ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF DEVELOPMENT STUDIES

Linkages Between Livelihood Diversification and Changes of Land Use/Land Cover in Pastoral Regions: The case of the Karrayu pastoral community, Oromiya, Ethiopia.

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Development Studies
(Environment and Development)

By
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Title

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DEVELOPMENT STUDIES

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Acronyms

CSA	Central Statistic Agency
DAs	Development Agents
DFID	Department for International Development
GDI	Global Drylands Imperative
GDP	Gross Domestic Product
GIS	Geographical Information System
GNP	Gross National Product
IDS	Institute of Development Studies
ILRI	International Livestock Research Institute
LUCC	Land-use/cover change
MoFED	Ministry of Finance and Economic Development
NGO	Non Governmental Organization
PRA	Participatory Rural Appraisal
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PAT	Population, Affluence, and Technology
SL	Sustainable Livelihood
WISP	World Initiative for Sustainable Pastoralism

Abstract

This paper examines the recently growing adoption of non-pastoral livelihood strategies and its linkages with changes of land use/land cover among the Karrayu pastoralists in Fentale Woreda, East Showa Zone. Three kebeles were selected from 18 rural kebeles. With a constructive combination of surveys, qualitative and quantitative data collection techniques for the livelihood diversification study and analysis of remote sensing data by GIS framework to study the land use/land cover dynamics.

The study showed that, a large portion of the current non-pastoral participation is in farming, natural resource-based activities and waged labors. A host of natural and anthropogenic forces drive this growing pastoralist shift in to cultivation and other non pastoral livelihood system. Pastoralist activity choices reveal that access to natural resource and infrastructure determines how they diversify. This natural resource based shift is bound to cause changes in land use/land cover in the study area. Two sets of remotes sensing data from 1986 and 2000 were analyzed to study the land use/land cover change.

The findings underscore that there is an increase of farm land by 64%, which was 1.9% of the total land mass in 1986 and by 2000 3.4%, where as bare rock cover had increased by 108%. On the other hand bush land had decreased by 68%, where as grazing land show a decrease of 19.5%.

Key words: Pastoralism, Agro pastoralism, Karrayu, Livelihood Diversification, Land Use/Land Cover Changes

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Studies have shown that there remain only few landscapes on the Earth that is still in their natural state. Due to both natural forces and anthropogenic factors, the Earth surface is being significantly altered. Human use of land has had a profound effect upon the natural environment thus resulting in a significant change in the land use/land cover over a period of time.

Pastoralists live in a range of environment in many countries across every continent in the world. In Africa, especially sub-Saharan Africa, mobile pastoralism is practiced since the areas are hot and dry with low and erratic rainfall (Oxfam, 2008). And when they are faced with challenges that curtail their mobility to look for better pasture land, livelihood diversification is the conventional wisdom of coping strategy in pastoral communities anticipated as a risk management measure to the impacts of climate change and recurrent drought on peoples' livelihoods (Nori and Davis, 2007).

Pastoralism constitutes a unique and important way of life for a large part of Ethiopia. Pastoral communities take a share of about 12-15 percent of the total population of Ethiopia, living in 7 regions, which are characterized by unpredictable and unstable climatic conditions as well as ecologically fragile environments. At the same time, the livestock population in the pastoral areas is high compared to the country's total, and the pastoral areas are rich in cultural and traditional heritage, flora and fauna diversities, valuable minerals and other resources (MoFED, 2006).

Pastoral areas in Ethiopia, which cover about 0.7 million square kilometers, are generally classified as a range lands. These areas support about 9.8 million people of which 56 % are pastorals, 32% are agro-pastoral and the remaining 22% are urban dwellers (EEA, 2005; Mulat, 1998). Pastoralism relies on livestock diversity to exploit and make use of the diverse rangeland resources, and typical pastoral herds and flocks.

And it represents complex form of natural resource management, involving a continuous ecological balance between pastures, livestock and people (Nori and Davis, 2007).

Pastoralists have adapted to the reality of the dry lands that they occupy, and are able to make meaningful use out of what is considered to be harsh areas to support their livelihoods. As Lane (1998) has observed, "efficient use of the dry lands depends on pastoralist's ability to move herds away from them during the driest periods of the year before they become degraded. The nature of pastoralist production system thus depends on movement, and relatively non-intensive use of the best land is necessary in order to make any use of all poorer lands". Regrettably, they are not as effective as they have been in the past; firstly, they are no longer as mobile as they have been due to factors that impede their mobility such as expansion of settlement, conflict with neighboring communities (Oxfam, 2008). The second reason is shrinking of pasture land as a result of introduction of large state owned plantations and conservation schemes, which forces in turn push them to browse intensively the land they still have access to and degradation inevitable (Nori and Davis, 2007).

When the traditional livestock production system is getting less viable, pastoralists adapt to the reality through source of income diversification to cop with changing environment. Diversification can either refer to an increasing multiplicity of the current activities, or it can refer to a shift away from traditional livelihood system resulting sectoral change from pastoral to agro pastoral livelihood system (Start and Johnson, 2004). A change of livelihood system comes with a new land use strategy; a land which was pasture now will be need for cultivation. And a change in land use brings respective land cover change.

The land use/land cover pattern of a region is an outcome of natural and socio–economic factors and their respective implication on decision making by human beings on how they utilize land in time and space. When a pastoralist is being strained by such forces his/her respective response will be to make use of the very resources under his/her disposal to cop with the challenge. As a result a land, which was utilized as grazing land by his/her ancestors could be converted to farm land or mining site if it

brings a better production. Hence, land use/land cover is evident in many pastoral areas, recently Land use and land cover change has become a central component in current strategies for managing natural resources and monitoring environmental changes. And information on land use/land cover pattern and the potential for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs.

As Ayalew (2001) rightly portray it, the karrayu pastoral community is experiencing a gradual shift to agro-pastoralism and new sets of values in relation to the meanings attached to land and its various uses as well as the social organization of production. The causes for the shift from the predominant pastoral livelihood to in part sedentary and agro-pastoral way of life can be broadly enlisted as natural treats (droughts, and shortage of water or rain), population and settlement pressure (migrant pastoralists, and influx of non pastoral people after the establishment of state based enterprises like Metehara Sugar State, Nura Era Farm), political and economic marginalization.

Understanding the linkage between livelihood diversification and the growing environmental change in the area is very crucial for any future intervention recommendations.

1.2 Statement of the Problem

Pastoralists in the arid/semi-arid lands of Eastern Africa live in environments that are characterized by perennially low, unpredictable and variable rainfall, resulting in periodic drought and even famine. In Ethiopia, pastoral lands cover 51 percent of the national land mass and it is a home for 12% of the country's total population (EEA, 2005). Although pastoralism plays significant role in the Ethiopian economy, this sector with huge economic, social and environmental roles and benefits has been largely marginalized by the development policies and strategies in the past.

Currently there is a vast expansion of projects in to pastoral areas in Ethiopia. As a result there is remarkable expansion of commercial plantations and towns, which leads to modification and alteration of the preexisting land use practice. All this puts

pressure on sustainability of pastoral livelihood system, which is strongly dependent on paramount access of land (Wassie, et al., 2008). When the traditional livestock production system is getting less viable, pastoralists adapt to the reality through source of income diversification to cop with changing times. In East Showa Zone, Fentale Woreda, the Karrayu pastoral community has been under continuous pressure; loosing their pasture land to state owned commercial plantations; Metehara Sugar Factory and Nura Era Plantation (Ayalew, 2001).

Previous studies in Fentale area show that there are sound evidence on growing population and decline of livestock per households (CSA, 2008; Piguet et al, 2001; Girum 2007). There is a growing need for addressing the problem of pastoralists, both natural and man made. And a better way to do so is studying how pastoralists are managing risk through livelihood diversification (Kejela et al, 2005; Wassie et al, 2008) and how these activities cause changes in land use/land cover of the area(Belay, 2002; Reid et al., 2000).

In Ethiopia, there are a few land-use and land-cover change studies conducted in some parts of the country which indicate that croplands have expanded at the expense of natural vegetation, including forests and shrub lands (Girmay, 2003; Belay, 2002; and Solomon, 1994). Those limited studies were focused on the Northern Ethiopian highlands, areas early settled and where population pressure is relatively high, (Belay, 2002). There is huge knowledge gap in the study of land use/land cover change in the south and lowlands of Ethiopia, particularly in pastoral lands considering their land size 0.7 million square kilometers, which is more than half the total land mass of the nation (EEA, 2005).

In order to understand the historical and contemporary linkages between livelihood activities and changes land use/land cover, it will be necessary to make significant advances in documenting the different livelihoods that are being practiced by the Karrayu and the trends, rates and magnitude of changes in land use/land cover.

Therefore, this research addressed linkages between livelihood diversification and Land use/land cover changes in the area, which may contribute to sustainable

management of low land, semi-arid environment and hence the betterment of livelihoods of the transforming Karrayu pastoral community in the study area and beyond.

1.3 Objectives of the Study

General Objective

The main objective of the study is to examine the linkage between livelihood diversification and land use land cover change in the study area.

Specific Objectives

1. To identify the different livelihood activities practiced by the Karrayu's.
2. To determine the trend, rate, and magnitude of land use land cover change.
3. To study the links between livelihood diversification and changes in land use/land cover.

1.4 The Research Questions

1. What are the different livelihood activities practiced by the Karrayu?
2. What are the trend, rate and magnitude of land use land cover change in the study area?
3. What are the links between livelihood diversification and changes in land use/land cover?

1.5 Scope and Limitations of the Study

The remote sensing data from 1986 to 2000 might not be enough to analyze the land use/land cover change which has started long before and still happening. To summarize, the processes of livelihood, land use and environment interaction are linked to a wider spatial and temporal setting, an appropriate spatial and temporal scale for the study had been hard to determine. What was done is a compromise between availability of resources (time, skills, and financial resources) and the optimal quantity and quality of information needed to draw these credible conclusions.

1.6 Organization of the Study

The thesis has five chapters. The first deals with the introductory section, the problem, and its approaches. The second chapter presents the review of literature and conceptual frameworks. The third part describes the study area and research methodology. Chapter four presents' characteristics of the sampled respondents, treats the analysis and interpretation of data. Finally, chapter five deals with conclusion and recommendation.

1.7 Definitions of Operational Terms

Livelihood is a means to a living which comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household.

Livelihood Diversification is the process by which households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve standard of living.

Land cover originally referred to the kind and state of vegetation, such as forest or grass cover, but it has broadened in subsequent usage to include human structures such as buildings or pavement and other aspects of the natural environment, such as soil type, biodiversity, and surface and ground water.

Land use is the term that is used to describe human uses of land, or immediate actions modifying or converting land cover.

CHAPTER TWO

REVIEW OF LITERATURE

2.1 Theoretical and Conceptual Framework

In this section the main concepts of the real life situation of household's livelihood production system and its environmental ramifications are analyzed using theories and concepts from previous works.

2.1.1 Pastoralists' Livelihood System

Pastoral livelihood systems take many different forms, adapted to particular natural, political and socioeconomic environments. The main production process is characterized by direct dependence on mobile livestock rearing (GDI, 2003). Depending on the degree of dependence on livestock-based activities, and the nature and form of mobility pastoralists are further defined.

