Ways Forage Innovation Introduced to Households**

| Introduction of forage innovation | Responses | |
|---|---|---|
| | Yes | No |
| Have you ever been asked /invited to grow forage species? | 94(78.3) | 26(21.7) |
| ▪ By DAs | 89(94.7) | 5(5.3) |
| ▪ *By Kebele* administrator | 9(9.6) | 85(90.4) |
| ▪ *By Woreda* experts | 24 (25.5) | 70(74.5) |
| Have you ever participated in evaluating forage varieties? | 0(0.0) | 120(100.0) |
| Have ever seen forage technology demonstration plot? | 36(30.0) | 84(70.0) |

*Source: Field survey, 2008* *Figures in brackets are percentages*

The smallholders are practicing different way of growing forage innovation. Cut and carry plot, cover crops under trees, living fence, ground cover for erosion control, contour hedgerows, and grazed plots are the ways of growing forage innovations in the study area. The sample households stated that cut and carry system is the most used way of growing the technology. About 50.7 percent of the adopter household heads use cut and carry plot way to grow forage species. The least used ways of growing forage innovation are grazing plots and improved fallowing, which account to about 7 percent and 10 percent of the adopter households respectively (Table 5.20)

Forage species are established through direct seeding of farm lands, through seedling and through cut and plant. The majority 95.9 percent of the adopter households mentioned that they established forage species through direct seeding. It is only about 5.5 percent and 27.4 percent of the sample adopters who established the species through seedling and cut and plant respectively (Table 5.20)

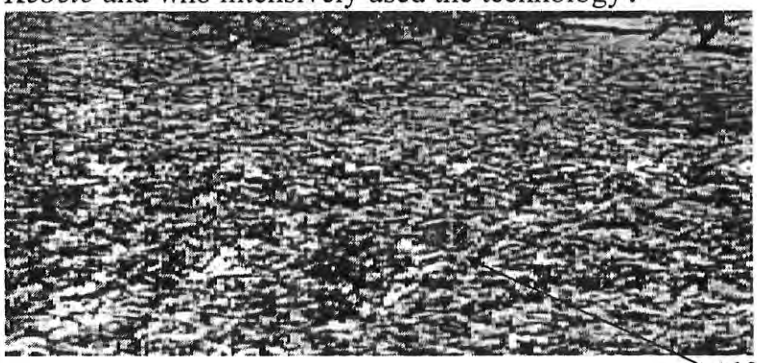
**Table 5.20 Ways used to Grow and Establish Forage species**

| Descriptions | Responses | |
|---|---|---|
| | Yes | No |
| **1. Ways to grow forage species** | | |
| Cut and Carry plots | 37 (50.7) | 36 (49.3) |
| Grazed plots | 5 (6.8) | 68 (93.2) |
| Living fence | 21 (28.8) | 52(71.2) |
| Contour hedge rows | 18 (24.7) | 55 (75.3) |
| Improved fallows | 7 (9.6) | 66 (90.4) |
| Cover Crops under trees | 28 (38.4) | 45 (61.6) |
| Ground cover for erosion control | 15 (20.5) | 58 (79.5) |
| **2.Ways to establish forage species** | | |
| Direct seeding ways of establishment | 70(95.9) | 3(4.1) |
| Through seedling ways of establishment | 4(5.5) | 69(94.5) |
| Through cut-and-plant ways of establishment | 20(27.4) | 53(72.6) |

*Source: Field survey, 2008* *Figures in brackets are percentages*

The majority (63.9%) of the sample adopters indicated that growing of *pigeon pea* is most practiced. The species is most practiced due to the fact that it can be implemented with other crops as inter-cropping. Most part of the *Woreda* is producing sorghum which is suitable for the development of pigeon pea as inter-cropping. The practice to grow *alfalfa* is attached with the dairy production.

BOX 1. The use of alfalfa in homestead of a farmer in *Marbet* village of *Tekake* PA. The farmer is one of the dairy producers in the *Kebele* and who intensively used the technology.




As it is revealed in Table 5.21, the least used varieties of forage innovations are Vetch and Cowpea 5.6 percent and 12.5 percent respectively.

**Table 5.21 Varieties of Forage Species Adopted by the Households**

| Varieties of forage species | Number of adopters | Percent |
|---|---|---|
| Alfalfa | 20 | 27.8 |
| Pigeon pea | 46 | 63.9 |
| Elephant grass | 25 | 34.7 |
| *Sesbania* | 21 | 29.2 |
| Cowpea | 9 | 12.5 |
| Common Vetch | 4 | 5.6 |
| Lablab | 16 | 22.2 |

*Source: Field survey, 2008*

According to farmers' observation of varieties they grow, the species are suitable to local soil types. The result of questionnaire survey in Kalu shows that majority (94.5 %)@ of the adopter found that the varieties are suitable to the soil type of their respective farm. Moreover, the productivity of the species is mentioned 'good' and 'very good' by almost 93[b] percent of the household heads (Annex.2).

Moreover, as it is shown in Annex.2, the sample household heads agreed with essentiality of the technology for livestock development and production. About 74.3 percent of the household heads have 'very strong' agreement for the requirement of forage innovation in the livestock sector. However, the priority given to grow forage is next to cereal and cash crops. About 53.1 percent of the sample households give the third priority. The farmers give the first priority to cereals and the second to cash crops. The farmers stated that their livelihood is highly dependent on cereal crops and cash crops are also considered as immediate cash generating crops than forages do. To mention the direct words of their reasoning: '*kdimiya lerasie keziya lekbtochu, enie kalnorkugn kebtochu aynorum; frafrie ena atkilt degmo tolo tolo gebi yasgegnalu silzih kemeno yikedimalu*'. The farmers understood that forage technology does not give direct benefit. It passes through livestock and the benefit is an indirect type.

As far as the supply of forage seed is concerned, the sample household heads stated that forage seed is freely provided by the *Woreda* Office of Agriculture and Rural development (WOAgRD). Almost 99 percent of the sample smallholders mentioned that they get forage seed from the WOAgRD (Table 5.22).

The smallholder farmers stated that they do not purchase forage seed from market. The use of own production as a source of seed is not also usual practice. Some farmers, particularly the user of alfalfa forage disclosed that the species cannot produce seeds. According to farmers the problem is liked with vegetative nature (locally called as *yigashbal)* of the species.

@ The observation of 69 hhh of the 73 adopter. [b] 40 'very good ,and 25 'good' attitudes of 73 adopter hhh

The farmers use forage species to feed different livestock in different cases. The majority (68.5%) of the sample households use forage as additional feed at night. Some farmers (33%) use the innovation to feed all of the livestock regularly.

**Table5.22 Forage Seed Supply and Feeding Systems**

| Descriptions | Response | |
|---|---|---|
| | Frequency | Percent |
| **1. Sources of forage seed** | | |
| Own production | 8 | 11.0 |
| Market | 1 | 1.4 |
| Neighboring farmers | 7 | 9.6 |
| NGOs | 0 | 0 |
| Extension offices (WOAgRD) | 72 | 98.6 |
| Research organization | 2 | 2.7 |
| **2.Farmers feeding habit of the technology** | | |
| Regular feeding for all livestock | 24 | 32.9 |
| Emergency source of feed | 35 | 47.9 |
| Difficult seasons when feed short is challenging | 5 | 6.8 |
| For sick and pregnant animals | 14 | 19.2 |
| As additional feed at night | 50 | 68.5 |

*Source: Field survey, 2008*

## 5.5 Factors and Constraints of Adoption of Forage Innovation

### 5.5.1 Descriptive and Statistical Analysis

Factors affecting the adoption of forage innovation encompass a number of components such as socio-economic, institutional and biophysical factors. Among the socio-economic factors educational level of household heads, age of household heads, family size and labor availability, farm size, and livestock resources were seen. The institutional factors assessed were access to credit services, access to market, extension contacts, training, and demonstration systems. The biophysical conditions discussed were water availability and grazing habits of the localities. The factors were seen by categorizing the population into

adopter and non-adopter and then looking the prevailing difference among the two groups in relation to the specified variables. Moreover, discussion results from *Woreda* experts, DAs and FGDs are included.

### 5.5.1.1 Socio-economic factors

#### I) Educational Level of the Household Heads

The adopter and non-adopter categories with regard to educational level of the household heads showed that the majority in both adopters and non-adopters are literates who can at least read and write. About 74 percent of the adopters and 57.4 percent of non- adopters are literates as it is indicated in Table 5.24. But, the percentages show that the adopters' percentage is greater than the non-adopters' in educational level. The same table also shows that there is statistically significant difference between adopters and non-adopters concerning their educational level($x^2$ =3.559, $p<0.1$). This implies that there is statistically significant association between adoption of forage technology and educational level (Table 5.24)

The significant association between educational level and adoption of forage innovation shows contradiction with the result of key informant discussion with the *Woreda* experts. The *Woreda* experts had been experienced with biased exclusion of hard working farmers from using improved technologies. The discussants mentioned that consideration of literates was creating negative implication on hardworking illiterate farmers. The distribution of forage seed was considering educational level as criterion at the start of introducing the technology. However, it did not result in sustenance of the adoption practice. Now according to the discussants forage seed distribution is regardless of educational level as far as the farmer is reported to be hard working in a certain *Kebele*. Moreover, the experts said that the farmers can practice growing of the technology by hearing what they have been told.

### II) Family Size and Labor Availability

The smallholder farming systems are largely dependent on family labor. Households with larger family members are considered as favorable to handle agricultural activities. Moreover, the larger family size shows lager labor supply in a household. Larger labor size is assumed to have propensity of increasing adoption of forage technologies. The average family size of adopters is 6.14. About average of 1.64 and 1.23 females and males aged below 15 years are found in the adopter households. Moreover, the average numbers of males and females at the age group of 15 to 65 years are 1.63 and 1.48 respectively under the adopters' category. The old age category of adopters consists of an average 0.07 and 0.08 males and females respectively. This description shows that working age groups are more or less better than other categories of age (Table 5.23).

As it is indicated in Table 5.23, the non-adopters have an average family size of about 5.26.The family members of the non-adopters consists of 1.13 and 1.15 males and females below 15 years; 1.45 and 1.34 males and females aged 15 years to 65 years and 0.06 and 0.02 male and female above 65 years. The dominance of average working age group is also revealed in the non-adopters category.

The statistical analysis showed that there is statistically significant difference ($t= 2.153$, $p < 0.05$) between adopters and non-adopters with size of family members. There is also statistically significance ($t= 2.639$, $p<0.01$) difference between the groups with number of females age below 15 years. However, the average working force group does not show statistical significance difference between adopters and non-adopters (i.e., males, $t = 1.106$, $p>0.1$ and for females, $t=0.899$, $p>0.1$). This means that active labor forces do not significantly differ between adopter and non- adopter of forage technology. The result does not show that active labor forces enhance adoption of forage technology and make differences between adopters and non-adopters. But association is revealed between adoption and total family size that the larger family size the more adoption will be by the smallholder farmers (Table 5.23).

The farmers' labor availability may also be measured with the full time farm workers, assisting children and relatives. The average full time farm workers of adopter and non-adopters are almost the same, 1.88 and 1.87 respectively. The statistical analysis shows that the number of fulltime farm workers are not significantly ($t = 0.031$, $p>0.1$) differed between adopters and non-adopters. Table 5.23 also shows that there is no pronounced difference between the adopters and non-adopters in getting assistance from children at their rest time. The t-test shows that there is no significant ($t=0.694$, $p> 0.1$) difference between adopters and non-adopters with number of assistant children. However, the assistance gained from relatives significantly ($t =3.107$, $p<0.01$) differed between adopters and non-adopters (Table 5.23).

With regard to non-farm occupations, about 59.6 percent of the non-adopters are engaged in non-farm occupation while only about 37 percent of the adopters are doing non-farm businesses. The statistical analysis indicated that there is no statistically significant ($x^2=0.143$, $p>0.1$) difference between the adopters and non-adopters with non-farm occupation (Table 5.24).

The sample households were asked if labor shortage was constraint to grow forage species. The statistical analysis to the households response does not show significant ($x^2= 0.187$, $p>0.1$) difference between adopters and non-adopters with labor shortage as constraint to grow forage technology (Table 5.24).

The statistical test to labor shortage as constraint to grow forage species goes in line with result of key informant and focus group discussions. Discussions with *Woreda* experts and DAs revealed that labor shortage is not as such a pronounced problem in the study area. The discussants did not deny the existence of resistance from some farmers while asked to adopt forage. According to the discussants, these households mention labor shortage as one of their problem for non-adoption. Moreover, the discussion held with selected farmers (FGDs) also implied the limitedness of labor shortage in impeding adoption of forage innovation. The discussants mentioned that there are larger family size households with larger work force

who did not grow forage technology. On the contrary, these discussants stated that there are households with a wife and husband who practiced the growing of forage.

### III) Age of the Household Heads

The average age of adopter is 43.58 while the non-adopter is 43.17 years. The numbers do not show magnified difference in age of the household heads between the two groups. The statistical analysis also indicated that there is no statistically significant (t=0.208, p>0.1) difference between adopters and non-adopters with age of household heads (Table 5.23).

**Table 5.23 Continuous Socio-economic Variables and Respective T-Tests**

| Variables | Adopter | | Non-adopter | | T-statistics | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Value | Sig. |
| Age of the household heads in years | 43.58 | 10.647 | 43.17 | 10.072 | 0.208 | 0.836 |
| Total number of the family members | 6.14 | 1.939 | 5.26 | 2.532 | 2.153** | 0.033 |
| Number of male aged below 15 years | 1.23 | 1.021 | 1.13 | 1.035 | 0.548 | 0.585 |
| Number of female aged below 15 year | 1.64 | 1.032 | 1.15 | 0.955 | 2.639*** | 0.009 |
| Number of male aged 15 to 65 year | 1.63 | 0.808 | 1.45 | 0.996 | 1.106 | 0.271 |
| Number of female aged15 to 65 years | 1.48 | 0.915 | 1.34 | 0.668 | 0.899 | 0.371 |
| Number of male aged above 65 year | 0.07 | 0.254 | 0.06 | 0.247 | 0.099 | 0.921 |
| Number of female aged above 65 year | 0.08 | 0.277 | 0.02 | 0.146 | 1.389 | 0.167 |
| The size of farm land owned in *timad* | 5.1336 | 2.02933 | 4.2809 | 2.29334 | 2.134** | 0.035 |
| Number of fulltime workers | 1.88 | 0.666 | 1.87 | 0.900 | 0.031 | 0.976 |
| Number of assistant children | 1.21 | 1.154 | 1.06 | 0.987 | 0.694 | 0.489 |
| Number of assistant relatives | 0.56 | 0.943 | 0.11 | 0.429 | 3.107*** | 0.002 |
| Average working hours per day | 8.644 | 1.8587 | 8.511 | 1.1955 | 0.436 | 0.663 |
| Number of oxen | 1.62 | 0.876 | 1.34 | 0.841 | 1.711* | 0.090 |
| Number of cows | 1.52 | 1.396 | 1.11 | 0.729 | 1.875* | 0.063 |
| Number of calves | 1.18 | 1.229 | 0.85 | 0.908 | 1.569 | 0.119 |
| Number of heifer | 0.45 | 0.708 | 0.40 | 0.648 | 0.373 | 0.710 |
| Number of bulls | 0.30 | 0.811 | 0.38 | 0.848 | -0.528 | 0.598 |
| Number sheep | 0.77 | 1.654 | 1.34 | 2.632 | -1.467 | 0.145 |
| Number of goats | 1.70 | 2.453 | 1.47 | 3.056 | 0.456 | 0.649 |
| Number of donkey | 0.08 | 0.323 | 0.13 | 0.397 | -0.688 | 0.493 |
| Number of camel | 0.32 | 0.574 | 0.04 | 0.204 | 3.124*** | 0.002 |
| Number of chicken | 7.27 | 14.069 | 7.91 | 29.188 | -0.161 | 0.872 |
| Total Livestock size | 7.84 | 4.66 | 7.06 | 5.19 | 0.846 | 0.399 |
| Estimated beef fattening annual income | 1,130.14 | 1,643.55 | 315.53 | 904.48 | 3.106*** | 0.002 |
| Estimated dairy product annual income | 1,759.47 | 4,807.97 | 72.87 | 227.93 | 2.400** | 0.018 |

*Source: Field survey, 2008* *** *Significant at p<0.01,* ** *significant at p<0.05,* * *significant at p<0.1*

### IV) Land Availability (Land Holding Size)

Land is the basic source of livelihood in rural Ethiopia. Land availability often influences farmer decision to practice extensive farming practices; and based on related cases is assumed to affect the adoption of forage innovation.

The average farm size of adopters' is 5.13 *timad* and the non-adopters hold an average land size of 4.28 *timad*. These figures indicate that the two groups have different land holding size. The statistical analysis also indicates that there is statistically significant ($t=2.134$, $p<0.05$) difference between the adopters and non-adopters in land holding size (Table5.23). The sample households were asked whether land shortage is constraining factor to grow forage species. About 87.7 percent of the adopters and 80.9 percent of the non-adopters stated that land shortage is one of the problems to grow forage species. The statistical analysis, however, shows that there is no significant ($x^2=1.043$, $p>0.1$) difference between the two groups with shortage of land as problem to grow forage species (Table 5.24).

The insignificance of the statistical analysis related to land as constraint shortage to adopt forage innovation goes in line with the discussion results of *Woreda* experts and DAs. Most smallholders in the *Woreda* grow forage species with other crops as intercrop. The discussants stated that intercropping can be used in sorghum fields and fruits at homesteads. Hence, according to these discussants land size is not a problem to grow forage. The discussants mentioned that some farmers do not want to plant forage due to lack of awareness.

Most of the focus group discussions conducted with selected farmers showed that land shortage is constraining problem in most households. Discussants in one selected *Kebele*, however, did not deny the existence of exceptional farmers who devoted their total land for growing of forage species and practice dairy production.

Generally, there is difference between respondents with regard to land availability and land shortage as constraining factor to adopt forage innovation. The statistical difference between the adopters and non adopters in land holding size may imply that adoption is related to large farm size because the adopters hold relatively larger average land size. This statistical difference is shared with the idea of most FGDs. However, the responses of DAs and *Woreda* experts to land shortage as constraining factor that affects adoption of forage innovation show that land shortage should not be the reason for non-adoption by most households. According to DAs and *Woreda* experts, nature of the technology and its benefits should be considered while talking about adoption and land holding size. Most forage species have the nature of being used as intercrop with fruit or other crop productions; and can be used as soil erosion control while generating direct benefit for the livestock sector.

**V) Livestock Resource**

Forage development and production is practiced for livestock production in *Kalu* District. The result of questionnaire survey shows that adopters have an average herd size of 1.62 oxen, 1.52 cows, 1.18 calves, 0.45 heifers 0.30 bulk, 0.77 sheep, 1.70 goats, 0.08 donkeys, 0.32 camels and 7.27 chicken while the non-adopters hold average livestock size of 1.34 oxen, 1.11 cows, 0.85 calves, 0.40 heifers, 0.38 bulls, 1.34 sheep, 1.47 goats, 0.13 donkeys, 0.04 camels and 7.91 chickens (Table 5.23). In most of the livestock components there is no magnified difference between adopters and non-adopters. The t-test shows statistically significant difference only for oxen ($t=1.711$, $p<0.1$), cows ($t=1.875$, $p<0.1$) and camel ($t=3.124$, $p<0.01$) between adopters and non-adopters.

The total livestock size does not show pronounced difference between adopters and non-adopters. The average livestock size (counted) is 7.84 and 7.06 for adopters and non-adopters respectively. The statistical analysis indicated that there is no statistically significant ($t= 0.849$, $p>0.1$) difference between adopters and

non-adopters with total livestock size. The result shows that there is no association between adoption and livestock size (Table 5.23).

For intensive practice of growing forage species, the practice in dairy production and beef fattening are considered essential under this study. As it is shown in Table 5.24, the descriptive statistics revealed that the majority of adopters and non-adopters do not practice in beef fattening activities, 52.1 percent and 85.1 percent respectively. However, the adopters practice beef fattening more than the non-adopters do. The chi-square statistics also indicates the existence of statistically significant ($x^2$=13.729, $p<0.01$) difference between adopters and non-adopters with practice in beef fattening. Concerning the dairy production activities, again the majority of the adopters (60.3%) and non-adopters (85.1%) do not practice dairy production. However, most (80.56%) of diary producers were growing forage species. The statistical analysis indicated that there is significance ($x^2$=8.396, $p<0.01$) difference between adopters and non-adopters with regard to dairy production (Table 5.24).

The use of improved technologies like cross bred cows revealed the association of adoption of forage species and use of technologies in livestock sector. As it is indicated in Table 5.24, all the non-adopters do not rear cross bred cows. The chi-square statistical test supported the assumption that smallholders with cross bred cows are growers of forage species. There is statistically significance ($x^2$=18.379, $p<0.01$) difference between the adopters and non-adopters with regard to improved livestock technologies.

The result of FGDs and KIDs support the result of statistical analysis that the majority of dairy producers, particularly users of cross bred cows, are growers of forage innovation. DAs and *Woreda* experts stated that most of the dairy producers are forced to use *alfalfa*. The species is adopted because it increases the productivity of cows.

**Table 5.24 Categorical Socio-economic Variable and Chi-square ($X^2$) Tests**

| Descriptions | Adopter | | Non-Adopter | | $X^2$ statistics | |
|---|---|---|---|---|---|---|
| | N | % | N | % | value | Sig. |
| Educational level of household heads | | | | | | |
| ▪ Illiterate | 19 | 26 | 20 | 42.6 | | |
| ▪ Literate | 54 | 74 | 27 | 57.4 | 3.559* | 0.059 |
| Do you have occupation other than farming? | | | | | | |
| ▪ Yes | 46 | 37 | 28 | 59.6 | | |
| ▪ No | 27 | 63 | 19 | 40.4 | 0.143 | 0.705 |
| Do you have family members living and working outside your place of living? | | | | | | |
| ▪ Yes | 11 | 15.1 | 5 | 10.6 | | |
| ▪ No | 62 | 84.9 | 42 | 89.4 | 0.486 | 0.486 |
| Did shortage of land impede you from growing forage | | | | | | |
| ▪ Yes | 64 | 87.7 | 38 | 80.9 | 1.043 | 0.307 |
| ▪ No | 9 | 12.3 | 9 | 19.1 | | |
| Did labor limit you from growing forage? | | | | | | |
| ▪ Yes | | | | | | |
| ▪ No | 39 | 53.4 | 27 | 57.4 | 0.187 | 0.666 |
| | 34 | 46.6 | 20 | 42.6 | | |
| Do you practice in animal fattening? | | | | | | |
| ▪ Yes | 35 | 47.9 | 7 | 14.9 | | |
| ▪ No | 38 | 52.1 | 40 | 85.1 | 13.729** | 0.000 |
| Do you practice in Dairy production? | | | | | | |
| ▪ Yes | 29 | 39.7 | 7 | 14.9 | | |
| ▪ No | 44 | 60.3 | 40 | 85.1 | 8.396** | 0.004 |
| Do you use improved livestock technologies? | 68 | 93.2 | 27 | 57.4 | | |
| ▪ Yes | 5 | 6.8 | 20 | 42.6 | 22.099** | 0.000 |
| ▪ No | | | | | | |
| Do you use cross bred cows? | | | | | | |
| ▪ Yes | 23 | 31.5 | 47 | 100 | | |
| ▪ No | 50 | 68.5 | 0 | 0 | 18.379** | 0.000 |
| Do you have radio? | | | | | | |
| ▪ Yes | 53 | 72.6 | 22 | 46.8 | 8.117** | 0.004 |
| ▪ No | 20 | 27.4 | 25 | 53.2 | | |

*Source: Field survey, 2008* *** Significant at p<0.01,* significant at 0.1*

### 5.5.1.2 Institutional Factors

#### I) Access to Credit Services

Access to credit was assumed to be one of the major institutional factors that show difference between adopters and non-adopters of forage species. Descriptive statistics in Table 5.25 indicates that both the adopters and non-adopters are challenged by shortage of cash to run their farming activities. About 58.9 percent of the adopters and 63.8 percent of non-adopter mentioned the existence of shortage of cash. The statistical analysis showed that there is no statistically significant ($x^2$=1.267, p>0.1) difference between adopters and non-adopters with regard to cash shortage to run farming activities. The test result shows no difference between the adopters and non-adopters. This may be due to the two groups are equally challenged by the shortage.

About 87.7 percent of adopters and 74.5 of non-adopter took credit from different sources. This indicates that most of the sample households took credit and there is no pronounced difference between adopters and non-adopters. The statistical analysis however, elucidates that there is statistically significant ($x^2$=3.452, p<0.1) difference between the adopter and non-adopter groups with regard to credits taking habits (Table 5.25).

The household heads response to ease of access to formal credit services showed difference between the adopters and non-adopters. The majority (58.9%) of adopters has ease of access to get credit whereas; the majority (66.0%) of non-adopters faces difficulty in accessing formal credit services. The chi-square statistical test also indicated that there is statistically significant ($x^2$=7.041, p<0.01) difference between the adopters and non-adopters with ease of access to credit services (Table 5.25).

The significant statistical analysis contradicts with discussion results of FGDs and KIDs. Credit service is available for resident in the *Woreda*, particularly for participants in the 'safety net program'. Farmers are encouraged to take credit particularly for undertaking beef fattening and dairy production. The discussants, however, stressed that the religious influence is constraining factor. The majority of dwellers are Muslims where the religion doesn't allow interest bearing services. Except such religious influence the discussants added that 'we couldn't find a farmer who is in need of credit and couldn't fulfill the request'. The *Woreda* office under its safety net program provides a 7.5 percent interest bearing credit services.

Generally, there is an indicated shortage of cash that challenged the sample households. The majority of the sample households had taken credit from different sources especially *Woreda* office. There is also difference in ease of access for credit between the adopters and non-adopters particularly associated with cultural influence on creditors and borrowers.

**II) Market Access**

Physical access to market was assumed to influence the adoption of forage innovation particularly associated with the beef fattening and dairy production practices. The access to market center was seen with distance traveled to and availability of town market. Moreover, the access to/availability of/ farm gate and local market were also among the demanded centers for the farming units.