Considering livestock dependence, when one household produce more than 50 percent of total gross from livestock related activities its economic system will be labeled as pastoral, where as households who generate more than 25 percent their income from livestock related activities and more than 50 percent from cultivation may be labeled as agro-pastoralists (GDI, 2003).

Regarding mobility, substantial irregular movements of livestock can be labeled as nomadic, while regular back and forward movements between two or more rational fixed locations such as summer and winter pasture as transhumant, and those who remain settled in one locality regardless of the season are known as sedentary (GDI, 2003).

Such crude classification is useful, though various studies reveal that pastoralists' livelihood is rather complex and extremely diverse (Ayalew, 2001; cited in Girum 2007). Pastoralists live in a range of environment in many countries across every continent in the world. In Africa, especially sub-Saharan Africa, mobile pastoralism is practiced since the areas are hot and dry with low and erratic rainfall (Oxfam, 2008).

Such conditions oblige for adaptation and complex form of natural resource management, involving a continuous ecological balance between pastures, livestock and people (Nori and Davis, 2007).

2.1.2 Livelihoods Concept

Describing livelihood provides a better picture on how households diversify their livelihood. Households can have several options and resources of income to contribute for their livelihood. A wide range of income activities varying in sector, space, scale and relations of production together provide a variety of procurement strategies for food and cash comprise livelihood systems (Sen, 1981).

In the context of Sustainable Livelihood framework; Livelihood comprises the capabilities, assets and activities required for a means of living. And a livelihood is sustainable only when it can cope with and recover from external stresses and shocks, and maintain or enhance its capabilities and assets now and in the future, while not undermining the natural resource base (DFID, 1999).

Livelihood and income are not synonymous, they are nevertheless inextricably related because the composition and level of individual or household income at a given point is the most direct and measurable outcome of the livelihood process. Total households income is disaggregated in to different categories and sub-categories of income sources reflecting different features of the resources such as their accessibility in terms of individuals' skills, spatial location, seasonality, and the capital required to utilize them.

2.1.3 Concepts of Livelihood Diversification

Diversification is a core strategy of contemporary rural livelihood systems in developing countries (Ellis 2000; Barrett et al. 2001; Reardon 1997; Reardon et al. 2001; Niehof 2004). Pastoral livelihood diversification is defined as the pursuit of any non-pastoral income-earning activity in both urban and rural environments. This includes various forms of wholesale and retail trade (e.g. selling livestock, milk, hides and skins, honey, and artisan goods etc.), rental property ownership and sales, waged

employment (local and non-local, including working as a hired herder, farm worker, and migrant laborer), farming (subsistence and commercial), and the gathering and selling of wild products (e.g. firewood, or medicinal plants) (Little 2001).

Diversification can either refer to an increasing multiplicity of livelihood activities (regardless of the sector), or it can refer to a shift away from traditional rural sectors such as agriculture to non traditional activities in either rural or urban space – i.e. sectoral change.

Diversification as multiplicity

Diversification is considered a diversity of income sources a household can have with out changing their sector of production. Several recent studies have emphasized it as 'multiple livelihoods' (Bryceson, 2000) or 'occupational multiplicity' (Breman, 1996). An individual has a diversified livelihood where she/he has multiple jobs or incomes, but a household can have multiple livelihoods, even though each member is in fact specializing in one activity (Ellis, 2000).

Diversification as sectoral change

When households venture in to new form of livelihood activity to add to their existing income sources their collateral effect cause sectoral change or, more generally, 'adaptive' diversification (Start and Johnson, 2004). Such diversification takes place at different levels of the economy. Thus diversification of a rural economy, which is the expansion of the rural non-farm economy (RNFE), is separate from the diversification of a household or individual economy. The increasingly urban nature of a national economy may be at odds with the increasingly rural nature of a particularly enterprise or family strategy. And while the local economy may become increasingly formalized, an individual's own work becomes increasingly non-formal. There are links between these various levels, but they are not always direct.

Livelihood Diversification Vs Sustainable Livelihood (SL) Framework

In the SL framework livelihood Assets include: human capital (the education, skills and health of household members); physical capital (farm equipment or a sewing machine); social capital (the social networks and associations to which people belong);

financial capital and its substitutes (savings, credit, cattle, etc.); and natural capital (the natural resource base) (Carney 1998; Scoones, 1998). In pursuing various livelihood strategies composed of a range of activities, both the access to assets and the use to which they can be put are mediated by social factors (social relations, institutions, organizations) and by exogenous trends (e.g. economic trends) and shocks (drought, disease, floods, pests) (DFID, 1999). The framework has been developed to set out the factors in a SL system and to represent the relationship between these factors.

In line with the SL framework, a livelihood is defined here as 'the activities, the assets, and the access that jointly determine the living gained by an individual or household'. Rural livelihood diversification is then defined as 'the process by which households construct a diverse portfolio of activities and social support capabilities for survival and in order to improve their standard of living' (Ellis, 1998).

Livelihood Diversification and Food Security

During the 1980s, the study of famine and food security continued as a major area of empirical research and conceptual debate. Several frameworks evolved to better incorporate issues of food security, coping and vulnerability, environmental sustainability and adaptation, and livelihood diversification.

With the exception of relatively wealthy pastoralists, livelihood diversification is generally perceived as an ex ante strategy adopted to reduce risk exposure (McPeak and Barrett 2001). Pastoralists' diversification profiles illustrate clear dualistic tendencies, i.e. the richest diversify in order to promote economic growth and accumulate additional wealth, whereas the poorest diversify in order to survive and overcome food insecurity (Little 2001). According to Little et al. (2001), food secured mid-level income pastoralists tend not be as heavily involved in income diversification as those in the extremes. The poor and the better-off differ in their motive towards diversification and the big difference comes on how they diversify.

Livelihood Diversification and Entitlement

The entitlement approach to micro economic model of livelihood is developed by Sen (1981) had as its focus the analysis of poverty and famine that was central to

development studies during the late 1970s and 1980s (Start and Johnson, 2004). The approach was still micro-economic in frame – attempting to understand how limited endowments were transformed into commodities. Entitlement is defined as the effective command and control an individual had over a commodity or to use Sen's (1981) words directly 'the set of different alternative commodity bundles that the person can acquire'.

The essence of the entitlement approach is that people do not necessarily starve due to an insufficient supply of food, they starve because they posses insufficient command over or access to food and resources. On the other hand, entitlements themselves mean 'the set of alternative bundles of commodities over which a person can establish command given the prevailing legal, political and economic arrangements' (Dreze and Sen, 1989: 9). It is clear that entitlement over resources and opportunities can determine the level of diversification a household can practice.

2.1.5 Concepts of Land Use/Land Cover Change

Human environment interaction at a local scale is in part the concern of the global change research community. The characteristics of land cover have important impacts on climate, biogeochemistry, hydrology, and the diversity and abundance of terrestrial species. Hence being able to project future states of land cover is a requirement for making numerical predictions about other global changes.

Land use is obviously constrained by environmental factors such as soil characteristics, climate, topography, and vegetation. Human activities that make use of, and hence change or modify, attributes of land cover are considered to be the proximate sources of change, which range from the initial conversion of natural forest into cropland to on-going grassland management e.g., determining the intensity of grazing and fire frequency (Turner, 1989). Such actions arise as a consequence of a very wide range of social objectives, including the need for food, living space, and recreation; therefore cannot be understood independent of the underlying driving forces that motivate and constrain production and consumption.

Land use affects land cover and changes in land cover affect land use. A change in either however is not necessarily the product of the other. Changes in land cover by land use do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere (Riebsame et al, 1994).

Natural events such as weather, flooding, wild fire, climate fluctuations, and ecosystem dynamics may also initiate modifications upon land cover. Globally, land cover today is altered principally by direct human use; expansion of agriculture and livestock rearing, forest clearing and urban and suburban construction and development. There are also incidental impacts on land cover from other human activities such as forest and lakes damaged by acid rain from fossil fuel combustion and crops near cities damaged by tropospheric ozone resulting from automobile exhaust (Meyer, 1995).

Consequently, in order to use land optimally, it is not only necessary to have the information on existing land use/land cover but also the capability to monitor the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape. In order to study and monitor land use/land cover change caused by both anthropogenic and natural forces in a traditional labor intensive methods is time consuming and quite difficult. And if it is done once the land use/land cover change map soon will become outdated, particularly in rapidly changing environment. In recent years, satellite remote sensing techniques have been developed, which have proved to be of immense value for preparing accurate land use land cover maps and monitoring changes at regular intervals of time. In case of inaccessible region, this technique is perhaps the only method of obtaining the required data on a cost and time – effective basis.

Satellite imagery has been well utilized in the natural science communities for measuring qualitative and quantitative terrestrial land cover changes (Campbell, 1987). More recently, social scientists have begun to use satellite imagery to address issues at the interface of socioeconomic conditions, politics and the natural

environment. Among these interdisciplinary researches, the study of land use/land cover change attempts to integrate remote sensing with socioeconomic data in order to understand the anthropogenic causes of land conversion. Because satellites observe land cover and not land use, therefore there needs to be complementary link between remotely sensed observations of the landscape with deep study on human activity on the ground. For these cross disciplinary, integrated studies, a core requirement is information on how land is used, and what are the conditions that force/encourage human beings in these making decisions.

In some instances, land use land cover change may result in environmental, social and economic impacts of greater damage than benefit to the area (Moshen, 1999). Therefore data on land use change are of great importance to planners in monitoring the consequences of land use change on the area. Such data are of value to resources management and agencies that plan and assess land use patterns and in modeling and predicting future changes.

2.1.6 Land Use and Land Cover Dynamics in Pastoral Regions

The land cover has gone under a continuous change for millennia either caused by human induced forces or natural phenomenon. Apparently, land cover changes occurring as a result of human induced factors have shown a greater tendency of surpassing that of changes resulting from natural agents in the past two centuries. Because human's production demands cannot be fulfilled without modification and/or conversion of land covers (De Sherbinin, 2002). Such human induced changes are more common in sedentary farmers and urban settler communities than mobile pastoralists. In view of the fact that pastoralism is advocated to represent rather complex form of natural resource management, involving a continuous ecological balance between pastures, livestock and people than changing or modifying the land cover for new purpose (Nori and Davis, 2007).

Pastoralists have been adapting to the reality of the dry lands that they occupy, and also they are able to make meaningful use of what are considered to be shaky areas to support their livelihoods. They have developed extensive traditional knowledge about their environment and have evolved survival techniques that are premised on

flexibility in natural resource use, mobility and diversification of herds to insure against such eventualities as droughts and disease outbreaks.

Mobility and adaptation are important aspects of this opportunistic use of natural resources by pastoralists. As Lane (1998) has observed, "efficient use of the dry lands depends on pastoralist's ability to move herds away from them during the driest periods of the year before they become degraded. The nature of pastoralist production system thus depends on movement, and relatively non-intensive use of the best land is necessary in order to make any use of all poorer lands". With impeded mobility and ever shrinking grazing land they are getting more sedentary than usual which in turn resulted land degradation, in particular there is a growing concern that much of sub-Saharan Africa's natural resource base and ecological environment are deteriorating mainly due to high population growth combined with unsustainable consumption pattern (Gibson et al, 2000).

The study of human-environment interaction at a local scale is in part the concern of the global change research community. And climate change is one of the leading research issues of global research community. However, the unprecedented rate and scale of human-induced climate change is beginning to cause more problems for example on land use/land cover change, which is a major human dimension of global environment change. Human-induced transformations in terrestrial cover significantly change biogeochemical cycles and thereby affect climate, biotic diversity, and livelihoods (Turner and Meyer 1994).

Climate with its overall rising temperatures and increasingly variable and unpredictable rainfall distribution is likely to affect diverse regions, locations and population groups differently. Its respective impacts on pastoral livelihoods should be extensively researched. There is an ongoing debate on how much it is affecting pastoralists in particular, some scholars argue that pastoralists are going to be more than anyone else since rangelands will tend to become drier, and existing water shortages will worsen, thus affecting the overall sustainability of their livelihoods. While others see pastoralists as the most capable to adapt to climate change, since pastoral livelihoods are shaped to deal with scarce and variable natural resources and

to tackle difficult and uncertain agro-ecological conditions and climate change could conceivably lead to the extension of territories where pastoralism could show comparative advantages (Nori and Davis, 2007).

According to de Sherbinin (2002), land use is the term that is used to describe human uses of land, or immediate actions modifying or converting land cover. On the other hand, land cover refers to the natural vegetative cover types that characterize a particular area. Land use change is the proximate cause of land cover change. The driving forces to this activity could be economic, technological, demographic, scenic and or other factors. Hence, Land use/land cover dynamics is a result of complex interactions between several biophysical and socioeconomic conditions which may occur at various temporal and spatial scales (Reid et al., 2000; cited in Ephrem, 2008).

There is growing international concern on the need to study the effect of human induced changes on the environment. Among others, the three international conferences; on Human and the Environment (Stockholm, 1972) and the United Nations Conference on Environment, Development (UNCED) (Rio, 1992) and the World Summit for Sustainable Development (Johannesburg, 2002), called for substantive studies of land use and land cover changes and since then has become a global issue. This is because the effects of land use and land cover are directly related to the livelihoods of people. For almost all food requirements, people of the world totally depend on land resources, except for only 3% of the food which is coming from aquatic resources (Pimentel, 1993). Particularly pastoralists way of life much more dependent on land resource and also demand a very large land mass as one can see from Ethiopian pastoralists case; Pastoral areas in Ethiopia covers about 0.7 million square km from a national total of 1.13 million square kilometer, which is 61% of the national landmass, are generally classified as the range lands. While these areas support about 9.8 million people, which is only 12% of total population of the country (EEA, 2005 and Mulat, 1998).

In group effort with environmental and sociopolitical issues inappropriate agricultural practices, deforestation and overgrazing are affecting crop and livestock productivity of the pastoralists and hence their livelihoods. These alterations of ecosystem services,

due to changes in land use/land cover, negatively affect the ability of the biological systems to support the human needs. These changes also determine, in part, the vulnerability of places and people to climatic, economic or sociopolitical perturbations. To affirm to this, Ethiopia is one of the top six food aid recipient countries in the world (McClelland, 1998). Therefore, understanding the driving forces behind land use changes and developing appropriate measures to control or at least minimize the effects will then be very important.

2.1.7 Image Classification and Change Detection

In land use/land cover study image classification and change detection are the two core activities which became relatively easy up on the introduction of computer analysis and interpretation techniques of satellite imagery. Image classification is the process of creating thematic maps from satellite imagery. A thematic map is an informational representation of an image that shows the spatial distribution of a particular theme (Verbyla, 1995). Where as, Change detection is the process of identifying differences in the state of an object or phenomenon by observing it sequentially. Essentially, it involves the ability to quantify temporal effects using multi temporal data sets (Singh, 1989).

Image Classification

The computerized interpretation of remote sensing images through identification of pixels based on numerical properties is known as qualitative analysis, and there are usually different procedures of classification (Diday, 1994). In the classification process different pixels are categorized in groups based on their spectral characters. There are two classification procedures in spectral classification technique for land cover mapping, which are unsupervised and supervised classification methods.

In unsupervised classification the user specify some of the parameters that the computer can look for statistical patterns of pixels with similar spectral characteristics in the data (Diday, 1994). Where as in supervised classification the user supervises the pixel categorization process by clearly specifying numerical descriptions of different land cover types, which are known as training sites (areas) in the study area and the

computer numerically compare the input data with those on the remote sensing image to the category (Lillesand and Keifer, 2000; Anderson, 1972).

Unsupervised classification is subject to more errors in classifying land covers than supervised approach. For example, fallow land can be considered as open bare land in unsupervised classification since they both to some extent show similar spectral characteristics, which can be easily distinguished as fallow farm land if the study is supervised. Where as, the supervised classification of land cover is highly costly and time consuming.

Change Detection

In change detection process the image analyst looks for changes in type of land cover type, size and nature from the land cover map. There are many change detection methods that have been developed and used for various applications. For example, there are post-classification comparison, image differencing, image rationing, image regression, principal component analysis (Chen, 2000). However, they can be broadly divided into: post-classification and spectral change detection approaches (Singh, 1989).

Post-Classification Approach

Post classification is among the most widely applied techniques for change detection purpose. In this approach the user separately classifies multi-temporal images into thematic maps, then implements comparison of the classified images, pixel by pixel. The area of change is then extracted through the direct comparison of the classification results (Chen, 2000). It requires a great amount of time and expertise to create classification products. The final accuracy depends on the quality of the classified image of each date (Jensen et al, 1987).

Spectral Change Detection Approach

Puts multi-temporal data into a single file, then classifies the combined dataset and identifies and labels the changes. In this technique the transformation of the two

original images into a new single band or multiband image, in which the area of spectral change is highlighted. Most of the spectral change detection techniques are based on some type of image differencing or image rationing. According to Lu (2004) it is difficult to identify and label the change classes; since it cannot provide a complete matrix of change information requires estimating the a priori joint class probability.

2.2 Review of Related Works

In this section previous works in Ethiopia regarding livelihood diversification and land use/land cover change are reviewed.

2.2.1 Livelihood Diversification in Ethiopia

Not many studies specifically deal with the significance of livelihood diversification in Ethiopia. Most of the available studies are either regional (Woldenhanna and Oskam 2001; Carswell 2002; Holden et al, 2004; Demissie and Workneh, 2004; Wassie et al, 2008; Kejela et al, 2005) or focus on drought periods (Dercon and Krishnan 1996, Block and Webb 2001).

Using data from the southern part of the country, Carswell (2002) shows the role that women play in diversification and the particular importance of the contribution of diversification activities to cash incomes for poorer households. And also Demissie and Workneh (2004) examined the factors involved in rural households' choice of livelihood diversification strategies and the result shows that asset endowment of households has a significant effect on households' choice of livelihood diversification strategy. Another study in the southern Ethiopia pastoralists by Wassie et al (2008) focusing on livelihood sustainability and diversification in to non pastoral livelihood system reveals challenges faced by young resource poor pastoralists and calls for human capital investment if sustainability is to be achieved through livelihood diversification. Using survey data from the northern part of the country, Woldenhanna and Oskam (2001) argue that farm incomes and off-farm incomes are substitutes. They categorized off-farm employment in to; off-farm wage employment and off-farm self employment and arrive at the finding that farm households diversify their income

sources into off-farm wage employment discouraged by low farm income and availability of surplus family labor, whereas they enter into off-farm self employment to earn an attractive return.

The drought period focused studies by Block and Webb (2001) attempts to answer the question that which households increased their share of income from non-cropping activities the most during the inter-survey years? Their output was that wealthier households tend to have more diversified income streams; and, initially less diversified households subsequently realized greater gains in income diversification. Where as Dercon and Krishnan (1996) analyze the different income portfolios of households using survey data from rural Ethiopia and rural Tanzania. The results of their study contend that the different portfolios held by households cannot be explained by their behavior towards risk; it is better explained by differences in ability, location, and in access to credit (Dercon and Krishnan, 1996).

2.2.2 Land Use/Land Cover in Ethiopia

The extent and rates of change in land cover and some land uses are known with some certainty (Turner and Meyer, 1994). According to Turner et al. (1993), most of the earth's surface is already modified, except those areas that are peripheral in location or are fairly inaccessible. In the case of Ethiopia, studies on land-use and land-cover change are few. This being so, however, accurate information is believed to be critical for resources analysis (Solomon, 1994). Those limited studies were focused on the Northern Ethiopian highlands, areas early settled and where population pressure is relatively high, (Belay, 2002). Since, the highlands in Ethiopia were historically the basis for the early development of agriculture and have been prior targets of settlement for the human population which indicate the presence of pressure on land, vegetation and water resources (Hurni, 1990).

Land cover transformation in both tropical and temperate regions has important implication for dramatic loss of plant species in term of density, diversity and community composition through intensified deforestation (Vanacker et al., 2003). Ethiopia, with the fifth largest flora in tropical Africa (Seyoum, 1994; Cited by

Solomon, 2005) and with about 12 percent of its plant population being endemic (Tewoldebirhan, 1991), has been critically affected by the loss of plant biodiversity.

In Ethiopia, there are a few land-use and land-cover change studies conducted in different parts of the country which indicate that croplands have expanded at the expense of natural vegetation, including forests and shrub lands (Girmay, 2003; Belay, 2002; and Solomon, 1994). For instance, Solomon (1994) reported cover changes of cultivated land and forestlands in spatial and temporal terms between 1957 and 1982 in the Metu area, southwestern Ethiopia. Similarly, Belay (2002) has reported a significant decrease of natural vegetation cover due to the expansion of cultivated land between 1957 and 1986 in Derekolli catchment, southern Wollo, Ethiopia. While Kebrom and Hedlund (2000) reported that open areas increased by about 33.3% while urban and rural settlements increased by about 192 and 57%, respectively in twenty eight years (between 1958 and 1986), in Kalu area of Wello. Furthermore, Gete and Hurni (2001) have documented the expansion of cultivated land at the expense of forestland between 1957 and 1982 in Dembecha area, northwestern Ethiopia. During the same period, forestland and cultivated land expanded in west Guraghe land, at the expense of grazing land and shrub land (Muluneh, 2003).

CHAPTER THREE

STUDY AREA DESCRIPTION AND METHODOLOGY

3.1 THE STUDY AREA

3.1.1 Location

The study area is located in Eastern Showa zone, Oromiya. Specifically in Fentale woreda with an area of 1339.64 square kilometers, this is located at the northeastern end of East Showa Zone.