The smallholders sell their agricultural products in local markets and town markets in majority of the cases. About 83.4 and 89 percent adopters use local and town markets respectively; and 70.2 and 74.5 percent of non-adopter supplied their farm outputs to local and town markets respectively. The users of farm gate markets are fewer for both adopters and non-adopter categories. The statistical tests reveal a statistically significant difference between adopters and non-adopter in all the three market places. The test result for

the three centers are ($x^2$=3.002, p<0.1) for local market, ($x^2$=4.869, p<0.05) for farm gate market and ($x^2$=4.372, p<0.05) for town markets (Table 5.25)

The descriptive statistics indicates that the average distance the adopters traveled is about 11.55km. Non-adopters also traveled an average distance of 7.38km to reach the nearest market town. These average distances are at standard deviations of about 8.27 and 7.60 for the adopters and non-adopters groups respectively. There is statistically significant (t=2.778, p<0.01) difference between the two groups with distance to the nearest town market.

The statistical analysis implies the existence of significant differences between adopters and non-adopters with regard to distance from the nearest town market, and use of local, farm gate and town markets. However, the discussion with different bodies in the *Woreda* offices and selected farmers showed contradictory ideas. The discussants at *Woreda* office indicated that at a maximum radius of about 10 to 20 km from each Kebele, there is a possibility of getting town markets such as *Bati, Kombolcha, Harbu* and *Haik*. Hence, according to these discussants shortage of market place is not challenging. The discussants, however, didn't deny the problem once faced by farmers engaged in beef fattening where the farmers were asking the *Woreda* office to form a kind of association and sell fattened animals. With regard to dairy production, some FGDs resulted in shortage of market particularly for milk products. Some farmers stated that there are possibilities of getting spoiled milk and milk products. According to these discussants cafeterias and other local users were raising negative tests to dairy products. Moreover, discussants in some another *Kebele* stated that they form a cooperative of dairy producers and send products to towns such as *Milie* and *Logaya* (towns found in Afar Regional States).

According to the idea of majorities of discussants, market access becomes useful depending on nature of farm outputs. Farm gate markets are used for feed resources, fruits and vegetable products including

sugarcane and *chat*; local markets for cereals and dairy products; and town markets for dairy produces of large volume and beef fattening at large.

**Table 5.25 Credit and Market Services, Chi-square Tests**

| Descriptions | Adopter | | Non-Adopter | | $X^2$ statistics | |
|---|---|---|---|---|---|---|
| | N | % | N | % | value | Sig. |
| Did you face cash shortage to run your farming activities? | | | | | | |
| ▪ Yes | 39 | 53.4 | 30 | 63.8 | 1.267 | 0.260 |
| ▪ No | 34 | 46.6 | 17 | 36.2 | | |
| Have you ever taken credit? | | | | | | |
| ▪ Yes | 64 | 87.7 | 35 | 74.5 | 3.452* | 0.063 |
| ▪ No | 9 | 12.3 | 12 | 25.5 | | |
| Are formal credit services easily accessible? | | | | | | |
| ▪ Yes | 43 | 58.9 | 16 | 34 | 7.071*** | 0.008 |
| ▪ No | 30 | 41.1 | 31 | 66 | | |
| Do you sell your products to local market? | | | | | | |
| ▪ Yes | 61 | 83.4 | 33 | 70.2 | 3.002* | 0.083 |
| ▪ No | 12 | 16.4 | 14 | 29.8 | | |
| Do you sell your products to farm gate market? | | | | | | |
| ▪ Yes | 26 | 35.6 | 8 | 17 | 4.869** | 0.027 |
| ▪ No | 47 | 64.4 | 39 | 83 | | |
| Do you sell your products to town market? | | | | | | |
| ▪ Yes | 65 | 89 | 35 | 74.5 | 4.372* | 0.037 |
| ▪ No | 8 | 11 | 12 | 25.5 | | |

*Source: Field survey, 2008 *** Significant at p<0.01, ** significant at p<0.05 and,* significant at 0.1*

## III) Extension Services

Information about a new technology can be obtained through different ways; visiting demonstration plots (fields), participation in formal or informal trainings, listening to agricultural program on radio, contact with extension agents and others.

As it is revealed in Table 5.26, about 98.6 percent of adopters and 78.7 percent of non-adopter had made contacts with extension workers. This implies that both groups had contacts with extension agents. But the figures show that adopters contact with extension workers was greater than the non-adopters. It is only 1.4

percent of the adopter that were with no extension contacts while about 21.3 percent of non-adopters had never made contacts with extension workers. It was also shown in the statistical analysis that there is statistically significant ($x^2$=13.608, p<0.01) difference between adopters and non-adopters regarding to contacts of farmers with extension workers (Table 5.26).

In the study area, the average distance between the development agents' office and the village of the households elucidated that there is no pronounced difference between the adopter and non-adopters. About an average of 2.58 km is the distance between the offices of DAs and the adopters' villages. Non-adopters travel an average distance of 2.73 km to reach the offices of DAs. The t-test indicated that there is no statistically significant (t= -0.262, p>0.1) difference between adopters and non-adopters related to distance between the offices and villages.

Table 5.26 also depicts that both the adopters and non-adopters had taken different farm related trainings. About 94.5 percent and 66 percent of adopters and non-adopters got farm related training. It implies that only about 5.5 percent of the adopters without appropriate farm related training whereas 34 percent of non-adopters had never gotten training of farm related activities. The statistical analysis also indicates significant ($x^2$=16.795, p<0.01) difference between adopters and non-adopters regarding to training of farm related activities (Table 5.26).

The farmers' awareness towards forage technology through training, probably informal training, by extension agents is also shown in Table 5.26. About 65.8 percent of the adopter attained forage related training while only about 19.1 percent of non-adopters had taken forage technology training. There is an indication of the pervasiveness of being trained forage technology and adoption. The chi-square test also reveals that there is statistically significant ($x^2$=24.902, p<0.01) difference between adopters and non-adopters with training of forage technology (Table 5.26).

The habits of adopters and non-adopters towards visiting demonstration plots showed that about 58.9 percent and 87.2 percent of adopters and non adopters respectively had never visited demonstration plots. While 41.1 percent of adopters had visited demonstration plots, it is only 12.8 percent of non-adopters visited plots. The statistical analysis reveals that there is statistically significant ($x^2$=10.927, $p< 0.01$) difference between adopters and non-adopters with regard to visit of demonstration plots (5.26).

The extension agents may be required to motivate farmers to use new technologies. Concerning this study area, most households were asked to grow forage innovation. The descriptive statistics in Table 5.26 shows that about 91.8 percent of adopter had been asked /invited to grow forage innovation in their farms. About 57.4 percent of non-adopters were also asked to plant forage species. The same table holds the statistical analysis which reveals that there is significant ($x^2$=19.859, $p<0.01$) difference between adopters and non-adopters with the motivation of farmers to grow forage species by extension agents.

Farmers may not only get information directly from extension workers, they listen to agricultural programs and got an inspiration to use new technologies. As far as the farmers in this study area are concerned, the majority (72.6%) of adopters has radio and about 67.1 percent in the group listen to agriculture related radio programs. The non-adopters also listen to radio programs even if the majority (53.2%) does not have the electronics. The statistical test shows the presence of statistically significant ($t$=8.117, $p<0.01$) difference between adopters and non-adopters with ownership of radio. The experience of listening to radio programs also shows statistically significant ($x^2$=3.941, $p<0.01$) difference between adopters and non-adopters (Table 5.26).

The discussions conducted with selected farmers support the descriptive statistics that the majority of the households have contacts with extension workers. The discussants stated that DAs are living with farmers and they spent their time with farming units. But complains are forwarded that the concentration of

extension workers is highly directed to participants of the 'safety net program' and dairy production cooperatives.

**Table 5.26 Extension Services and Chi-square Tests**

| Descriptions | Adopter | | Non-Adopter | | $X^2$ statistics | |
|---|---|---|---|---|---|---|
| | N | % | N | % | value | Sig. |
| Do you have contact(s) with extension workers? | | | | | | |
| ▪ Yes | 72 | 98.6 | 37 | 78.7 | 13.608** | 0.000 |
| ▪ No | 1 | 1.4 | 10 | 21.3 | | |
| Have you ever taken farm related training? | | | | | | |
| ▪ Yes | 69 | 94.5 | 31 | 66 | 16.795** | 0.000 |
| ▪ No | 4 | 5.5 | 16 | 34 | | |
| Have you ever taken forage technology related training? | | | | | | |
| ▪ Yes | 48 | 65.8 | 9 | 19.1 | 24.902** | 0.000 |
| ▪ No | 25 | 34.2 | 38 | 80.9 | | |
| Did you visit demonstration plots in the last five your? | | | | | | |
| ▪ Yes | 30 | 41.1 | 6 | 12.8 | 10.927** | 0.001 |
| ▪ No | 43 | 58.9 | 41 | 87.2 | | |
| Do you listen to radio agriculture programs? | | | | | | |
| ▪ Yes | 49 | 67.1 | 23 | 48.9 | 3.941* | 0.047 |
| ▪ No | 24 | 32.9 | 24 | 51.1 | | |
| Have you ever been asked to grow forage? | | | | | | |
| ▪ Yes | 67 | 91.8 | 27 | 57.4 | 19.859** | 0.000 |
| ▪ No | 6 | 8.2 | 20 | 42.6 | | |
| Is shortage of forage seed a problem to you? | | | | | | |
| ▪ Yes | 27 | 37 | 13 | 27.7 | 1.119 | 0.290 |
| ▪ No | 46 | 63 | 34 | 72.3 | | |

*Source: Field survey, 2008* *** Significant at p<0.01,* significant at 0.05*

## IV) Seed supply

The availability of forage seed is one of the factors that influence the adoption effort of farmers. As it is indicated in Table 5.26, the majority of both the adopters (63.0%) and non-adopters (72.3%) stated that there is no shortage of forage seed. The statistical analysis shows that there is no statistically significant

(x2=1.119, p>0.1) difference between adopters and non-adopters with shortage of seed as their major problem to adopt forage innovation.

The focus group discussions resulted in different views among discussants. One discussion group presented that there is no shortage of forage seed; while another group stressed that there is no timely availability of seed and added that the intensity of adoption was slow down due to seed shortage. Some DAs also stated that seed shortage is prevailing as the number of practicing farmers increased over periods. However, an expert in the *Woreda* office explained that what is needed from the farmers is to develop interest to practice growing of forage species.

Picture 1 below shows one of the plots in which the *Woreda* office of agriculture and rural development produces forage seeds and test the adaptability of the species to climate and soil conditions.


**Picture1: Forage plot used to test forage varieties and to produce seed for the farmers, in the picture *Desmodium* and Elephant grasses are shown among others which are dried out.**

### 5.5.1.3 Bio-physical Factors

#### I) Water Availability

Water availability is one of the factors assumed to create difference between adopters and non-adopters. Rain fed agriculture is assumed to have retarding effect on practice of growing forage technology.

Household heads reply to the shortage of water as problem to grow forage technology clarify that both the adopters and non-adopters are challenged with the shortage of water to grow forage. The descriptive statistics in Table 5.27 shows that about 53.4 percent of the adopters and 74.5 percent of non-adopters face shortage of water. The figures show the extent of the problem is much greater for the non-adopters. The statistical analysis also reveals statically significance ($x^2$=5.356, $p<0.01$) difference between adopters and non-adopters regarding to water shortage as problem to grow forage species.

The result of discussions with experts, DAs and selected farmers supported the statistical analysis. The *Woreda* experts and development agents stressed on the shortage of water particularly in the dry season. Water shortage is challenging in areas where development of irrigation schemes is not possible. The farmers after mentioning the importance of water harvesting, they stated that the shortage of water is one of the constraints to adopt forage innovation. Some discussants expressed their positive feelings on farmers who are fortunate with irrigation water. Hence, water shortage constrained the adoption of the innovation and will hurt the sustainability.

#### II) Uncontrolled grazing

Uncontrolled grazing is the challenging and constraining factor for the practice of growing of forage innovation. Adopter felt better than non-adopters how far free grazing is irritating problem in growing forage species. About 64.4 percent of adopters mentioned that free grazing is an obstruct factor in growing forage innovation. The statistical analysis also indicates the existence of significant ($x^2$=10.555, $p<0.01$) difference

between adopters and non-adopters with free grazing as problem in growing forage technology (Table 5.27).

The challenging effect of free grazing is magnified when the discussions conducted with different bodies such as *Woreda* experts, DAs, selected farmers is considered. According to the *Woreda* experts and DAs, there is no challenging problem as free grazing in the study area. They stressed that it is highly devastating problem for natural resource management system and growing of forage species in *Kalu*. The discussants mentioned even the involvement of NGOs to avoid free grazing. They added that these efforts failed.

The selected farmers for FGDs had the same view as the experts and DAs. They stated that 'it may be possible to allocate land, use water harvesting, hire labor, take credit and sell products in other places; but it becomes impossible to avoid such deep-rooted problem, uncontrolled grazing'. Farmers mentioned the solutions used which actually failed to avoid free grazing. One of measures taken was a kind of punishment such as deletion from membership of local institutions like *Iddir*. The discussants stated that such punishments were failed because of social bonds among the community where one farmer fear to pose the other for punishment. Moreover, the discussants added that the farmers clashed each other associated with the punishments used as solutions.