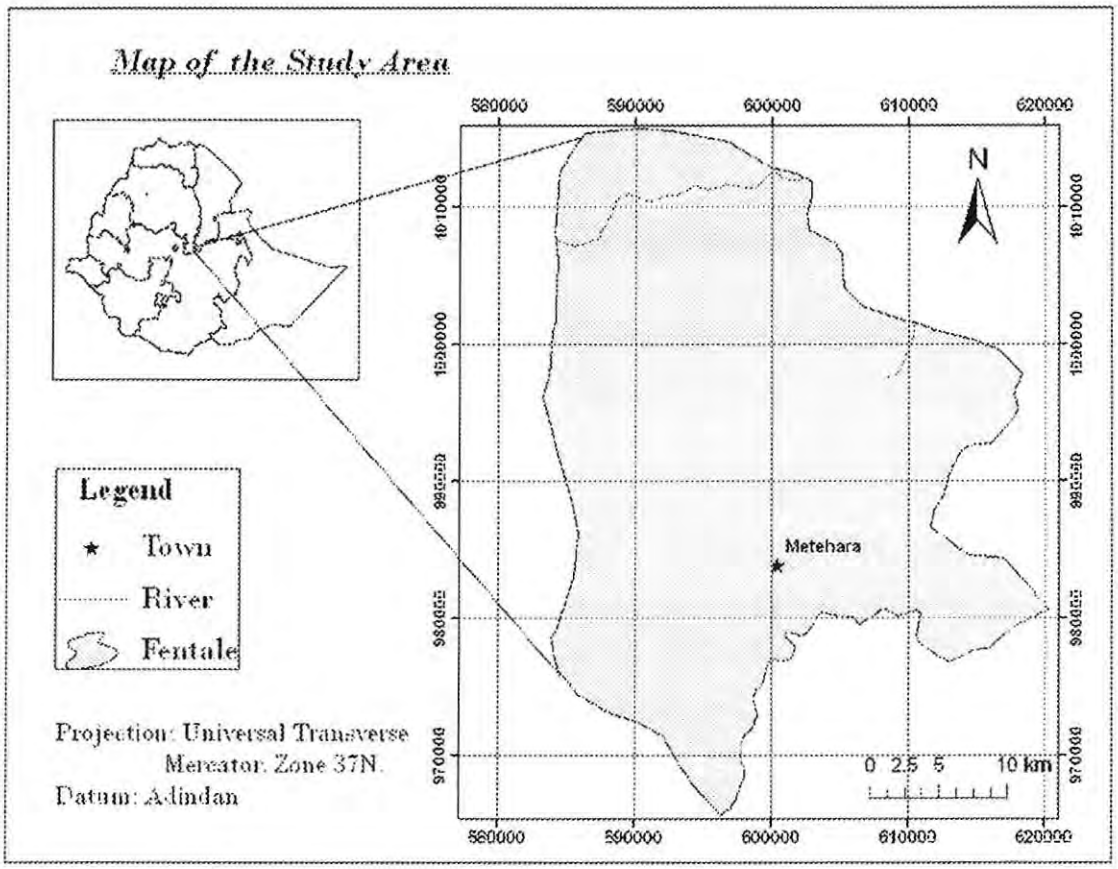

Figure 1: Map of the study area

The woreda comprises 20 kebeles, which are categorized under rural and urban kebeles. The administrative center of Fentale is Metehara, where most service centers are stocked and the rest are located Haro Addi (formerly known as Addis ketema). These two towns represent the two urban kebeles, which are inhabited by heterogeneous population where as the rest 18 kebeles are dominantly inhabited by the

Karrayu pastoral community and small number of Ittu's, who migrated from western Harrarghe.

3.1.2 Climate

According to the FAO (2005) Ethiopia's tropical monsoon climate is subjected to wide topographic-induced variations. Areas with elevations below 1500 m (including the Main Ethiopian Rift) are subject to arid to semi-arid conditions. There are two rain seasons; the main rainy season from July to September and Between March and April a short period of rainfall occurs, known as the *belg* rain season. The mean annual potential evapotranspiration logged at Metehara, a small town adjacent to Lake Beseka, is about 2560 mm while annual rainfall averages out at 550 mm. The mean annual temperature recorded over 35 years in Metehara is approximately 25°C (MoWR, 1999). With average temperatures of 30°C, June is the hottest month whereas the annual minimum of 19°C is measured in December. Rainfall does also have a distinct seasonal component (Lamb et al., 2000).

3.1.3 Drainage and Soil Types

According to the Oromiya State Government profile, most parts of this woreda range from 900 to 1000 meters above sea level; Mount Fentale (2007m) is the highest peak of the district. Rivers include the Awash and the Kesem. Lake Basaka is an important body of water in this woreda. Points of interest include the Awash National Park in the north.

Major soil types in the district are regosols, rendzinas and phaezems, fluvisols, luthosols and andosols covering.35.9%, 29.3%, 16.8%, 12.0%, and 6.0% respectively (Socio-economic profile of East Showa, last accessed May 2009). The soil types fairly describe the whole region with the exception for the Beseka Lake catchments. Its geology is characterized as highly permeable composed of volcanic ash, sub-recent basalt and young basalt (Tenalem, 2005a).

Bushes, shrubs, grazing lands and cultivated land cover nearly half of the district where as the rest is degraded land. Maize is the only cereal crop grown both by rain

fed and irrigation. Where as fruits and vegetables are important cash crops in Fentale district.

3.1.4 Population

The population of Fentale woreda was reported to be 82, 225 (CSA, 2008). Of this total about 25 percent were reported to live in the two urban kebeles, while 75 percent settled in the 18 rural kebeles. The latter category show strong homogeneity ethnic wise, since most of the rural dwellers are from the Karrayu community except for few migrants from west Harrarghe. The 18 rural kebeles are further categorised as; Pure Pastoralists, Agro-Pastoralists and Sedentary Agro-Pastoralists (CSA, 1996). The gender proportion reveals that 53% are male and 47% females. The average population density was reported to be 41.69 persons per square kilometres in the 1996 report by CSA. While the recent population and housing census report (2008) show that a population density of 61.37, which implies an increasing pressure on the existing fragile natural resource. Furthermore, the Fentale district was the least populated as compared with the other 11 woredas in the East Showa Zone in the last census, whereas currently it is the 7th populated district. This actually calls for the earliest possible comprehensive policy interventions aiming at a wise utilization of natural resources for sustainable development.

3.1.5 Economic Activities

According to the recent population census, 75 percent of total population in the woreda belongs to the Karrayu pastoral community whose livelihood primarily depends on livestock (CSA, 2008). And target of this study is the Karrayu, the economic characteristics described here is totally focused on the 18 kebeles of Fentale woreda.

Though is showing an alarming decline livestock rearing is the main economic activity in the district. There were 160,088 cattle, 131,829 sheep, 147,535 goats, 1,700 horses, 7,828 donkeys, 81,204 camels and 17,425 poultry (Socio-economic profile of East Showa, last accessed May 2009). The major animal diseases are blackleg, anthrax,

lumpy skin, internal and external parasites, sheep and goat pox, African horse sickness, camel pox and pneumonia. The condition for livestock production system goes through further bottleneck since the whole pastoral regions in Ethiopia are characterized by inadequate and inefficient of the veterinary services (MoFED, 2006). In addition, feed shortages resulting from drought, range degradation, and land shrinkage are major constraining factors to livestock development and pastoral livelihood. Drought is a recent experience for the Karrayu and the neighboring woredas, as they had not received rain between August 2001 and mid June 2002, as a result the boreholes had dried and a significant amount of their livestock were fatalities (Piguet et al., 2002). At the time there were some pastoralists who had lost up 45% of their livestock.

Cultivation has been practiced in most kebeles disproportionately. And the kebeles are further categorized by the intensification of farming in the land. Seven of the kebeles are considered as pure pastoral kebeles. While other seven are classified as agro pastoralist kebeles. These kebeles are classified as settled agro pastoralists, most of the dwellers in these kebeles no longer leave their plot of land in search of grazing land as they used to, even in drought times (*bona* they call in the local tongue) they prefer to use other risk management strategies than mobility for a shortage of fodder, which are gathering and buying sugar cane sheet, grass, conserve hay and maize cane.

3.2 Methodology

3.2.1 Research Design

The study was conducted with the complementary integration of household socio-economic survey and remote sensing data of the three Kebeles. The socio-economic data did help to explain human-environment decisions in resource use under the prevailing socio-economic conditions. Where as the remote sensing data was used to analyze the respective land use/land cover changes in the area for 15 years by using Geographical Information System (GIS).

Since the pastoral and agro pastoral economy is multi-dimensional and heterogeneous, it is likely to pose challenges for research unless a judicious mix of qualitative and quantitative techniques are applied. Hence, a combination of qualitative and quantitative methods was used foe the study.

3.2.2 Sample Size and Sampling Method

To gather accurate data, applying appropriate sampling techniques depend on the nature of the population, the type of investigation and degree of precision at the minimum cost is recommended (Robson, 2002). In view of this, the study primarily focused on three Kebeles of the Fentale Woreda. There are 18 kebeles in the woreda and they are categorized in three (Table 3.1); transhumant pastoral, agro-pastoral and sedentary agro-pastoral kebeles depending on their primary production system, mobility and the intensity of agricultural practice by the Karrayu. The whole sample is selected by stratified random sampling technique.

Table 3.1: The three strata for sampling

The three strata	Transhumant pastoral kebeles	Agro-pastoral kebeles	Sedentary agro-pastoral kebeles
Name of Kebeles	Banti-mogasa	Diresaden	Algae
	Dhegadu	Fate ledi	
	Fentale-debit	Gelcha	Gara-dima
	Haro-Karsa	Godo-fafate	
	Illala-Karari	Kanifa	Gidara
	Kobo	Sara-Weba	
	Tututi	Turo-badanota	Golla

Source: Field survey, 2009

For the purpose of this study, a single kebele is selected from each stratum to make the sample more representative to the general population. Therefore; Dhegadu, Gelcha and Golla kebeles were selected respectively from transhumant pastoral, agro-pastoral and sedentary agro-pastoral strata of kebeles. Each kebeles have villages (known as *ketenas* locally) with different type and level of diversification depending on their

comparative advantage in terms of their access to natural resource, infrastructure and population density.

Lists of selected villages were obtained from the Woreda Pastoral and Agro-pastoral Office. Where as the complete lists of household heads of selected kebeles were obtained from Development Agents (DAs) and elders at each kebele. The selection of households for the household questionnaire survey was undertaken proportionately from each ketena based on total number of households.

Accordingly, 173 sample households (11.9% of the total households total of the three kebeles) were taken, i.e., 43(12%) households from Dhegadu kebele, 90(11.7%) households from Gelcha kebele, and 40(12%) households from Golla kebele.

Table 3.2 Total number of household and sample size taken from three kebeles and their ketenas

Mane of kebele	Name of ketena/village	Number of households	Sample households taken for the study
Dhegadu	Dhegadu	124	**13**
	Yaya	70	**10**
	Balchu	71	**10**
	Imbiba	86	**10**
	Total	351	**43 (12%)**
Gelcha	Gelcha	275	**30**
	Ajjo Terrae	210	**25**
	Dire Redie	160	**20**
	Haro Addi	120	**15**
	Total	765	**90 (11.7%)**
Golla	Golla	228	**28**
	Kallo	100	**12**
	Total	328	**40 (12%)**
Over all Total		**1444**	**173 (11.9%)**

Source: Field survey, 2009

3.2.3 Sources of Data Collection

Data Sources

Both primary and secondary data sources were used for this study. The primarily data were gathered through household survey, focus group discussions, key informant interviews, and direct observation techniques. The survey generated both qualitative and quantitative data pertaining to their socio-economic and demographic characteristics, different income sources for the households and respective challenges, and trend of changing land use options.

I. Primary Data source

Structured Questionnaire

The study was based mainly on sample pastoralist households cross-sectional survey using pre-tested structured questionnaire organized in a logical order of presentation. The survey generated both qualitative and quantitative data pertaining to:

- Socio-economic and demographic characteristics, different sources of income for households
- Level of livelihood diversification and respective challenges faced by households in the new venture and existing source of livelihood and how they respond those challenges.
- Factors enhancing or hindering pastoralist's desire to diversify their livelihood related to access to resource, and labor, human capital and social network.

Key Informant Interview

In-depth key informant interviews were conducted with community elders, local development agents (DAs), local association leaders, and young household heads. These include: three community elders (one from each Kebeles), another three DAs from each Kebeles, Two association leaders one from both Sand miners and white stone miners. Moreover, in-depth interview was also conducted with local government officials from Woreda pastoralist and agro pastoralist's development bureau experts (5 in number).

Focus Group Discussion

Focus group was also another qualitative method of data collection instrument used for this study. Accordingly, FGDs were planned to take place in each villages (Ketenas) which would have been 10 in number. The number of participants in a Focus group range from five to ten. And the general direction pursued in those discussions were left for the researcher to trigger issues for discussion and promote active group participation. All contents of the discussion were recorded in a tape recorder for later transcription. And all the discussions were conducted in Oromifa in view of the fact that not all the participants speak Amharic, therefore translators were employed for each focus group discussions.

II. Secondary data sources

The primary data gathered was supplemented by review of documents and other secondary sources. The following are the major secondary sources that were utilized during the study.

- Books and periodicals, related publications, seminar papers, conference proceedings.
- Previous works done as Master's thesis and PhD dissertations as well as socio-economic, land use/land cover studies by in line agencies.
- All relevant documents and project reports, internal by-laws of the two associations.
- Statistical publications, satellite images (Remote Sensing Data) of the study area and maps.

Landsat imagery is available since 1986 from satellites in the Landsat series. These satellites have been a major component of NASA's Earth observation program, with three primary sensors evolving over fifteen years: TM (Thematic Mapper), and ETM+ (Enhanced Thematic Mapper Plus).

Table 3.3 Satellite Images used

No	Landsat type	Path / Row	Date of acquisition	Spatial resolution	Source
1	Landsat-TM	168_054	Jan. 21, 1986	28.50X28.50	ILRI
2	Landsat-ETM+	168_054	Dec. 5, 2000	28.50X28.50	ILRI

3.2.4 Data Analysis

Household Survey Data Analysis

The survey data was analyzed employing mainly descriptive statistics with the help of statistical soft wares (SPSS). Further, information obtained from focus group, key informants and officials has been summarized and used in the triangulation of evidences.

The process of analysis was carried out by using qualitative description and descriptive statistics. The portion of data that was readily quantifiable (information from the closed questions of the questionnaire) was discussed using tabulation and cross - tabulation of variables with percentage values and other descriptive statistics. Readily non-quantifiable data (information from open-ended questions, key informant interviews, and focus group discussions) was discussed through qualitative description.

Remote Sensing Data Analysis

The land use/land cover study was performed by multi-temporal remote sensing data of the area, which have been imported to image processing software. Image enhancement, rectification and classification were applied on the raw image. This has allowed the extraction of information on land cover condition and quantification of changes and its rate over the past 15 years using multi temporal GIS analysis. The land cover conditions of two different periods have been spatially compared and the trend, rate and quantity of change have been calculated.

Remote sensing data for the mentioned period were extracted from Landsat Thematic Mapper (TM) and Landsat Enhanced Thematic Mapper Plus (Landsat ETM+) images for 1986 and 2000 respectively. The 1986 land cover data set provide the foundation for all further data development and based on 1986 (base year) and 2000 land cover out put, the land cover classes analyzed for changes were: Bush land, Farm land,

Grazing Land, plantation, Rock, and Water body. The description of these land cover categories is given in Table 3.4.

Table 3.4 Description of land cover categories for categorical mapping and change detection between 1986 and 2000 for the study area.

Type of land use/land cover	Description
Farm land	Areas of land ploughed/prepared for growing rain fed or irrigated crops. This category includes areas currently under crop, fallow and land under preparation.
Bush land	Areas covered with small trees, bushes and shrubs, mainly *Acacia Ethiopica*.
Grazing land	A land with low-growing vegetation cover used for grazing of livestock as part of unenclosed pastoral systems.
Plantation	The land covered with sugar cane plants, for the sugar factory.
Water Body	Any significant accumulations of water, usually covering part land of the study area are Lake Besseka and other small collection of water.

The other component of methodology was to acquire primary data for the research is ground verification for image interpretation premeditated for the supervised classification. Land cover maps were generated from analysis of the georectified satellite images, using a supervised maximum likelihood classification.

The following flowchart shows the course of action used in land use/land cover analysis in this study.

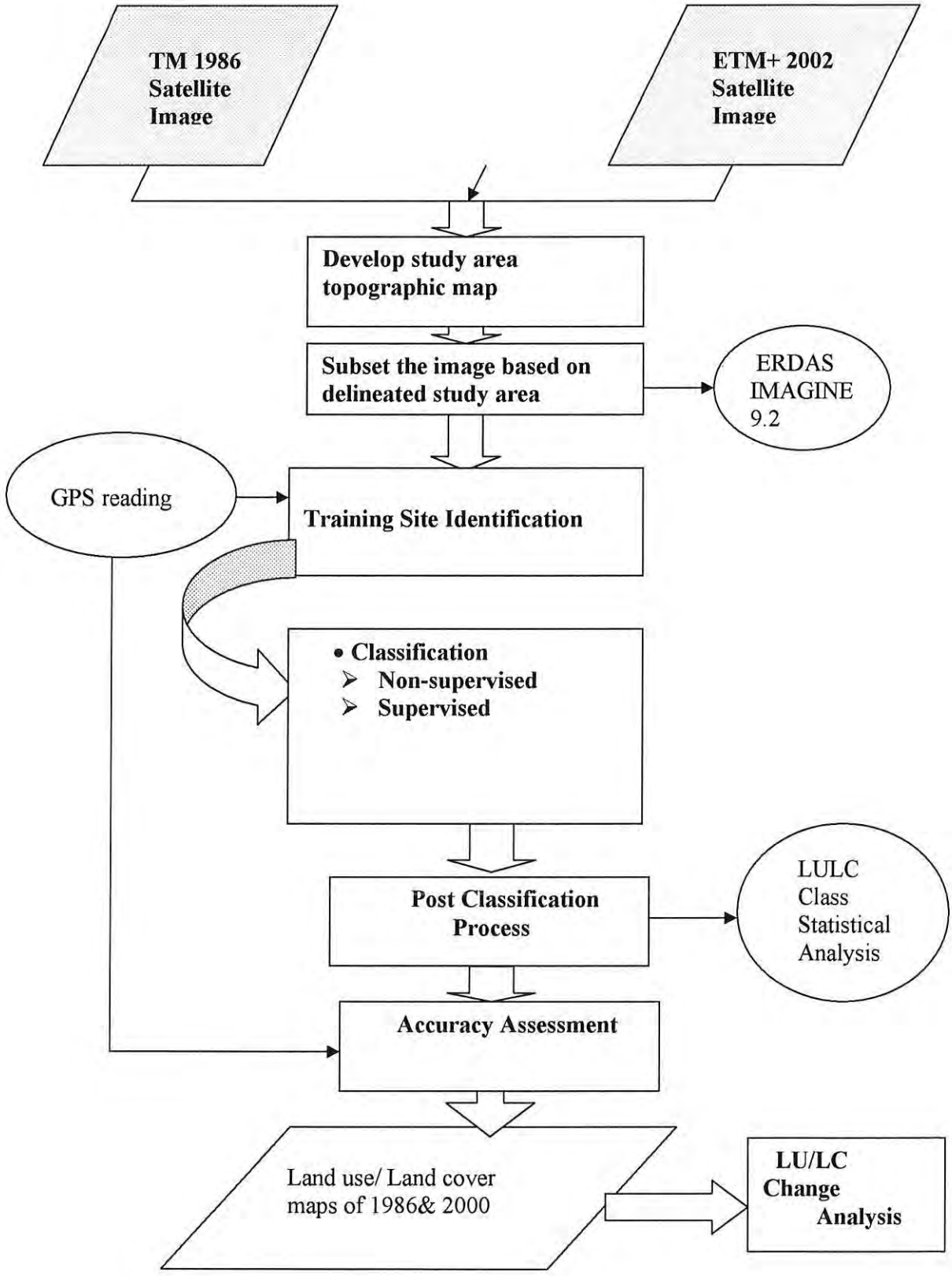

Figure 2: Flow chart method

Image Classification

Supervised image classification was done on each of the satellite images using the image processing software ERDAS IMAGINE 9.2. The maximum likelihood classification were applied for the image classification after selecting 18 and 20 training areas on the 1986 & 2000 Land-sat images respectively. The selection of training areas were made based on the information obtained from field data.

Land cover Change Rate

The land cover map for the period of 1986-2000 images is analyzed based on land cover type's area comparison. And land cover changes using graphs and charts. The changes over 15 years were analyzed and rate of change for each land cover type is calculated. The rate of land cover change is calculated for the period from 1986 -2000 using the following formula below.

Rate of land cover changes (ha/year) = (A-B)/C
Where A= Recent land cover area size
B= Previous land covers area size
C= Number of years between A and B

Accuracy Assessment

To validate and crosscheck the result of the Landsat classification with known ground truthing data accuracy assessment was checked for the signature values of classified images by calculating the error matrix in ERDAS IMAGINE 9.2. Software. The confusion matrix is a table with the columns representing the reference (observed) classes, and the row the classified (mapped) classes (Rossiter, 2001). The kappa coefficient calculation was the next steep; it represents the agreement between the classified land use/land cover and the observed land use. The kappa coefficient is a powerful technique in its ability to provide information about single matrixes well as to statistically compare matrices.

The Kappa coefficient is given by the formula: $\text{Kappa (k)} = \frac{Po - Pe}{1 - Pe}$

Where: Po- is the proportion of correctly classified cases

Pe- is the proportion of correctly classified cases expected by chance.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

4.1 Background Characteristics of the Karrayu

Among the three investigated Kebeles; Dhegadu is m homogenous group of the Karrayu clan and the livelihood characteristics of the 43 respondents (12% of the population) show nearly similar livelihood system. While the other two kebeles do not have exclusive homogeneity both in clan and also in livelihood system.

The gender profiles of the respondents reveal that female household heads comprise 23 percent of the whole 173 sample households. With regards to the age distribution majority of the respondents fall in a range of (31-45) and mean age distribution of household heads from the three kebeles show some what consistent; 40.5, 39.2 and 38.9 from Dhegadu, Gelcha and Golla kebeles respectively. The mean land holding size of respondent households show difference amongst kebeles and even ketenas; 0.625 hectares, 1.91 hectares and 1.64 hectares respectively from Dhegadu, Gelcha and Golla kebeles. Where as mean family size in the Kebeles was 7.0, while the range falls between 6.5 and 7.0. Specifically amongst the kebeles, Gelcha was with the highest family size (7.0), followed by Dhegadu (6.9) and Golla (6.5). The detailed data on land holding size and household's size are in the tables 4.1 and 4.2.