**Table 5.27 Biophysical Factors and Chi-square Tests**

| Variables | Adopter | | Non-Adopter | | $X^2$ statistics | |
|---|---|---|---|---|---|---|
| | N | % | N | % | value | Sig. |
| Did you face water shortage to grow forage? | | | | | | |
| ▪ Yes | 39 | 53.4 | 35 | 74.5 | | |
| ▪ No | 34 | 46.6 | 12 | 25.5 | 5.356* | 0.021 |
| Do you think free grazing is problem to grow forage? | | | | | | |
| ▪ Yes | 47 | 64.4 | 16 | 34 | | |
| ▪ No | 26 | 35.6 | 31 | 66 | 10.555** | 0.001 |

*Source: Field survey, 2008* *** Significant at p<0.01,* significant at 0.05*

## 5.5.2 Econometric Result and Discussion

The logit model was used to estimate and identify statistically significant variables that affect the farmers' adoption decision. A number of factors were assumed to affect the adoption decision of forage innovation. At significant Chi-square estimate ($x^2$= 91.56 at $p<0.01$) with 17 degrees of freedom and 69.115 log likelihood ratio as well as 3.488 model fit in Hosmer and Lemeshow tests, the model achieved 85.8 % overall cases correct predictions. Based on fifty-fifty probability classification, the logit model predicted 90.4% of adopters and 78.7% of non-adopters correctly. The logit model has resulted in estimates of the variables shown in Table 5.28.

### Age of Household Heads

Age of the household head was considered to have negative influence on adoption of forage innovation. However, the model estimate shows that age of the household head has non-significant effect on adoption of the technology at 10 percent significance level. Empirical studies resulted in different views on age of household head as determinant factor to affect adoption of agricultural innovations. For example, Wortman and Kurungu (2000) and Gebremedihin *et al.* (2003) have identified that age of a household head has no significant influence on adoption of forage innovation. The model estimate by Wanyama *et al.* (2003), however, resulted in the positive and significance influence of age of the household head in determining adoption of pastures and fodders in west Kenya.

### Educational Level of Household Head

Educational level of a household head was considered as one of the factors that determine adoption decisions. However, the model result shows that there is no significant relationship between level of education and adoption of forage innovations at 10 percent level of significance. This might be attributed to extension works. The *Woreda* office distributed forage seed regardless of educational level of household heads. Because it is identified by the experts that arrangement of seed distribution with educational level as

one of the criteria excluded hard working farmers. They stated that educational level was considered at the start of dissemination of the innovation; now it is not used as criterion. Moreover, hard working farmers can handle forage species through hearing information from development agents and experts. The result is similar with findings of Wortman and Kurungu (2000) on adoption of legumes for soil improvement and forage by smallholder farms in Africa with particular reference to adoption of *Mucuna* in Benin. Tenkir (2001) also identified that education was not significant even at 10 percent level to affect adoption decisions of agricultural innovations. The result, however, contradicts with the model result of Lapar and Ehui (2003) and Wanyama *et al.* (2003) that educational level of household heads had significantly and positively influenced adoption of forage species.

**Family size**

The model result shows that there is no significant influence of family size in determining the adoption of forage innovation at 10 percent level of significance. This might be attributed to hard working farmers with a family of husband and wife who can adopt the innovation. Children are sent to school which may limit the importance of larger family size. The t-test also revealed that the adopters are not different from non-adopters in getting assistance from children at their rest times. Fulltime farm workers were almost equal in the adopters and non-adopters categories. The result also goes in line with the chi-square test result in which the adopters and non-adopters have mentioned that labor shortage is not a constraint to grow forage. This result matched with the model result of Wanyama *et al.* (2003) that family size is insignificant to affect adoption of forage components by smallholder farms. Gebremedihin *et al.* (2003), however, reported that family size and labor availability influenced the adoption decision of forage innovation in highlands of Ethiopia.

**Estimate of a Logit model of factors affecting adoption of Forage Innovation**

| | B | S.E. | Wald | Sig. | Exp(B) |
|---|---|---|---|---|---|
| | -0.010 | 0.040 | 0.060 | 0.807 | 0.990 |
| | 1.038 | 0.756 | 1.885 | 0.170 | 2.822 |
| | 0.203 | 0.170 | 1.414 | 0.234 | 1.224 |
| | -0.266 | 0.180 | 2.182 | 0.140 | 0.766 |
| | 2.227*** | 0.848 | 6.894 | 0.009 | 9.272 |
| | 2.399** | 0.946 | 6.425 | 0.011 | 11.010 |
| | 0.122** | 0.050 | 6.069 | 0.014 | 1.130 |
| | 4.994** | 2.147 | 5.411 | 0.020 | 147.518 |
| | -0.114 | 0.107 | 1.139 | 0.286 | 0.892 |
| | 2.220*** | 0.766 | 8.394 | 0.004 | 9.209 |
| | 0.595 | 1.006 | 0.350 | 0.554 | 1.813 |
| | 1.702* | 1.031 | 2.723 | 0.099 | 5.483 |
| | -2.979*** | 1.081 | 7.595 | 0.006 | 0.051 |
| | 0.678 | 0.752 | 0.813 | 0.367 | 1.970 |
| | 2.459*** | 0.771 | 10.166 | 0.001 | 11.698 |
| | 0.030 | 0.082 | 0.135 | 0.714 | 1.030 |
| | -0.073 | 1.115 | 0.004 | 0.948 | 0.930 |
| | -8.730 | 3.051 | 8.185 | 0.004 | 0.000 |
| | -2 Log likelihood | Cox& Snell R Square | Nagelkerke R Square | | |
| | 69.115 | 0.534 | 0.723 | | |
| **v Test** | $X^2$= 3.488 | Df = 8 | Sig.=0.900 | | |
| **Model** | $X^2$ = 91.562 | Df = 17 | Sig =0.000 | | |
| | **Overall cases** | **Adopters** | **Non-adopters** | | |
| | 85.8% | 90.4% | 78.7% | | |

*<0.01, **significant at p<0.05 and *significant at p<0.1*

considered as determinant factor in adoption of new innovations. However, the result in

adoption of forage components. Moreover, the adopters and non-adopters were not different in livestock size when the t- test result is considered.

**Intensifications in Livestock Sector**

Intensification in the livestock sector incorporates practice in beef fattening and dairy production. The dairy production and beef fattening were hypothesized to determine the adoption of forage innovation in the study area. The model result shows that dairy production and animal fattening practices affect positively and significantly the adoption of forage innovation at 5 percent and 1 percent level of significance respectively. The odds of adopting forage innovation increases by a factor of 9.272 and 11.010 due to practice in animal fattening and dairy production respectively. Dairy production in the study area is particularly supported with crossbred cows which are highly using forage species. Discussion results with DAs and *Woreda* experts show the same fact that those farmers with dairy production and animal fattening are users of forage innovation. Empirical studies by Wortman and Kurungu (2000) identified similar results. They reported that nearly all adopters of *calliandra* in central Kenya owned dairy cows and *Mucuna* is having a place with smallholder dairy farmers in eastern Uganda.

**Land Holding Size**

The model estimate under this study does not confirm expectation. The result shows insignificant, at 10 percent level of significance, influence of land holding size in affecting adoption of forage innovation. This may be due to the nature of the technology. Forage species can be grown as intercrop with cereal crops such as sorghum, maize, and fruits. Moreover, the households' response to 'Is land shortage a constraint to grow forage?' shows insignificant difference between adopters and non-adopters. Lapar and Ehui (2003) also identified the same result that farmers with more land to labor ratio are less likely to adopt forage technologies. The result, however, is contradicted with the t-test result. There is significant difference between adopters and non-adopters with land size when the t- test is taken into consideration.

### Access to Extension

The model estimate confirms that the adoption of forage innovation is positively and significantly affected by contacts with extension workers at 5 percent level of significance. The odds of adoption of forage innovation increases by a factor of about 148 as a result of contact with extension agents. It is identified that the majority of the households have contacts with extension workers. The contact, according to the FGDs results; however, is more for households who are participant of the 'safety net program' and dairy production cooperatives. The chi-square test reveals the existence of difference between adopters and non-adopters with regard to contacts of households with extension workers. Wortman and Kurungu (2000) identified the same finding that for successful adoption of forage legumes extension services were significantly essential in Benin. Distance of the development agents' office from the village of a household has no significant impact to influence the adoption of forage innovation. This is probably because offices of DAs are available at similar distance from all villages. It is also found out that there is insignificant difference between adopters and non-adopters with regard to distance from DAs' offices.

### Training Forage related Activities

Training particularly technical training of the technology was assumed to influence the farmers' decision to adopt the technology. The model estimate shows that forage related trainings have positive and significant, at 1 percent level of significance, influence on adoption of the innovation by the smallholders. It is indicated that the odds of adopting the innovation can be increased by a factor of 9.209 for associated increase in training services. The result has shown similarity with the findings of Tenkir (2001) that the probability adoption of different technologies has increased with training at 5 percent level of significance.

### Asking/ Inviting Farmers to Grow Forage

The model estimate shows that motivating farmers to grow forages has influence on the adoption of the technology. It is indicated in Table 5.28 that asking/inviting farmers to grow forage can increase adoption by the odds of 5.483 with a unit increase in inviting farmers.

### Visits to Demonstration Plots

It was hypothesized that visits to demonstration plots can positively affect the adoption decision of household heads. However, the model estimate shows that visits to demonstration plots have insignificant influence to determine adoption of forage technology at 10 percent significance level. This might be attributed to the time demonstrations were arranged. Visit to demonstration plots was started after some farmers adopted the technology through the influence of extension agents. This may imply that visits to demonstration plots have little effect once the farmer informally knew the technology from his neighbors. Undeniably, even if it is not significant, visits to demonstration plots have the probability of increasing the odds (*Exp (B)* = 1.8135) of adoption of forage innovation.

### Forage Seed Supply

Availability of planting material such as seed is one of the critical issues in most of empirical studies on adoption of biological innovations. This study also hypothesized that availability of forage seed increases the practice in growing of forage. The model estimate reveals that seed shortage is not significant, at 10 percent significance level, to influence adoption of forage innovation. This might be due to the provision of forage seed by the extension agents to farmers who are hard working and have the interest to grow forage. The majority of the sample household heads stated that there is no forage seed shortage that influences the adoption decision. Moreover, there is no statistically significant difference between adopters and non-adopters with regard to their response to a question 'Is shortage of seed a constraint to grow forage?'

**Access to Credit Service**

Credit taking habit of the households has no significant influence on the likely of adoption decision. The model result shows that there is no significant influence of credits taken to influence adoption of forage innovation at 10 percent level of significance. This might be due to the availability of credit for all farmers who are interested in taking credit. The result of Wanyama *et al.* (2003) also showed the insignificant of credit service on adoption of pastures and fodders in west Kenya. According to Lapar and Ehui (2003), however, availability of credit service has positive impact on adoption of forage innovation in Philippines.

**Access to Market**

The model result confirms that distance from town market has influence on adoption of forage technology at 5 percent level of significance. It is unexpected to find that households from remote distance adopt the technology. The model result shows that adoption is increased by a factor 1.130 with a km increase in distance from town market, given other factors remain unchanged. This might be attributed to shift in major occupations and to the existence of other feed option in towns. Farmers who are closer to towns show propensity of shifting to non-farm occupations. They can also purchase feed resources from the nearby town market.

**Water Availability**

The availability of water was hypothesized to positively influence adoption of forage innovation. The model estimate confirms that water shortage negatively and significantly affects adoption of forage innovation at 1 percent significance level. The odds of adoption of forage innovation decreases by a factor of 0.051 related to a unit decrease in water availability for a household.

**Uncontrolled Grazing**

Uncontrolled/free grazing was assumed to influence the adoption of forage innovations. The model estimate shows that uncontrolled grazing significantly affects the adoption of forage innovation at 1 percent level of significance. However, the result of the model estimate shows positive sign. This is to imply that the odds of farmers with free grazing problem referring to those farmers who did not identify free grazing as problem is 11.698, given other factors are constant. The positive sign may be showing that adopters identified the pronounced effect of free grazing better than the non-adopters do; and it may be also due to the presence of options to grow forage species. The smallholder farmers may grow forage species at homesteads where the possibility of controlling other peoples' livestock is better. Adopters require control of free grazing to expand the intensity of adoption. The result goes in line with the findings of Wortman and Kurungu (2000) that successful adopters of *stylosanthes* had to fence their pasture to protect their fodder banks from uncontrolled grazing. The authors also identified that adoption of *Sesbania* and *Tephrosia* were preferred to pigeon pea (*Cajanus Cajan*), which was more likely to be consumed by other peoples' cows during the dry season.

# 6. SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 6.1 Summary and Conclusion

*Kalu Woreda* is one of the districts in South Wollo Zone where mixed farming (crops and livestock production) system is practiced. Smallholder farming system is dominant in the district. Crop production is highly dependent on livestock mainly for traction power.

There is reported average of number of 8.22 livestock per household. About 29 percent of available land is used as cultivated land. Only small portion of the total land is used to graze livestock. It is only 1 percent of the total land in the district used as grazing land.

The sample households have an average livestock size of 7.6 which is equivalent to 4.83 TLU. There is predominant feed shortage for livestock development and production. Feed shortage is challenging for 70.6 percent of the sample households.

The major feed resources are crop residues (95.7%), weeds (90.8%), aftermath (85.7%) and natural pasture (i.e., private grazing land (63%) and communal grazing land (58%)). Collecting and piling crop residues and hays are major practices to manage and control feed resources. Moreover, the households purchase feed resources to supplement owned ones.

In alleviating feed shortage, the introduction of forage innovation is one of the major efforts undertaken by *Woreda* Office of Agriculture and Rural Development. The innovation is introduced 25 years ago in the district. The innovation is currently known almost in every *Kebeles* of the district. The commonly grown species are pigeon pea, elephant grass, alfalfa, lablab, sesbania, cow pea and vetch. Direct seeding and cut and carry plot system are highly practiced to establish and to grow forage species. The spread of the

innovation is through the influence of extension agents and there is no participatory evaluation of forage species in the adoption process.

The level of adoption is limited when the land allocated and the priority given to forage species is considered. The majority of the households who have adopted the technology allocated small land size. About 87 percent of the households allocated land size of less than or equal to a *timad* (0.25 ha). And about 57 percent of those adopters gave a land size of less than or equal to 0.5 *timad* to grow forage species. Moreover, it is the third priority that is given to forage production next to cereal and cash crops. The limitedness of the level of adoption may be attributed to a number of related socio-economic, institutional and biophysical factors.

The biophysical factors such as water and uncontrolled/free grazing are the most constraining factors that affect the adoption of forage innovation. These factors are identified as very challenging for every participant in the adoption process of forage innovation. Most of the focus group discussants, *Woreda* experts, DAs stressed to the difficulty of uncontrolled grazing in the adoption process. About 64.4 percent of the adopters mentioned free grazing as one of the constraints in growing forage species while it is a problem only for about 34 percent of non-adopters. Different institutions were involved to avoid free grazing. But their efforts to avoid the problem failed due to their individual actions, lack of integration and coordination among the institutions. Water shortage, particularly in the dry season and where irrigation scheme development is not possible, is challenging to adopt forage species. About 74.5 percent of the non-adopter and 53.4 percent of the adopter households stated the existence of water shortage in the study area. Water harvesting strategy is one of the solutions used to alleviate the prevailing water shortage in the district.

intercrop with fruit or other crop productions; and can be used as soil erosion control while generating direct benefit for the livestock sector.

Credit service is available for residents in the district and it is not a challenging problem in growing forage species. With regard to access to market places, market towns such as *Kombolcha*, *Bati*, *Harbu* and *Haik* are available to sell farm produces.

Generally, discussion results concerning to land shortage, labor shortage, financial constraints, access to market, educational level, and forage seed as constraints to adopt forage innovation show limited impacts.

The model result identified that practices in dairy production, animal fattening, contact to extension agents, training of forage related activities, distance from town markets, inviting farmers to grow forage species, water shortage and free grazing are the factors that determine the adoption of forage innovation. Dairy production, animal fattening, training of forage related activities, inviting farmers to grow forage species, contact with extension workers, distance from town markets and free grazing practices positively affect the adoption decision of the smallholders. From the significant variables that affect adoption decision, distance from town markets and free grazing practices show positive relation in contrast to the hypothesis. The first may be due to the shift in major occupations. Farmers may shift to non-farm occupations when they are closer to towns. The second may be because of the presence of options to grow forage species. The smallholder farmers may grow forage species at homesteads where the possibility of controlling other peoples' livestock is better.

There is strong relationship and determinant effect of dairy production and adoption of forage innovation. Particularly farmers with cross-bred cows are growers of the technology. The shift to improved-bred is therefore, the positive sign for the intensive use of the innovation.

## 6.2 Recommendations

Based on the formal survey results, informal discussions, and major outcome of the study, the following recommendations are forwarded.

- Major feed resources available in the district such as crop residues are considered low quality, which lack major nutrients for the livestock. These resources need treatments through additives to increase their nutritive contents. It might be required to identify the level of nutritive contents of the available feed resources and determine the quantity of chemical to be mixed. Moreover, financial problems may challenge smallholders to buy additives for which financial institutions and donor agencies are required to enable the households use proposed additives.

- The *Woreda* office of agriculture and rural development has started to make smallholders use improved breeds. The start to intensify the livestock sector and concentrate on 'quality rather than quantity' has to be a sustainable endeavor. Because intensification using cross bred cows and beef fattening can leave resources to crop production and also minimize the prevailing free grazing. Stall feeding is part of the intensification which minimize uncontrolled grazing. This may require investigating the opportunity cost of shifting to modern breeds.

- Water harvesting is the suggested solution that the farming unit was using. The smallholder farmers mentioned their fear in using water harvesting to minimize prevailing water shortage. Because it does not result in sustenance throughout the years because of its insufficiency. Thus water harvesting strategy should be extensively implemented to alleviate the shortage. This may require investigation of materials necessary for establishment; potentials of available water sources for the respective *Kebeles* and awareness creation for the farming unit on how to use the strategy.

Majority of the sample household heads can at least read and write. About 74 percent of the adopters and 57.4 percent of non-adopters are literates. Educational level of the household heads is disregarded in seed distribution arrangements. This is because hard-working farmers were excluded when educational level was considered in forage seed distribution at initial times the innovation was disseminated.

The adopters and non-adopters have average family members of 6.14 and 5.26 respectively. The two groups have equal number of average fulltime farm workers. Labor shortage is not an impeding factor to grow forage. Because the direct response of the households to 'Is labor a constraint to grow forage?' is not statistically significant between adopters and non-adopter; and discussions with *Woreda* experts, DAs and selected farmers for FGDs show the limitedness of labor shortage to constrain adoption of forage innovation.

Forage seed is distributed cost free to the farmers. The majority of the households indicated the non-existence of forage seed problem. But there are farmers who complained that seed distribution is not timely; DAs also mentioned the prevalence of shortage of forage seed as the number of adopters is increasing over periods.

There is difference between respondents with regard to land availability and land shortage as constraining factor to adopt forage innovation. The statistical difference between the adopters and non- adopters in land holding size may imply that adoption is related to large farm size because the adopters hold relatively larger average land size. This statistical difference is shared with the idea of most FGDs. However, the responses of DAs and *Woreda* experts to land shortage as constraining factor that affects adoption of forage innovation show that land shortage should not be the reason for non-adoption by most households. According to DAs and *Woreda* experts, nature of the technology and its benefits should be considered while talking about adoption and land holding size. Most forage species have the nature of being used as

- Extension service has shown significant influence in adoption of forage innovation by smallholders which has to be encouraged. There are, however, complains from farmers particularly who are not participants of the 'safety net program'. This requires the extension agents to extend their service to all farming units.

- Forage seed supply is largely provided and distributed by the *Woreda* office of agriculture and rural development. It enables farmers to get seed free of cost. The problem of forage seed is emerging as the number of adopters is escalating over periods. Therefore, it reminds farmers to produce their own seed. The extension agents have to enable farmers produce and conserve seed for future use.

- Participatory forage varieties evaluation is not practiced at all. Researchers and *Woreda* experts have to include the farming units in evaluating species adaptability; and select species based on their needs and know how towards the same. Top-down approach of adoption procedure may end up with resistance from end users.

- Producers' co-operatives have to be used as role model for others. Because dairy producers associations in some selected *Kebeles* are enabling the producers sell dairy products even in remote towns.

- The deep-rooted uncontrolled/free grazing problem needs integration and coordination among NGOs, *Woreda* office and farmers. The existing situation shows individual works done by these organizations. These bodies have to be organized to act as a single unit with prior attention on the smallholder farmers' needs and priorities.

- It is required to have detailed investigations for the realized species adoption level using panel data and to assess the impact of the innovation in the livelihood strategy of the smallholder farmers.

## References

Agajie Tesfaye, Sitotaw Ferede and Ibrahim Jemal (2007). "Agricultural technology transfer pathways in Central Ethiopia". In: Tesfaye Zegeye, Senait Regassa and Dawit Alemu (eds.) *Technologies, markets and poverty: evidence from studies of agricultural commodities in Ethiopia*. Proceeding of the second workshop, 29-30 November 2005 to discuss the socio economics research results of 2004-2006. Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia. Pp.7-24

Aklilu Bisrat (1976). *Technical change in subsistence agricultural: Adoption of minimum package program*. PHD Dissertation, Boston University.

Alemayehu Mengistu (1997). *Conservation based forage development for Ethiopia. Self-Help Development International and Institute for Sustainable Development*. Berhanena Selam Printing Press, Addis Ababa, Ethiopia. Pp.197

Alemneh Dejene (2003). *Integrated natural resources management to enhance food security: the case for community-based approaches in Ethiopia*. Environment and Natural Resources Service Sustainable Development, FAO Working Paper 16.Rome.Pp.48.

Antholt, C.H. (1998). "Agricultural extension in the twenty first century". In: Eicher, C.K. & Staatz, J.M. (ed). *International Agricultural Development*, 3rd Edition, Baltimore and London, Johns Hopkins University Press, Pp.354–369.

Aregay Waktola (1980). "Assessment of the diffusion and adoption of agricultural technologies in Chilalo." *Ethiopian Journal of Agricultural Science*. V.2. No.1

Baur , H., Sissoko, K. and Debrah, S. (2003). *The economics of peasant cattle feeding in Mali*. ILCA, Bamako, Mali.

Biggs, S.D. (1990). "A multiple source of innovation model of agricultural research and technology promotion". *World Development*, 18, Pp.1481–1499.

Biggs, S.D. and Clay, E.J. (1981). "Sources of innovation in agricultural technology". *World Development*, 9, Pp.321–336.

Biggs, S.D. and Smith, G. *(1998). "Beyond methodologies: coalition-building for participatory technology* development". *World Development*, 26, Pp.239–248.

Chambers, R. (1997). *Whose reality counts? Putting the first last*. London, Intermediate Technology Publications.

Chambers, R., Pacey, A. and Thrupp, L.A. (1989). *Farmer first*: Farmer Innovation and Agricultural Research, London, Intermediate Technology Publications.

Chandra, N. and Sigh, R.P. (1992). "Determinants and impacts of new technology adoption on tribal agriculture in Bihar". *Indian journal of agricultural economics*. 7(3);Pp.397- 403.

Cramb, R.A. (2003). *Process influencing the successful adoption of new technologies by smallholders*. University of Queensland, Australia. Pp. 22

Dagnew Negash. (2006). *Adoption of improved natural resource management technologies in North Western Ethiopia*: a case study in Dangila Woreda of Amhara Region. MA Thesis, Addis Ababa University. Addis Ababa, Ethiopia. Pp.163

Darnhofer, I. (1997). *Tagasaste and oats–vetch production for crossbred dairy cows in the Ethiopian highlands: animal feeding, farmer decision making and economic consideration*. Ph.D. Dissertation. University of Vienna, Agricultural Sciences, Austria. Pp .178

David, J. P., Graham, R. M., Neil, B., Allan, C., Frank, V. and Roger,W. (2006). "Adoption of conservation practices by rural landholders": a summary of Pannell, D.J., Marshall, G.R., Barr, N., Curtis, A., Vanclay, F. and Wilkinson, R., 2006. Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture* 46(11) Pp.1407-1424.

de Haan, C., Schillhorn van Veen, T., Brandenburg, B., Gauthier, J., Le Gall, F., Mearns, R. and Simeon, M (2001). *Livestock development: implications for rural poverty, the environment and global food security*. World Bank, Washington, DC.

Doss, C.R. (2003). "*Understanding farm level technology adoption: lessons learned from CIMMYT'S micro surveys in Eastern Africa*". CIMMYT Economics Working Paper 03-07. Mexico, D.F.: CIMMYT. Pp. 20

Elliott, R.C., Folkersten, K. (1961). "Seasonal changes in composition and yield of veldt grass". *Rhod. Agricultural Journal*. 18, Pp. 186.

Ellis, F. (1993). *Peasant economics: Farm Households and Agrarian Development*. 2nd Edition, Cambridge, Cambridge University Press.

Ellis, F. (1997). "*Household strategies and rural livelihood diversification*". Paper presented at Annual Conference of Development Studies Association, University of East Anglia, Norwich, England, 11–13 September 1997.

EEA (Ethiopian Economic Association) (2005). *Transformation of the Ethiopian agriculture: potential, constraints and suggested intervention measures*. Research Report, December 2005, Addis Ababa.

EEA/EEPRI (Ethiopian Economic Association/Ethiopian Economy Policy Research Institute) (2006). *Evaluation of the Ethiopian agricultural extension with particular emphasis on participatory demonstration and extension system (PADETES)*. Research Report, March 2006, Addis Ababa.

FAO. (1984). *Agricultural extension*: a Reference Manual, in Swanson, EB. (ed). Rome

FAO. (2002a). *World Agriculture: Towards 2015/2030*. FAO, Rome.

Feder, G., Just, R. E. and Zilberman, D. (1982). "*Adoption of Agricultural Innovation in Developing Countries*". Washington, DC: World Bank Staff Working Paper No.549.

Gardson,G.D.(2008, March). *Logistic regression*: State notes, North Carolina State University, Public Administration Program. Raleigh, North Carolina. Retrieved April 20, 2008 from www2.chass.nau.edu/gardson/PA765/logistic.htm

Gebremedhin, B., Amhed, M. M. and Ehui, S. K. (2003). "Determinants of adoption of improved forage technologies in crop-livestock systems: evidence from highlands of Ethiopia". In: Proceedings of the *Forage demand and adoption by smallholder livestock keepers' workshop, Tropical grasslands.* V. 37 (4), Pp. 262-273.

Gezahegn Ayele (1999). *Economic analysis of innovation and adoption of vertisol technology: a case study of smallholders' mixed farming in the highlands of Ethiopia.* PhD Thesis, Verlag Urrich E.Graur. Stuttgart.