Table 4.1: Household size of the respondents in the three Karrayu pastoralist kebeles

Name of kebele	Households size			Mean households size
	1-5	6-10	>10	
Dhegadu	16(37%)	20(46%)	7(16%)	**6.9**
Gelcha	28(31.2%)	40(44.4%)	22(24.4%)	**7.6**
Golla	17(42.5%)	18(45%)	5(12.5%)	**6.5**
Total	**61(35.2%)**	**78(45%)**	**34(19.8%)**	**7.0**

Source: Field survey, 2009

Table 4.2: Patterns of land holding of the respondents in the three Karrayu pastoralist kebeles

Name of kebele	Name of ketena/village	Average landholding size(ha)
Dhegadu	Dhegadu	0.7
	Yaya	0.5
	Balchu	0.5
	Imbiba	0.8
	Average	**0.625**
Gelcha	Gelcha	2.75
	Ajjo Terrae	2.10
	Dire Redie	1.60
	Haro Addi	1.20
	Average	**1.91**
Golla	Golla	2.28
	Kallo	1.00
	Average	**1.64**
Over all Average of the three kebeles		**1.40**

Source: Field survey, 2009

The pattern of land holding in each kebeles revealed that most respondents in the three kebeles own land for cultivation though it is not conclusive that they all would cultivate every year. Starting from 2003 every household in Dhegadu kebele is entitled to have quarter of a hectare land for farming by the Woreda Agro-pastoralists' Office. Since the rain fall distribution is short and unpredictable, some of the pastoralists might not bother to cultivate in a particular year. Given that the neighboring farmer can merge the whole or part of the bare land in the condition that he/she would transfer it back when needed by the rightful owner. Therefore, yearly land holding size of a pastoralist in Dhegadu kebele is continuously changing while they rightfully own only quarter of a hectare.

Where as in the two kebeles, it is rather different because they are more sedentary agro pastoralists except Ajjo Terrae ketena of Gelcha kebele. In Ajjo Terrae, every agro pastoralist can claim extra land to cultivate every year from the communal grazing land.

Nearly all the respondents in the three kebeles have livestock, while the highest share goes to pastoralists from Dhegadu kebele; they own more than 50% of the livestocks (cattle, camel and donkey) where as more than half of the rest are owned by agro pastoralists in Gelcha and the rest to those from Golla Kebele. The mean size of livestock per household for the three kebeles are 6.67 cattle, 14.7goats and sheep, 11 camels, 2 donkeys and 8 poultry.

Table 4.3: Households mean livestock size of the respondents in the three Karrayu pastoralist kebeles

Name of Kebele	Mean size and type of livestock/ households in each kebeles				
	Cattle	Goats/ Sheep	Camels	Donkey	Poultry
Dhegadu	12	25	15	3	4
Gelcha	5	15	7	2	12
Golla	3	4	0	1	8
Mean livestock of study area	**6.67**	**14.7**	**11**	**2**	**8**

Source: Field survey, 2009

4.2 Livelihood Diversification among the Karrayu

Karrayu way of life has predominantly been nomadic pastoralism, which is heavily dependent on livestock and environmental resources (Ayalew, 2001). This livelihood system has been affected by expansion of commercial plantations, wild life conservation schemes and settlements, which is strongly reaffirmed by all the three community elders from each kebeles. They emphasized that the gradual diversification towards non pastoral livelihood strategies as an adaptation and response to the continued forces that limit their mobility.

The various livelihood strategies that are practiced by the Karrayu had begun in different moments in time. For example cultivation was introduced by Ittu migrants

from Western Harraghe, who has been living in the area since mid 1970s (Ayalew, 2001). At the beginning cultivation was not fully accepted as an optional livelihood strategy but rather as a way of claiming land ownership. Particularly around the banks of Awash River and Golla Kebele is one the areas where cultivation was first practiced. Where as firewood and charcoal selling does not have a well documented history on when it has begun, but for in house consumption the Karrayu were gathering firewood as a source of energy. The critical times in firewood and charcoal selling business were the establishment of Metehara Sugar Factory (with its camp and settlement for workers) and the two urban towns (Metehara and Addis Ketema) 32 years ago. Waged labor opportunity for the Karrayu as a guard to the sugar cane plantation has been given by the sugar factory where as the other waged labor opportunity, which is guarding cattle keeps, has began around 12 years a go when cattle merchants turn their attention towards the livestock potential of the area. Mining is one of the livelihood strategies that is currently practiced by the Karrayu and it was being performed in a more organized manner for the last five years.

4.3 Extent of Livelihood Diversification in Fentale Woreda

The principal part of this study is to characterize the extent of livelihood diversification in the Karrayu pastoral community. The following output is based on various data gathered from both primary and secondary sources. The major sources of income were investigated for the surveyed Kebeles. Primarily, three basic sources of income were identified; Livestock rearing, farming and firewood and charcoal.

In table 4.4, there is a detailed description of response of households in the three kebeles about their main livelihood activity. About 42.2 percent of the respondents put livestock rearing as their main livelihood activity, while 26.6 % of the 173 respondents reveal that their major income come from farming and 24.8% of them have firewood and charcoal selling as their major livelihood source.

Table 4.4: Percentage responses on main occupation of the three Karrayu pastoralist kebeles

Name of kebele	Main Occupation						Total
	Livestock rearing	Farming	Waged labor	Mining activities	Petty trade	Firewood and charcoal selling	
Dhegadu	27(62.8%)	-	-	-	-	16(37.2%)	**100%**
Gelcha	38(42.3%)	28(31.1%)	4(4.4%)	5(5.5%)	-	15(16.7%)	**100%**
Golla	8(30%)	18(60%)	2(5%)	-	-	12(30%)	**100%**
Total	**73(42.2%)**	**46(26.6%)**	**6(3.5%)**	**5(2.9%)**	-	**43(24.8%)**	**100%**

Source: Field survey, 2009

4.3.1 Livestock Resource

Livestock is the primary source of livelihood income for many Karrayu pastoral households. Their livestock constitutes; cattle, sheep, goats, camels, donkeys and poultry. As a risk minimization and income maximization method the households in the study area commonly involve in livestock diversifying scheme, which is what several studies have emphasized as 'multiple livelihoods' (Bryceson, 2000; Francis, 2000). Based on the household survey data about study 75% of the total population own more than two types of livestock, while 15.5% of the population own no livestock at all and the rest 10.5% own only one or two type of livestock. These large responses reveal that diversification of livestock as the most predominant diversification technique employed by the Karrayu.

Through diversified livestock rearing strategy the pastoralists can reduce the risk of loosing all their livestock if there is outbreak or sever shortage of feed for one of the livelihood kind. In overall when the bleak season or phenomenon is affecting part of the livestock others will survive. For instance, there was severe rain water shortage during the period of August 2001-June 2002 as a result it was reported that some pastoralists loose up to 45% of their livestock (Piguet et al, 2002).

Livestock has been the base of the Karrayus' livelihood for long and there are various outcomes and services like; milk, meat and butter both for in house consumption and

for sale. Currently most of the products mentioned are used for in house consumption because of the reduction of livestock density by the drought in 2001/02 G.C, which significantly affected the size of livestock of the karrayu pastoral community. During an interview with a community elder (key informant) from Dhegadu kebele, I found out that the products like milk and butter can not even satisfy the need of his family. Further more in Agro-pastoralist households' oxen are used for ploughing and manure is harvested from the cattle keeps for cultivation.

Challenges of Livestock Production System

The livestock production of the karrayu was being challenged by both natural and man made constraints for a long time. The man made constraints began with the establishment of Metehara Sugar Factory, Nura Era Plantation and Awash Nation Park and increasing settlement and sedentary movement of immigrants from western Harraghe (Ayalew, 2001) which lead to the reduction grazing land in the area. The natural constraints were part of the ecosystem for years but the Karrayu were successfully managing to survive and even get improvement through the traditional risk management strategy of mobility. After the introduction of those new establishments, the Karrayu did not only loose their grazing land but also the potential for mobility through continued expansion of the urban towns and the fear of loosing the farming land they currently own.

Recently two of the sample kebeles; part of Gelcha and nearly every grazing land in Golla are being over taken by *Prosopis Juliflora* Invasive Species. As a result the previously known grazing land is now covered by Prosopis Juliflora. Both through Focus Group Discussions and through key informant interviews the species is considered as the deadly threat to the livestock production system in the area. They believe that the tree is introduced to the woreda in the 1990s.

Table 4.5 summarizes the challenges and constraints of livestock production system in the area. The challenges are across all the kebeles but their degree of damage on livelihood differs between villages. For example, drought is a challenge for all pastoralists in the woreda but the perception of drought as a major challenge differs from one kebele to the other. Accordingly, about 30%, 10% and 5% of the respondents

from Dhegadu, Gelcha and Golla respectively responded that drought is a major challenge. In the recent (2001/02) drought more cattle died from Dhegadu than Gelcha and Golla combined because pastoralists from the first kebele have a lesser access to sugar cane sheet than the latter two. Where as for challenges that are unique to only one or two of the kebeles like invasion of *Prosopis Juliflora* was not considered as a challenge in Dhegadu for the time being.

Table 4.5: Challenges and constraints of livestock production system in the three karrayu pastoralist communities

Name of kebele	The major constraints/challenges					
	Shortage of labor	**Shortage of grazing land**	**Raid while in migration**	**Parasite & diseases**	**Drought**	***Prosopis Juliflora* expansion**
Dhegadu	2(4.6%)	18(41.8%)	12(28%)	8(18.6%)	13(30%)	-
Gelcha	8(8.9%)	31(34.4%)	15(16.7%)	7(7.8%)	9(10%)	30(33.3%)
Golla	1(2.5%)	8(20%)	-	-	2(5%)	29(72.5%)
Total	11(6.3%)	57(32.9%)	27(15.6)	15(8.6%)	34(19.6%)	59(34.1%)

Source: Field survey, 2009

Seasonal Availability of Feed Resource

Table 4.6 summarizes the response of the respondents on availability of livestock feed throughout the year. It is grouped in to four based on the status of feed availability; abundant, sufficient, moderate shortage and sever shortage. The outliers like January and June are considered as the harshest ones in all the kebeles and there is no time in the year that can be described as feed abundant for pastoralist in Golla kebele since almost all the grazing land is being occupied by *Prosopis Juliflora*. And depending on the magnitude *belg* rain, which comes anytime between March and April, there might be sufficient feed.

Severe shortage of feed exists during the period between January and June, during sever shortage of feed the Karrayu's take a number of measures to alleviate damage. What the Karrayu's do in such cases can be better described in following section.

Table 4.6: Feed availability throughout the year in respective kebeles boundaries

Name of kebele	Feed availability status throughout the year			
	Abundant	**Sufficient**	**Moderate shortage**	**Severe shortage**
Dhegadu	August	July and Sep.	Oct. – Dec.	Jan. – June
Gelcha	August – Oct.	July	Nov. and Dec.	Jan. – June
Golla	-	July – October	Nov. and Dec.	Jan. – June.

Source: Field survey, 2009

The Dhegadu Kebele Pastoralists in this kebele, have two major strategies to get more feed for their livestock in the dry season; firstly, moving the livestock back and forth between grazing areas and water points is the first choice and secondly gathering or buying sugar cane sheet from the urban town (Metehara and Haro Addi).

Moving the livestock's to neighboring regions are done mostly in group for safety and to avoid raids. There are areas in Afar and Amhara regions in addition to near by woredas in East Showa zone, Oromiya. From the three destination points, Amhara and Afar regions are only as far as a day walk but recognized as risky territory learnt from past experience; possible conflicts and cattle raids. Where as Arusi zone is relatively far and safer.

Unlike the cattle movement strategy, gathering and buying sugar cane sheet/leaves is practiced by some of the pastoralists only. As it is located far from the sugar cane plantation.

In Gelcha Kebele, the Karrayu have more options than the ones from Dhegadu as the kebele is located close to the plantation and to the towns. And also the Karrayus' in Gelcha have a buffer of maize sheets/leaves from being an agro pastoralist. In addition the grass mowing around sugar plantation area and the pods of *Prosopis Juliflora* are important options. The respondents from Ajjo Terrae ketena, which is nearly five minutes away from Awash National Park, will trespass in to the National Park by night when the security is relatively weak, which in turn gives rise to the popular

conflict between the Karrayu and the guards. The guards are mandated by law to use any power at their disposal to keep the livestock of the Karrayu from trespassing in to the boundary, in so doing they can impound the livestock and charge a fine of 10 Birr per head.

The case for Golla is somewhat similar with the one in Gelcha; both are near to sugar plantation and urban towns. And both are agro pastoralists with access to buffer stalks of maize sheet/leave residues and straws and P*rosopis Juliflora* pollen grain.

4.3.2 Farming

Farming has been practiced for more than three decades and maize was cultivated dominantly both by irrigation and rain-fed. Recently, fruits and vegetables have become important cash crops in the area. Accordingly, sedentary pastoral communities appear to be growing in number in the neighborhoods very close to the Awash River, and the sugar plantation irrigation scheme. Most of these inhabitants are largely poor people who understood that they can no longer survive in the pastoral livelihood system. As a result they migrated to these areas looking for perennial water for cultivation.

Around 26.6% of the total sample of respondent's state that farming is their major livelihood source (Table 4.4). As indicated in table 4.2 it is clear that every pastoralist or agro pastoralist have a land to cultivate, though it does not mean that all are supposed to farm every year. As the difference of land holding size between kebeles reveals that, the degree of livelihood diversification towards farming is different as well. The response from household survey on yearly cultivation rate of the past three years is summarized in table 4.7.

Table 4.7: Yearly cultivation rate in the three Karrayu pastoralist kebeles for three years

Name of Kebeles	Yearly cultivation rate of respondents		
	2006	2007	2008
Dhegadu	30	32	20
Gelcha	75	80	71
Golla	28	32	31
Total	**133**	**144**	**122**

Source: Field survey, 2009

According to the respondent's response, regarding their yearly cultivation rate, in 2006, 133 households, which is 76.9% of the respondents, have said that they cultivated their land, while 144 households of the total 173 cultivate their land in 2007, which is 83.2% of the respondents, and for the year 2008 only 122 households from the respondents cultivated which represent around 70%. This numbers does not mean that the karrayu themselves cultivate their land because some have leased their land to farmers from the towns and few more do sharecropping according to the development agent (DA) in Gelcha Kebele.

Maize is the only crop, which is cultivated by every rain fed farmer. They choose to cultivate maize because the seed is cheep and it does not fertilizer at all, only sufficient rain and if fail to produce any harvest what is left of it will be used as buffer feed for livestock when there is shortage.

Rain-fed farming is usually during the major rain season, which is between July and September. However, farming is always given a lesser recognition than both livestock and firewood and charcoal, which are the two major livelihood sources in the Dhegadu kebele (table 4.2). Whatever they produce will be consumed at home and there is no need to measure the harvest as well. Based on the household survey a good harvest could last in a family of size 7.0, which is the mean size of family for Dhegadu kebele, for two months. Where as a bad season is simply no harvest at all.

In table 4.7 there was a small increase in number of households and individuals who cultivate between 2006 and 2007. While in an FGD in Dhegadu kebele concerning the yearly cultivation rate, it was understood that the increase in 2007 was because of the

better harvest in 2006, which gave a boost up of morale for the next season in 2007. The harvest of 2007 was not satisfactory as a result of shortage in rain distribution, which in return brought down the number of cultivators for the year 2008.

In Gelcha kebele, mixed rain fed and irrigated farming is practiced. Currently two of the ketenas, which are Haro Addi and Dire Reddie, do not have access to either irrigation line or water pump as a result only rain fed farming is being practiced once a year during the major rain season. Where as the other two ketenas; Gelcha irrigation line from the Metehara Sugar cane plantation and in Ajjo Terrae the farmers association own three motor pumps, which were provided by the Woreda Agro Pastoralists Bureau. Agro pastoralists in Gelcha ketena can cultivate the whole year where as in Ajjo Terrae all the farm land is covered with flood from Awash River during the major rain season and cultivation is possible for only 7-9 months, depending on the strength of the minor rain season the land may be available for service even for less.

In table 4.8 important issues like the average rain fed land size of respondents in Gelcha kebele, average production of maize per household are described. The average land holding pattern of Gelcha kebele in table 6 is 1.91 hectares and for ketenas such as Gelcha and Ajjo Terrae the land which is being utilized as rein fed farm is not part of the land that they rightfully own, where as these land is a communal property left as grazing land and in rainy season agro pastoralists cultivate it as their own. The land they rightfully own is correspondingly being cultivated by irrigation for those in Gelcha and by motor pump for those in Ajjo Terrae. These activities causing a change in land use from grazing land to seasonal farm land and commutatively, let's say another agro pastoralists cultivates the land, which will continuously change the original land cover type to a new one.

Table 4.8: Yearly rain fed cultivation rate of Maize in the Gelcha kebele Karrayu community for the last three years

Name of Ketena	Average land size (ha)	No of respondents who cultivate Rain fed and average production of Maize(Qt)					
		2006		2007		2008	
		No. HHs	Mean production Qt	No. HHs	Mean production Qt	No. HHs	Mean production Qt
Gelcha	1	8	4	10	3	9	5
Haro-Addi	1.2	7	3	9	2	5	4
Dire-Reddie	1.6	15	6	17	3	14	5
Ajjo-Terrae	1.6	10	15	12	12	10	15
Total	**1.35**	**40**	**5.6**	**47**	**5**	**38**	**7.25**

Source: Field survey, 2009

Irrigated farming is highly practiced in Kebeles which are close to the sugar cane plantations with the approval of the factory. Where as motor pump based cultivation is more appropriate to those which are very close to Awash River. Part of Gelcha Kebele qualifies for the first category and the other part to the second. Where as Golla Kebele, Kallo ketena is strictly in the first category, where as Golla ketena has access to both motor pump and irrigation scheme.

Agro pastoralists from the two kebeles not only get the benefit of getting perennial water for but also the disadvantage of loosing their crops and vegetables by flood. Their land will be flooded twice a year both with the major and minor rain seasons. Given that, they will cultivate in the mean time when flood clears of their land after renewing their land in the process. If there is any fluctuation in the rain season they might run a risk of loosing everything all together, and that happen quite often recently as a result of climate change.

The prospects of having perennial source of water give the agro pastoralists the option of cultivating more than once in a year and also a chance to diversify their crop. In rain fed farming it is impossible to cultivate more than once in a year in the area and

also diversifying in to cash vegetables like onions, sweet potatoes, and Cabbage, since they require better water than the soul crop of rain fed farming, maize.

While in an FGD in Gelcha kebele, Haro Addi and Dire Redie Ketena, the participants point out about how the diversification from maize in to cultivating vegetables likes onions, sweet potatoes, and Cabbage. But the agro pastoralists are restricted due to lack of initial capital for because they cannot afford to buy seeds and also the inevitable expense of fertilizers. For those who can afford to buy the seedlings and the necessary fertilizers, they don't want to put their money at risk since the area is prone to shortage of rain fall.

The over all analysis of table 4.9-11 shows some what consistent consumption of land over the three years. Especially in the two ketenas; Gelcha and Kallo, over all land consumption of the three years remain the same while the cultivation rate shows variation in the other two kebeles; Ajjo Terrae and Golla, which are very close to Awash River than the former two and as a result they are repeatedly flooded, given that the yearly cultivation rate varies, i.e. when the flood remains on their land repeatedly on the year the cultivation period decrease and the vice versa.

Table 4.9: Average farm size cultivated by irrigated and motor pump for Gelcha and Golla kebeles for 2006

Name of kebele	Name of ketena	Type of Vegetables and crops			
		Onions (ha)	Tomatoes (ha)	Cabbage(aa)	Maize (ha)
Gelcha	Gelcha	1.50	0.50	0.50	2.00
	Ajjo-Terrae	1.10	0.60	0.75	2.00
Golla	Golla	2.20	1.22	0.60	2.40
	Kallo	0.50	0.50	-	1.00
Average Total		**1.325**	**0.74**	**0.46**	**1.85**

Source: Field survey, 2009

Table 4.10: Average farm size cultivated by irrigated and motor pump for Gelcha and Golla kebeles for 2007

Name of kebele	Name of ketena	Type of Vegetables and crops			
		Onions (ha)	Tomatoes (ha)	Cabbage(ha)	Maize (ha)
Gelcha	Gelcha	1.80	0.50	0.50	1.70
	Ajjo-Terrae	1.70	-	0.75	2.00
Golla	Golla	2.20	1.10	-	2.40
	Kallo	0.80	-	0.50	0.70
Average Total		**1.625**	**0.40**	**0.44**	**1.70**

Source: Field survey, 2009

Table 4.11: Average farm size cultivated by irrigated and motor pump for Gelcha and Golla kebeles for 2008

Name of kebele	Name of ketena	Type of Vegetables and crops			
		Onions (ha)	Tomatoes (ha)	Cabbage(ha)	Maize (ha)
Gelcha	Gelcha	2.20	0.40	0.30	1.60
	Ajjo-Terrae	1.10	0.60	0.75	2.00
Golla	Golla	1.90	1.22	0.60	2.10
	Kallo	0.70	0.50	-	0.60
Average Total		**1.475**	**0.74**	**0.41**	**1.60**

Source: Field survey, 2009

4.3.2 Non-Farm Non-Pastoral (NFNP) Activities

NFNP livelihood activities, which are both non pastoral and non farm, practiced by the Karrayu constitute; firewood and charcoal production, mining, waged labor, brokering and petty trade.

Firewood and Charcoal Production:-

Firewood and charcoal have been the source of livelihood to the karrayu poor households for long time, even though it is considered as an illegal activity. Those who live near the two towns bring their commodities to the towns, while others which are far will bring the firewood and charcoal to the nearest highway and wait for the trucks passing by the road to buy. Recently many families and individuals who are

highly involved in the livelihood as an additional income source because of the recurrent drought that killed their livestock.

From the household survey it is possible to estimate that 71.6% of the respondents are involved in firewood and charcoal business. And 24.8% of them consider it as their major livelihood source (Table 4.4). From the output of FGDs conducted during the study, the production of firewood and charcoal has been increasing since 2002 in all the three kebeles for different reasons. The main reason behind is the growing demand for cheaper energy source in the towns. For example in Dhegadu kebele the resource base, which is from the bush land on Mount Fentale, is showing significant decrease but the production rate show continuous increase nonetheless. It is getting tougher these days to gather firewood says one women household head from Yaya ketena

> *It used to take us 2 hours to go up on the mountain and bring down firewood on two donkeys and our back but now we have to spend 5 hours to bring the same amount of firewood. The wood land that we usually gather from is getting cleared out every year.*

Where as in the other two kebeles, which are Golla and Gelcha, the source of firewood and charcoal shows tremendous increase due to the recent expansion of *Prosopis Juliflora* invasive tree made this venture the most feasible one for the resource poor.