Giller, K. E. (2001). *Nitrogen fixation in the tropical systems.* 2nd Edition. CABI: Wallingford, UK. 150-300

Goshu M. (1984). *"Agricultural research and extension in Ethiopia:* an Overview". Paper prepared for the fourth annual conference on Ethiopian Economy, Debrezeit, Ethiopia.

Gujarati, D.N. (1995). *Basic econometrics.* 3rd Ed. McGraw-Hill: New York, USA. Pp.100-343

Habtemariam Kassa (2005). *"Historical development and current challenges of agricultural extension with particular emphasis on Ethiopia".* Working paper No.2/2005.

Hailu Beyene, Rashid M.Hassen and Berhanu GebreMedhin (2007). "Pattern and sequence of adoption of improved teff and wheat technologies in Northern and Western Shewa Zones of Oromiya". In: Tesfaye Zegeye, Senait Regassa and Dawit Alemu. (eds.). *Technologies, Markets and Poverty: Evidence from Studies of Agricultural Commodities in Ethiopia.* Proceeding of the second workshop, 29-30 November 2005 to discuss the socio economics research results of 2004-20056 Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia. Pp.111-131

Hayami, Y. and Ruttan, V.W. (1985). *Agricultural Development: An International Perspective,* Baltimore. The John Hopkins University Press. Baltimore, USA.

Hove, L., Franzel, S., and Moyo, P. S. (2003). "Farmer experiences in the production and utilization of fodder trees in Zimbabwe: constraints and opportunities for increased adoption". In: Proceedings of

the *Forage demand and adoption by smallholder livestock keepers' workshop, Tropical grasslands.* V. 37 (4), Pp. 279-283.

IFAD. (2004). *Livestock services and the poor.* A global initiative for collecting, coordinating and sharing experiences. IFAD,Rome.

Jackson, C. (1995). "Environmental reproduction and gender in the Third World." In: Morse, S. & Stocking, M. (ed.) *People and Environment*, London, UCL Press, Pp.109–130.

John Abdu, Anteneh G., Rahel M., Rbeka G.T. and Yealembirhan M. (2007). "Technology use and participation of female and male headed households in agricultural research and extension in Northern Shewa Zone of the ANRS: The case of Merenta- Jirru and Besana Werana Woredas". In: Tesfaye Zegeye, Senait Regassa and Dawit Alemu. (eds.). *Technologies, markets and poverty: evidence from studies of agricultural commodities in Ethiopia.* Proceeding of the second workshop, 29-30 November 2005 to discuss the socio economics research results of 2004-20056 Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia. Pp.193-205.

Kaliba, A.R.M., Verkuijl, H., Mwangi, W., Moshi, A., Chilangane, A., Kaswende, J.S., and Anadajayasekeram, P. (1998). "*Adoption of maize production technologies in Eastern Tanzania*". Mexico, D.F.: International Maize and Wheat Improvement Center (CIMMYT), The United Republic of Tanzania, and The Southern African Centre for Cooperation in Agricultural Research (SACCAR). Pp. 40

Lapar, M.L.A. and Ehui, S. (2003). "Adoption of dual-purpose forages: some policy implications". In: Proceedings of the *Forage demand and adoption by smallholder livestock keepers' workshop, Tropical grasslands.* V37 (4), Pp. 284 –291.

Lele, U. (1996). "Understanding determinants of agricultural technology adoption". In: Heidues, F. and Fadani, A. (eds), *Food security and innovation: successes and lessens learned*, 1997. PeterLang, Franckfurt am main, Germany.

Mapiye, C., Foti, R., Chikumba, N., Poshiwa, X., Mwale, M., Chivurais, C. & Mupangw, J. F., (2006). *Constraints to adoption of forage and browse legumes by smallholder dairy farmers in Zimbabwe.* Livestock Research for Rural Development, Bindura University of Science Education, Bindura, Zimbabwe. (12) Pp.18

McIntire, J., Bourzat, D. and Pingali, P. (1992). *Crop– livestock interaction in sub-Saharan Africa.* World Bank: Washington DC, USA. Pp. 246

MoFED. (2006). *Ethiopia: Building on Progress. A Plan for Accelerated and Sustained Development to End Poverty* (PASDEP), (2005/06-2009/10): Main Text. Addis Ababa, Ethiopia. 1, Pp. 267.

Moffat, K. and Austin, N. (2003). "Forage demand and constraints to adoption of forage technologies by livestock keepers in Malawi". *Tropical Grasslands*, 37: Pp. 274 –278

Mosher, A.T. (1979). *An introduction to agricultural extension in Singapore*: Agricultural Development Council.

Mwangi, D.M. and Wambugu, C. (2003). Adoption of forage legumes: the case of *Desmodium intortum* and *Calliandra calothyrsus* in central Kenya. *Tropical Grasslands*, 37: Pp.227–238

Phengsavanh, P., Phimmasan, H., Phimphachanhvongsod, V., Phengvichith, V. and Novaha, S. (2000). *Forage options for smallholder farmers in shifting cultivation farming systems of Lao PDR.* National Agriculture and Forestry Research Institute, Vientiane, Lao PDR.

Rogers, E. M. (1983). *Diffusion of Innovation.* 3rd ed. The free press. New York.

Rogers, E. M. (1995). *Diffusion of innovations.* 4th ed. New York, NY: The Free Press.

Rogers, E.M. & Swenging, L. (1969). *Modernization among peasants; the impact of communication.* Holt, Rinchart and Winston Inc., New York

Scherr, S.J. and Muller, E.U. (1991). "Technology impact evaluation in agro-forestry projects". *Agro-forestry Systems*, 13, Pp.235–257.

Scherr, S.J. (1995). "Economic factors in farmer adoption of agro-forestry: patterns observed in Western Kenya". *World Development*, 23: Pp.787–804.

Setotaw Ferede (2007). *Impact of technological change on household production and food security in smallholders agriculture*, a case of wheat- *teff* based farming systems in the Central Highlands of Ethiopia. PhD Dissertation. Cuvillier Verlag Gottingen.

Sitotaw Ferede and Abate Bekele (2007). "Adoption studies of improved durum wheat technologies in Ada, Gimbichu, and Merenta-Jirru Districts". In: Tesfaye Zegeye, Senait Regassa and Dawit Alemu (eds.). *Technologies, markets and poverty: evidence from studies of agricultural commodities in Ethiopia*. Proceeding of the second workshop, 29-30 November 2005 to discuss the socio economics research results of 2004-20056 Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia. Pp.57-72

Smith, T., Chakanyuka, C., Sibanda, S. and Manyuchi, B. (1989). *Maize Stover as a feed for ruminants, Overcoming constraints to the efficient utilization of agricultural by-products as animal feed.* ILCA, Addis Ababa, Pp.218-231

Steinbach J. (1997). "Alternatives to crop residues as feed resources in mixed farming systems". In: Renard, C. (ed) *Crop residues in sustainable mixed crop/livestock farming systems*. CAB international. Pp.197-213

Sunding,D. and Zilberman, D. (1999). *The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural Sector.* Handbook of Agricultural Economics, Giannini Hall.

Sundstol, F. and Owen, E. (1984). *Straw and other fibrous wastes as by-products*. Elsevier, Amsterdam.

Taddese Gulie (1996). *Adoption of improved wheat and Barely varieties by small farmers in Holeta Area*. MA Thesis, Addis Ababa University Addis Ababa, Ethiopia.

Tenkir Bongir (2001). *The Determinants of the Adoption of Farm Technology by Resettled Farmers in Chinyika, Zimbabwe*. Ethiopian Development Research Institute. XXVIII (II).

Tesfaye Zegeye, Bedassa Taddesse and ShiferawTesfaye (2001). *Adoption of High Yielding Maize Technologies in major maize growing regions of Ethiopia*. Research Report, No. 41.

Tilahun Amede, Mengistu Solomon and Roothaert, R. (2005). *Intensification of livestock feed production in Ethiopian highlands:* Potential and experiences of the African Highlands Initiative Presented at the 19th EVA Annual conference, 8 June, 2005, ECA, Addis Ababa.

Tilahun Ferede (1995). "The Livestock sector: potentials and constraints". In: Dejene Aredo and Mulat Demeke (eds.) *Ethiopian Agriculture: Problem of transition.* Proceedings of the fourth annual conference on the Ethiopian economy, Addis Ababa, Ethiopia.Pp. 271-92

Van den Ban, A.W. and Hawkins, H.S. (1996). *Agricultural extension.* 2nd Ed. Oxford, Blackwell Science.

Wanyama, J.M., Muyekho, F.N., Masinde, A.A.O., Cheruiyot, D.T., Odongo, J., Ojowi, M. and Okeyo, R. (2003). "Assessing factors influencing adoption of pastures and fodders amongst smallholder subsistence farmers in selected districts of west Kenya". In: Proceedings of the *Forage demand and adoption by smallholder livestock keepers' workshop, Tropical grasslands.* V. 37 (4), Pp. 219–226

Wortman,C. and Kirungu, B.(2000). *Adoption of legumes for soil improvement and forage by smallholder farmers in Africa.* Kampala, Uganda, CIAT. Pp.140-148

Yeraswork Admassie (undated) *Introduction to survey research*: Compiled teaching material, Addis Ababa University, Addis Ababa, Ethiopia

Yohannes K., John G., and Garth, C. (2007, April). *Strategic decision-making: adoption of agricultural technologies and risk in a peasant economy.* Retrieved May 1, 2008, from *tp://mpra.ub.uni-muenchen.de/387/.* MPRA Paper No. 387.

Zekarias Shumeta and Admasu Shibru (2007). "Adoption of coffee production technologies in the major coffee growing areas of Jimma Zone". In: Tesfaye Zegeye Senait Regassa and Dawit Alemu (eds.), *Technologies, markets and poverty: evidence from studies of agricultural commodities in Ethiopia,* Proceeding of the second workshop, 29-30 November 2005 to discuss the socio economics research results of 2004-2006.Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia. Pp.26-56.

**Annex 1. Spearman's Correlation coefficients of Variables Included in the Logit Model**

| Variable | Age | Educ | Family | Farm | Beef | Dairy | Town Dist | contact | Dist DAs | Train | Demon | Asking | Water | Seed | Freegr | Live stok | Credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1.000 | -0.254 | 0.265 | 0.081 | -0.064 | 0.011 | -0.034 | 0.084 | -0.065 | -0.031 | 0.149 | -0.039 | -0.084 | -0.057 | 0.021 | 0.057 | -0.019 |
| Educ | | 1.000 | -0.051 | 0.078 | 0.024 | 0.105 | 0.062 | 0.211 | -0.071 | 0.090 | 0.182 | 0.153 | 0.038 | 0.038 | 0.088 | -0.057 | -0.039 |
| Family | | | 1.000 | 0.229 | 0.158 | 0.156 | 0.010 | 0.187 | -0.044 | 0.152 | 0.037 | 0.158 | 0.037 | -0.120 | 0.027 | 0.272 | 0.017 |
| Farm | | | | 1.000 | 0.192 | 0.167 | 0.172 | 0.213 | 0.229 | 0.175 | 0.333 | 0.200 | -0.011 | 0.213 | 0.137 | 0.179 | 0.044 |
| Beef | | | | | 1.000 | -0.099 | 0.127 | 0.112 | 0.189 | 0.177 | 0.053 | 0.301 | 0.111 | -0.074 | 0.068 | 0.193 | 0.246 |
| Dairy | | | | | | 1.000 | 0.089 | 0.208 | -0.087 | 0.215 | 0.127 | 0.124 | 0.030 | 0.077 | -0.033 | 0.036 | 0.254 |
| TownDist | | | | | | | 1.000 | 0.195 | 0.405 | 0.043 | 0.086 | 0.281 | 0.067 | -0.105 | 0.078 | -0.068 | 0.254 |
| Contact | | | | | | | | 1.000 | 0.205 | 0.187 | 0.208 | 0.394 | 0.106 | 0.102 | 0.103 | 0.124 | 0.234 |
| DistDAs | | | | | | | | | 1.000 | 0.124 | 0.098 | 0.139 | 0.078 | 0.011 | 0.049 | 0.110 | 0.171 |
| Train | | | | | | | | | | 1.000 | 0.324 | 0.338 | -0.211 | 0.000 | 0.003 | 0.158 | 0.087 |
| Demon | | | | | | | | | | | 1.000 | 0.035 | -0.344 | 0.193 | 0.149 | 0.066 | -0.081 |
| Asking | | | | | | | | | | | | 1.000 | 0.085 | -0.057 | 0.107 | 0.130 | 0.130 |
| Water | | | | | | | | | | | | | 1.000 | -0.133 | -0.063 | -0.034 | 0.133 |
| Seed | | | | | | | | | | | | | | 1.000 | 0.000 | 0.057 | -0.047 |
| Freegr | | | | | | | | | | | | | | | 1.000 | -0.016 | 0.133 |
| Livestok | | | | | | | | | | | | | | | | 1.000 | 0.052 |
| Credit | | | | | | | | | | | | | | | | | 1.000 |

**Annex 2. Attitude of Sample Households on Different Forage Issues and Category of Distance from offices of DAs**

| Descriptions | Count | Percent |
|---|---|---|
| **1. How do you get the training of farm related activities?** | | |
| ▪ Very Poor | 1 | 1.0 |
| ▪ Poor | 7 | 7.0 |
| ▪ Enough | 36 | 36.0 |
| ▪ Very Good | 56 | 56.0 |
| Total | **100*** | **100.0** |
| **2. How do you evaluate the productivity of the species?** | | |
| • Very poor | 1 | 1.4 |
| • Poor | 4 | 5.5 |
| • Good | 25 | **34.2** |
| • Very Good | 40 | **54.8** |
| • No response | 3 | **4.1** |
| Total | **73** | **100.00** |
| **3. Forage development and innovation is essential.** | | |
| • Strongly Agree | 84 | 75.0 |
| • Agree | 25 | 22.3 |
| • Neutral | 0 | 0 |
| • Disagree | 3 | 2.7 |
| • Strongly Disagree | 0 | 0 |
| Total | **112*** | **100.0** |
| **4. Ho do you prioritize the need for forage innovation?** | | |
| • Next to cereal crops but prior to cash crops | 31 | 32.3 |
| • Next to cash props | 14 | 14.6 |
| • Next to all types of crops | 51 | 53.1 |
| Total | **96*** | **100.0** |
| **5. The supply of forage seed** | | |
| • sufficient | 39 | 53.4 |
| • Short of supply | 30 | 41.1 |
| • No response | 4 | 5.5 |
| Total | **73** | **100.0** |
| **6. Distance from DAs offices** | | |
| ▪ Distance <= 1km | 57 | 47.5 |
| ▪ Distance >1Km&<=5km | 49 | 40.8 |
| ▪ Distance >5km&<=10km | 12 | 10.0 |
| ▪ Distance >10 | 2 | 1.7 |
| Total | 120 | 100.0 |

*Source: Field survey, 2008* **non-responsive hhh are excluded*

## I. Personal Background and Demographic Characteristics of household

1. Age_____

2. Sex; 1= Male ☐ 2= Female ☐

3. Marital status

1= Single ☐ 2= Married ☐

3= Divorced ☐ 4= Widowed ☐

5= separated ☐

4. Educational level

1= Illiterate ☐ 2 = Read and write only ☐

3 = Elementary school (1-6 grade) ☐

4= Junior secondary school (7-8 grade) ☐

5 = Senior Secondary school (9-12 grade) ☐

5. Family size Male _____ Female _____ Total _____

6. Age group of the family:

1) Above 5 and below 15 year: male _____ female_____

2) 15 to 65 years: male _____ female_____

3) Above 65 year: male _____ female_____

## II. Resource Endowment (Economic Factors) of the Household

### a) Farm Land

7. What is the size (in *timad)* of land you own? _____

8. Do you allocate your farm for different cropping purposes? 1 = Yes ☐ 0= No ☐

9. If 'yes' for question 8, please indicate your land use pattern for the different activities

| Land use pattern | In *timad* |
|---|---|
| *Teff* | |
| Wheat | |
| sorghum | |
| Fruits trees | |
| Vegetables | |
| Grazing land | |
| Improved forage land | |
| Pulses and oil seed | |
| Others (specify) _____ | |

10. How do evaluate the trend of your cultivated land over the last five years?

1 = Decreasing ☐ 2 = Remain constant ☐

3 = Increasing ☐ 9 = No response ☐

11. What factors can you mention as reason(s) if decreasing/ increasing?

_____

_____

12. Grazing land under your holding is

1 = Decreasing ☐ 2 = remain constant ☐

3 = Increasing ☐ 9 = No response ☐

13. What factors can you mention as reason(s) if decreasing/ increasing?

_____

_____

## b) Labor Availability

14. Number of fulltime farm workers _____

15. Number of part time (partial) assistant farm workers,

1) Children _____

2) Relatives _____

3) Others (specify)_____

16. What is the average working hour per day in farming activities? _____hours

17. Are women involved in farming activities? 1= Yes ☐ 0=No ☐

18. If 'Yes', in which farm activities are women involved? Multiple answers are possible.

1) Plowing ☐ 2) Herd keeping ☐

3) Harvesting ☐ 4) Weeding ☐

5) Others (specify) _____

19. Do you face labor shortage in your farming activities? 1= Yes ☐ 0= No ☐

20. If 'Yes', what are your measures taken during family labor shortage?

1) Hire labor ☐

2) Use traditional labor exchange like *debbo* ☐

3) Use relatives ☐

4) Others (specify) _____

21. If you hired labor, what type of labor did you hire?

1) causal ☐ 2) Permanent ☐

22. If you use permanently hired labor, how much do you pay per year? _____Birr, in kind_____ (specify)

23. Do you have occupation other than farming? 1= Yes ☐ 0= No ☐

24. If 'yes', in which non-farm activities are you involved?

1) wage labor ☐ 2) petty trade ☐ 3) hand craft ☐

4)Other (specify) _____

25. Annual income earned from off-farm activity, _____Birr

26. Do you use off-farm income to purchase agricultural inputs? 1= Yes ☐ 0= No ☐

27. Do you buy animal feeds using your off-farm income? 1= Yes ☐ 0= No ☐

## c) Livestock Resources

28. Fill the table below for the livestock you own:

| Livestock Name | Number |
|---|---|
| Ox | |
| Cow | |
| Calf | |
| Heifer | |
| Bull | |
| Sheep | |
| Goat | |
| Donkey | |
| Mule | |
| Horse | |
| camel | |
| Others (specify)_____ | |

29. Do you have any beef fattening activity? 1= Yes ☐ 0= No ☐

30. If 'Yes", estimate your annual income from the activity, _____Birr

31. Do you practice dairy production? 1 =Yes ☐ 0= No ☐

32. If 'Yes", estimate your annual income from the activity, _____Birr

33. Do you use any improved technology in livestock production?

1 = Yes ☐ 0 = No ☐

34. If 'Yes' to question 33, in which areas?

1) Cross bred cows ☐ 5) Grazing improvement ☐

2) Fodder trees ☐ 6) Improved poultry ☐

3) Artificial insemination ☐

4) Health drugs for animals ☐ 7) Others (specify)_____

35. Where are the major constraints of livestock production?

1) Disease ☐ 2) Feed shortage ☐

3) Water source ☐ 4) Lack of grazing land ☐

5) Unproductive (poor) grazing land ☐ 6) Over grazing ☐

7) Lack of veterinary service ☐

8) Other (specify) _____

**d) Feed Resource Management Situation and Practice**

36. Which major feed resources do you use? More than one possibility can be selected.

| During the wet season | Rank | During dry season | Rank |
|---|---|---|---|
| 1) Own crop residue ☐ | | 1) own crop residue ☐ | |
| 2)Own grazing land ☐ | | 2) Own grazing land ☐ | |
| 3) Aftermath ☐ | | 3) Aftermath ☐ | |
| 4) Communal grazing ☐ | | 4) Communal grazing land ☐ | |
| 5) Industrial by products ☐ | | 5) Industrial by products ☐ | |
| 6) Forests, bush land and shrub land ☐ | | 6) Forests, bush land and shrub land ☐ | |
| 7) Weeds ☐ | | 7) Weeds ☐ | |
| 8) Own forage production ☐ | | 8) Own forage production ☐ | |
| 9) Purchase of hay, grass or straw form others(or markets ) ☐ | | 9) Purchase of hay, grass or straw form others(or markets) ☐ | |
| 10) Others (specify) _____ | | 10) Others (specify) _____ | |

37. Do you practice rotating of cattle grazing on your grazing lands? 1=Yes ☐ 0=No ☐

38. Do you collect crop residues and make pile? 1=Yes ☐ 0=No ☐

39. Do you have hays collected in this season? 1=Yes ☐ 0=No ☐

40. Did you face feed resource shortage in the last five years? 1=Yes ☐ 0=No ☐

41. If 'No' for question 40, more options can be selected, it is due to

1) Enough own grazing land ☐ 2) Sell cattle in the dry season ☐

3) Communal grazing lands are available throughout the year ☐

4) Cattle are sent to relatives in other areas ☐

5) Other please specify_____

## III. Institutional Factors

### a) Access to Credit services

42. Did you face cash shortage to run your farming activities?

1 = Yes ☐ 0 =No ☐

43. If 'Yes', in which areas did cash shortage limit your operation?

1) Land preparation ☐ 2) Frequency of weeding of developed land ☐

3) Harvesting practices ☐ 4) To use pesticides ☐

5) To use fertilizer ☐ 6) Others (specify) _____

44. Have you ever taken credit? 1 = Yes ☐ 0=No ☐

45. Indicate your source of credit in the following table, if any.

| Source of credit | Rank, if more than one sources |
|---|---|
| Government ( MoA) ☐ | |
| Farmers(neighbors) ☐ | |
| Local traders ☐ | |
| Local credit associations ☐ | |
| NGOs ☐ | |
| MFIs (specify) ☐ | |
| Relatives ☐ | |
| Others (specify)_____ | |

46. Are formal credit services easily accessible? 1 = Yes ☐ 0 = No ☐

47. If 'No for 46', why? (Multiple possibilities can be indicated)

| Reason(s) | Rank |
|---|---|
| 1) Tough bureaucracy ☐ | |
| 2) Distance of some credit offices ☐ | |
| 3) High interest rate ☐ | |
| 4) Short repayment period ☐ | |
| 5) Cultural influence on creditors ☐ | |
| 6) Collateral requirement ☐ | |
| 7) Others (specify) _____ | |

48. If collateral is required to obtain credit, what was the collateral you use?

1) Land ☐ 2) Future income ☐

3) Animal ☐ 4) Guarantor ☐

5) Other (specify) _____

49. Have you ever taken credit for forage development and production in the last five years?

1 = Yes ☐ 0 = No ☐

50. If 'Yes for 49', what amount of cash did you take? _____ Birr

51. If 'No for 49', why?

1) Do not want forage development and production ☐
2) Forage development is not my priority for credit ☐
3) Forage development is not known at all ☐
4) Credit is not available ☐
5) Others (specify) _____

52. If did not take any credit, what is your source of financing for production inputs?

1) Cash from sale of animals ☐ 2) Sale of wood and/or charcoal ☐
3) Remittance ☐ 4) Cash from labor wage ☐
5) Cash from sale of animal products ☐ 6) Cash from petty trades ☐
7) Sale of farm products, like crops ☐ 8) Others (specify)_____

## b) Access to Market

53. Where do you sell your products?

1) Local market ☐ 2) Farm gates ☐
3) Town markets ☐ 4) Others (specify) _____

54. Town market distance from home _____km

55. Time taken on foot for town market _____hours

56. Did you encounter problem of where to sale your agricultural products? 1= Yes ☐ 0= No ☐

57. Do you use modern transportation, such as car? 1= Yes ☐ 0= No ☐

58. If 'Yes', payment for the transportation service is _____birr per travel.

## c) Access to Extension Services

59. Do you have any contact with extension workers? 1=Yes ☐ 0= No ☐

60. If 'Yes', how many contacts did you made with extension workers in the last one year?

1= Once ☐ 2= Twice ☐ 3 = Five ☐ 4= Ten ☐
5 = More than ten times ☐ 6) others ☐

61. What is the maximum distance you travel to reach the office of DAs? _____km

62. What are the services you have been provided from DAs?

63. Have you ever taken farmers training courses? 1 = Yes ☐ 0= No ☐

64. If 'Yes', which training did you take?

1) Fertilizer use ☐ 2) Pesticides application ☐

3) Artificial insemination ☐ 4) Forage technology ☐

5) Feed resources management ☐

6) Others (specify) _____

65. Who did you give the training?

1) Trained farmers ☐ 2) DAs ☐

3) Woreda experts ☐ 4) Others (specify) _____

66. How do you evaluate the training you have taken?

1 = very poor ☐ 2= poor ☐ 3 = enough ☐

4 = very good ☐ 9= no response ☐

67. Did you visit demonstration or on-farm experiments in the last five years?

1= Yes ☐ 0= No ☐

68. If 'Yes', how many times? _____

69. Have you ever been asked to grow forage in your farm? 1 = Yes ☐ 0 = No ☐

70. If 'yes', who did ask you?

1) DAs ☐ 2) *Kebele* administrators ☐

3) *Woreda* experts ☐ 4) others, please specify, _____

71. If 'No' for question 70, what do you expect from these institutional bodies?

72. Do you have radio? 1= Yes ☐ 0 = No ☐

73. If 'Yes', have you ever listened to radio agriculture program in the last one year?

1=Yes ☐ 0=No ☐

## IV Technology Attributes

74. Have you ever been participated in forage development evaluation?

1 = Yes ☐ 0 = No ☐

75. If 'Yes' for 74 above, how many times? _____

76. If 'Yes' for 74 above, when? _____

77. If 'Yes' for 74 above, for which variety? _____

78. If 'Yes' for 74 above, what do get from the evaluation?

_____

_____

79. If 'No', please mention your reason(s) _____

_____

80. Adoption of forage innovation is essential for you in the livestock development process.

1 = Strongly agree ☐ 2 = Agree ☐

3 = Neutral ☐ 4 = Disagree ☐

5 = Strongly disagree ☐ 9 = No response ☐

81. Pease mention your reason(s) for your agreement in '80', above.

_____

_____

82. How do prioritize the need for forage with other crops?

1= Next to food crops ☐ 2 = Next to cash crops ☐

3 = Next to all crop types ☐ 9 = No response ☐

83. What is your reason(s) in prioritizing in '82' above?

_____

_____

84. Do you have forage species grown in your farm land? 1= Yes ☐ 0 = No ☐

85. How do you establish forage grown in your farm?

1) Through direct seeding ☐ 2) Through seedling ☐ 3) Through cut and plant ☐

86. In which way(s) you grown improved forage?

1) Cut and carry plots ☐ 5) Improved fallows ☐

2) Grazed plots ☐ 6) Cover crops under trees ☐

3) Living fences ☐ 7) Ground cover for erosion control ☐

4) Contour hedgerows ☐ 8) others (specify) _____

87. Which type of forge have you grown? 1) Perennial ☐ 2) Annual ☐

88. If you grow forage, which species are you using? _____

89. Does the species you have grown suitable to the soil type in your locality?

1=Ye s ☐ 0= No ☐

90. How do you evaluate the productivity of the species you have grown?

1= Very poor ☐ 2=Poor ☐ 3= Good ☐

4= Very good ☐ 5= No response ☐

91. The influence to grow forage came from whom?

1) Knowing the benefit but by force from DAs ☐

2) Willingly after knowing the benefit of forage in trainings ☐

3) Knowing its benefit from neighboring farmers ☐

4) Others, please specify_____

92. What is your source of forage seed?

1) Own trees seed ☐ 4) Local market ☐

2) Other farmers ☐ 5) Extension agents ☐

3) NGOs ☐ 6)Research organizations ☐

7) Others (specify) _____

93. If 'market', how much it costs per kg? _____Birr

94. If 'DAs' provision', what is the criterion used for allocation?

1) Based on land holding size ☐

2) Based on livestock owned ☐

3) Based on major practices, like dairy production and animal fattening ☐

4) Based on proximity to the office of DAs ☐

5) Based on capacity to handle farming activities ☐

6) Others (please specify)_____

95. What do you say regarding to the supply of forage seed?

1= sufficient ☐ 2= short of supply ☐

3= good supply but expensive ☐ 9= no response ☐

96. How do you use forage?

1) To feed all animals regularly ☐

2) As an emergency source of feed ☐
3) When feed is difficult to find particularly rainy season ☐
4) For sick or pregnant animals only ☐
5) As additional feed at night ☐
6) Other (specify) _____

97. Have you ever interrupted managing and/or protecting improved variety of forage since you started?

1= Yes ☐ 0 = No ☐

98. If 'Yes', why?

1) Species is not adaptable to soil condition ☐
2) Shortage of labor to manage ☐
3) Susceptible to disease ☐
4) Poor quality for local livestock ☐
5) Other (specify)_____

99. What are the major constraints for forge development and production for you?

| Major constraints | Rank |
|---|---|
| 1) Shortage in water supply ☐ | |
| 2) Land size ☐ | |
| 3) Labor ☐ | |
| 4) Uncontrolled grazing ☐ | |
| 5) Forage seed shortage ☐ | |
| 6) Toxicity of the species to children and animals ☐ | |
| 7) Lesser market access to livestock products ☐ | |
| 8) others (specify) _____ | |

THANK YOU

## Annex 4. Check List for Focus Group Discussions (FGDs)

1. How do you evaluate the land holding situation of farmers in your *Kebele*, like increasing, decreasing etc?
2. Does land holding size limit you from growing of forage?
3. Does labor shortage hinder you from growing forage in your farming system?
4. Have you ever been challenged by shortage of market centers?
5. Is there any transportation shortage for you to supply your products to the market?
6. Is there all weather road passing through your *Kebele*?
7. Does the existing market distance impede you from growing of forge innovations?
8. Do you get sufficient services from local development agents?
9. How do you evaluate the visit of DAs in your farm activities?
10. What is the agricultural extension looks, like its resource provision to farmers, creating linkage of farmers with local development centers etc?
11. Who are the major providers of agricultural inputs to farmers?
12. Have you ever participated in evaluating forage species varieties?
13. Who initiate you to evaluate the species?
14. What is the base in selecting participants?
15. How do you evaluate the growing situation of forage in the locality, such as the extent of adoption, risk associated etc?
16. What do you say about the availability credit in the *Kebele*?
17. Does credit availability hinder the growing of forage in the *Kebele*?
18. Is there any forage development demonstration plot in your locality?
19. How the visit to demonstration plots is arranged?

20. What are the major feed resources in your *Kebele*/village?
21. Is there feed resource shortage in your *Kebele*/village?
22. What are the measures taken to minimize the shortage, if the problem exists?
23. What are the major feed resource management practices in the *Kebele*, rotation on grazing lands, reserving crop residues for dry season etc?
24. How do you evaluate the benefits of forage grown in your farming activities taking into account the feed resource patterns in your locality?
25. What is the situation of grazing lands in the *Kebele*; increasing/decreasing and what are related reasons?
26. Do you want to continue in growing forage in your farming system?
27. What is the priority given to forage innovation with regard other crop production?
28. What do you want to say about the sustainable use of forage development and production?
29. Generalize the major constraints of growing of forage technologies in your localities.

## Annex 5. Discussion Check Lists for Key Informants (*Woreda* Experts)

1. Educational background _____Qualification_____
2. Work experience(years)_____

**Farm size**

3. What is the average farm size in hectare in the locality?
4. How do you evaluate the adoption endeavor of farmers associated with the current farm size?
5. Do you think that farm size impede the adoption of forage innovation in the locality?

**Labor**

6. What is the average household size in the locality?
7. How do you get the association of adoption of forage technology labor/family size?
8. Does labor hinder the adoption of forage technology in the locality?

**Credit**

9. How do you evaluate the availability of credit service in the *Woreda*?
10. What are the sources of credit for the farmers in the *Woreda*?
11. What is the credit use behavior of the dwellers in the *Woreda*?
12. Does the *Woreda* office provide credit to farmers?
13. What is the base of credit provision to farmers, like farmers' repayment habits, collateral etc?
14. Was there any try to provide credit to farmers for the purpose of forage development and production?
15. Do you think that growing forage by farmers is hindered by the shortage of credit?

**Livestock**

16. Who are the adopters of forage innovation considering the livestock ownership of farmers?
17. What are the major feed resources in the *Woreda*?

18. Is there any feed resource shortage in the *Woreda*?
19. What has been done to alleviate the shortage?

**Market access**

20. Where do farmers sell their products?
21. What is the average distance (in km) of the nearby market center in the *Woreda*?
22. Is there any association between availability of market and growing of forage?

**Seed supply**

23. What is the source of forage seed for the farmers?
24. What the *Woreda* has done with regard to forage seed?
25. Is there any try to make farmers conserve forage seed?

**Participation**

26. Do you involve farmers in forage development and production, like in evaluation of varieties (species)?
27. Does the participation of farmers have impact on the adoption of forage technology?
28. What is the base of selecting participant farmers, like education?

**Training and demonstration**

29. What the *Woreda* has done with regard to demonstration plots for forage development and production?
30. Have you ever given training for farmers to the development and production of forage?
31. Does educational level of farmers affect the adoption of forage technologies?

**Adoption of forage innovation**

32. What are the major forage species grown in the *Woreda*?
33. Are they annual / perennial in their type?
34. What are the major constraints for the diffusion and adoption of forage innovations in the *Woreda*?

## Annex 6. Discussion Check lists for Development Agents

1. Educational background _____Qualification_____
2. Work experience(years)_____

**Farm size**

3. What is the average farm size in hectare in the locality?
4. How do you evaluate the adoption endeavor of farmers associated with the current farm size?
5. Do you think that farm size impede the adoption of forage innovation in the locality?

**Labor**

6. What is the average household size in the locality?
7. How do you get the association of adoption of forage technology labor/family size?
8. Does labor hinder the adoption of forage technology in the locality?

**Credit**

9. How do you evaluate the availability of credit service in your work station?
10. What are the sources of credit for the farmers in your work station?
11. What is the credit use behavior of the dwellers in your work station?
12. Does the *Woreda* office provide credit to farmers?
13. What is the base of credit provision to farmers, like farmers' repayment habits, collateral etc?
14. Was there any try to provide credit to farmers for the purpose of forage development and production?
15. Do you think that growing forage by farmers is hindered by the shortage of credit?

**Livestock**

16. Who are the adopters of forage innovation considering the livestock ownership of farmers?
17. What are the major feed resources in your work station?
18. Is there any feed resource shortage in your work station?

19. What has been done to alleviate the shortage?

**Market access**

20. Where do farmers sell their products?
21. What is the average distance (in km) of the nearby market center in your work station?
22. Is there any association between availability of market and growing of forage?

**Seed supply**

23. What is the source of forage seed for the farmers?
24. What is the role of *Woreda* office with regard to forage seed?
25. Is there any try to make farmers conserve forage seed?

**Participation**

26. Do you involve farmers in forage development and production, like in evaluation of varieties (species)?
27. Does the participation of farmers have impact on the adoption of forage technology?
28. What is the base of selecting participant farmers, like education?

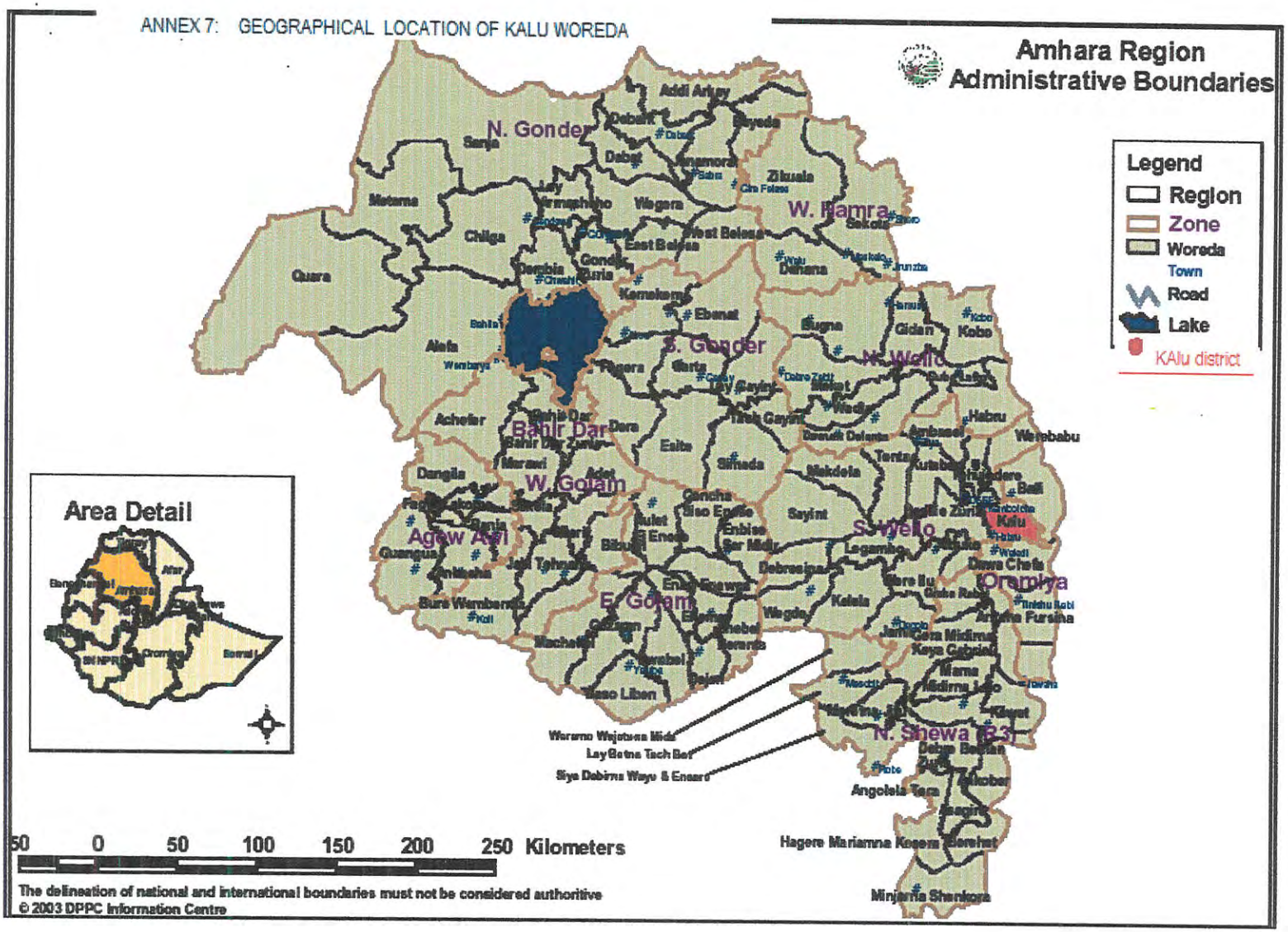
**Training and demonstration**

29. What the *Woreda* office has done with regard to demonstration plots for forage development and production?
30. Have you ever given training for farmers to the development and production of forage?
31. Does educational level of farmers affect the adoption of forage technologies?

**Adoption of forage innovation**

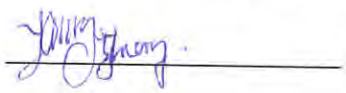
32. What are the major forage species grown in your work station?
33. Are they annual / perennial in their types?
34. What are the major constraints for the diffusion and adoption of forage innovations in your work station?

ANNEX 7: GEOGRAPHICAL LOCATION OF KALU WOREDA



Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any university, and all the sources of materials used for the thesis have been dully acknowledged.

| | |
|---|---|
| Name | Yimam Damtie Ali |
| Signature |  |
| Place | Addis Ababa University, Ethiopia |
| Date | June, 2008 |

This thesis has been submitted for examination with my approval as a university advisor.

Workneh Negatu (PhD)

June, 2008