The challenge of this livelihood system is obvious for kebeles like Dhegadu, shrinking bush land bring down the supply rate and for households and individuals to keep their production level up they need to meet the challenge of traveling far from their settlement. Where as for those kebeles which are being invaded by *Prosopis Juliflora*, the challenge is not in the usual resource shortage but too much resource (*Prosopis Juliflora)* is causing problem in curtailing mobility and further more, the direction of the expansion is directed towards the settlement areas. It is because firewood gatherers are acting as agents for *Prosopis Juliflora*.

Mining:-

Mining is spatially limited to two kebeles; Gelcha and Dhegadu. In the former kebele young individuals and household heads form legal associations to extract white building stone from the open commonly owned more than four years ago, according to key informant in Woreda Agro Pastoralists Bureau. From Table 4.4 it is possible to observe that 2.9% of household survey respondents state that mining is their major livelihood. The first association was formed with 40 young resource poor Karrayu individuals, and recently there are three associations performing the same task, which is extracting white stone and transporting it to the urban towns. According to the same source, at the time of the field research for this study, one more association is finalizing the legal requirement to start functioning.

Where as the mining activity in Dhegadu kebele is sand mining, benefiting from the geographical location of their settlement area, which is nearly at the bottom of Mount Fentale, every rain season will fill the surrounding area with sand. All the four ketenas of this kebele have the sand resource and there is a general association in which every household in the ketena is a member and own the resource communally.

Waged Labor:-

Employment opportunities in the study area can be generally categorized in to two based on their employer and longevity of the work; The Sugar Factory and private cattle merchants. From the household's survey it is understood that the older household heads are more capable of getting life time job with out pension from the sugar factory as guards. Where as the middle aged and young household heads tends to diversify towards a less attractive and a seasonal job as guards in cattle keeps for urban merchants.

While in a focus group discussion the participants openly confirmed my finding with reasons as follows; the waged labor opportunity provided by the sugar factory is mostly considered as a privilege for those who are more influential (in terms of age) and those household heads who could not get employed as a guard now think of their shortcoming as a stage of growth they are supposed to pass through until they reach to

the level that they will be considered as a senior member of the community and get employed.

Brokering:-

From the household survey and lengthy discussion with key informants and FGDs, it is understood that brokering the cattle market is another rewarding livelihood diversification strategy employed by the Karrayu individuals who have good communication individual from Dhegadu kebele explained that.

> *An individual whose livelihood is totally or partially dependent on livestock brokering needs to have contact in every kebele with good livestock production and also should have in the urban towns to attract the livestock merchants in the first place and find a safe cattle keep for rent in the outskirt of urban towns.*

Petty Trade

Even though the summary of Table 4.4 clearly show that no household or individual in the survey sample consider petty trade as a major livelihood or occupation, many respondents consider it as one of the diversification techniques that women in the household usually venture in to. Table 4.12 shows that out of the 39 female headed households in the sample, which is 23% the total 173, 34 of them state that they do petty trade either on a temporary basis or permanently. Where as out the 134 male headed households, 33 of them responded that either their wives or daughters are currently petty traders.

Table 4.12: Number of households and individuals who do petty trade

	Gender of households heads or individuals	**Number of households and individuals who do petty trade**
Households/ Individuals	Male individuals and male headed households	**34**
	Female individuals and female headed households	**33**
Total number households		**67**

Source: Field survey, 2009

4.4 Land use/ Land Covers Change Analysis

4.4.1 Land Covers Classification for 1986 and 2000

The land cover classification spectra for this study is based on logically accepted both in numbers of classes and with one class cover types changing. For a clear comparison of the land cover dynamics for 1986 and 2000 during classification it is usual to get some land cover types generalized when the cover classes are represented by fewer numbers of pixels. The major land cover classes for 1986 and 2000 are quantitatively analyzed for the area covered by each land cover unit. The land cover classes for Fentale Woreda as shown in Table 4.14 and Figure 4 and 5 below helps to compare each value for the major changes takes place for the past 15 years.

Table 4.13: Distribution of Land Use/Land Cover for the two periods

Land cover type	Area (1986)	%	Area (2000)	%
Grazing land	38382.71	35.29298	30876.71	28.3912
Farm land	2117.779	1.947303	3471.232	3.191805
Plantation	10681.33	9.821507	11005.01	10.11913
Rock	23716.73	21.80758	49493.24	45.50913
Bush land	30860.14	28.37596	9895.642	9.099064
Water body	2995.822	2.754664	4012.677	3.689665
Total	**108754.5**	**100%**	**108754.5**	**100%**

According to the data on Table 4.13 bush land used to cover 35% of the total land mass of Fentale Woreda in 1986, which is the largest of all the other land cover classes followed by bush land and rock covering around 28% and 21% respectively. Where as, in 2000 bare rock had shown significant increase and it covered the higher share of the area, which is around 45.5%, while grazing and bush land came down to cover 28% and 9% respectively.

To make the comparison more informative in showing where in the study area are the changes in land cover is highly observed. The land cover map of the area for the periods of 1986 and 2000 is portrayed in the Figure 3 and Figure 4.

Land Cover Classification for 1986

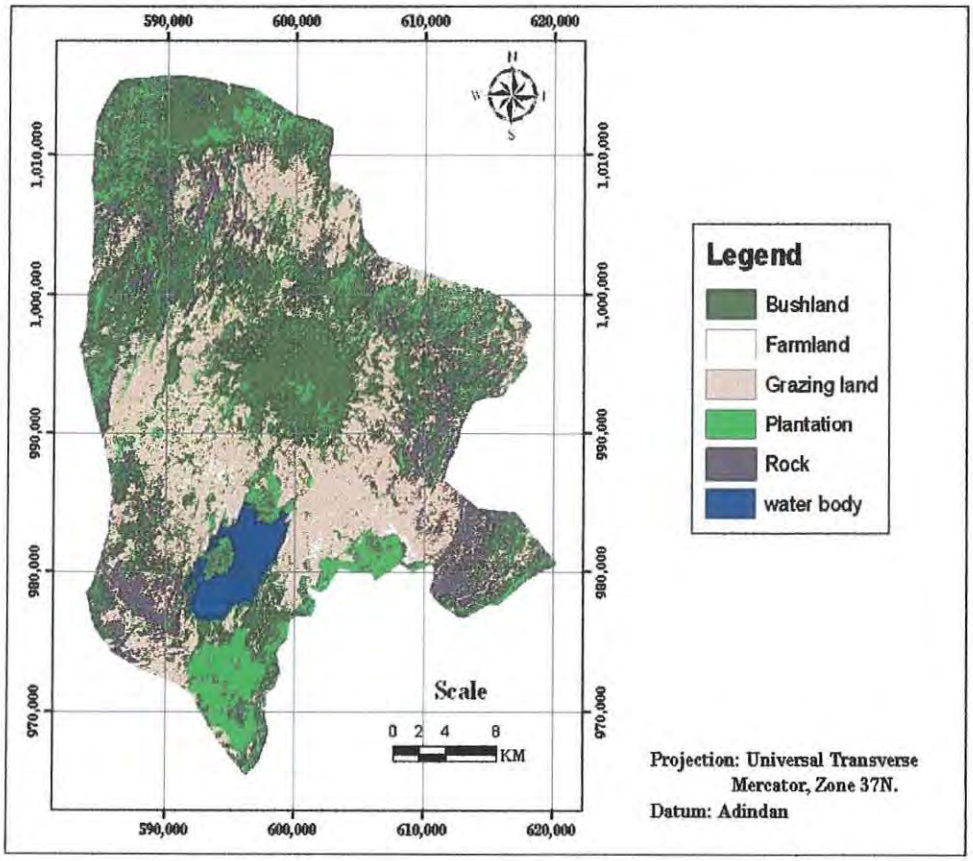

Figure 3: Land Covers class for 1986

Land Cover Classification for 2000

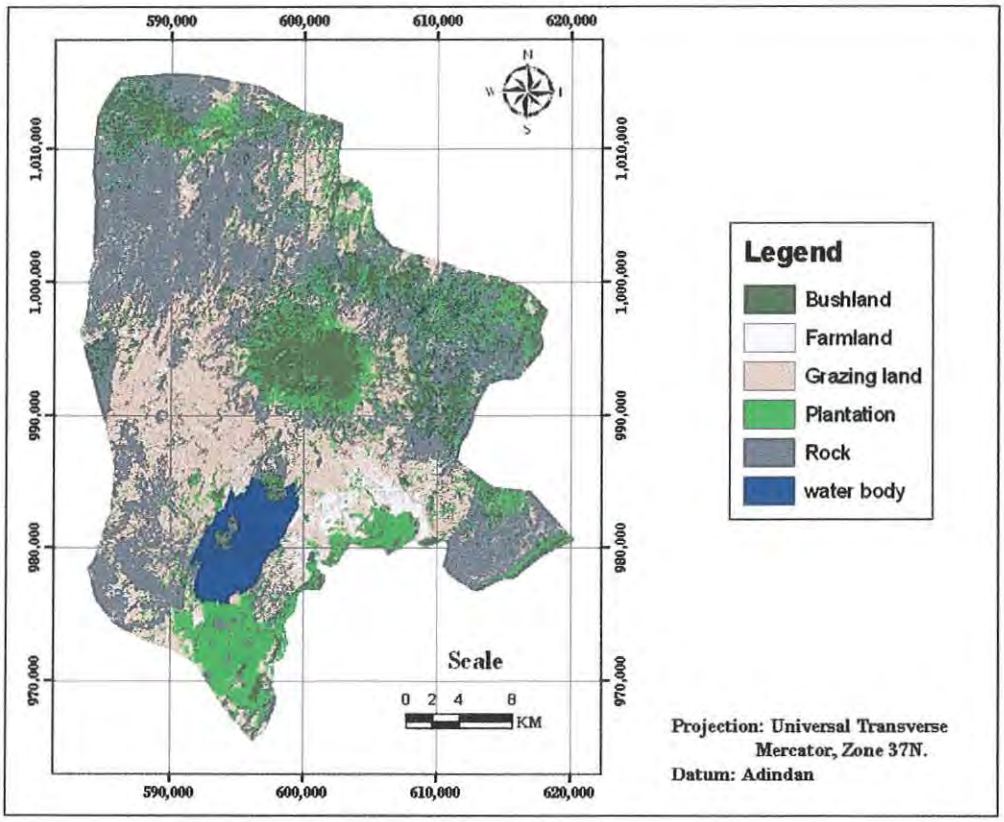

Figure 3: Land Covers class for 2000

4.4.2 Land Use Land Cover Change: Trend, Rate and Magnitude

As indicated in table 4.15 there is both negative and positive change in the different land cover classes. Between 1986 and 2000 bush land and grazing land showed negative change, where as bare rock, farm land, water body and plantation showed positive change. In the mentioned period 20,964.5 ha of bush land have been lost, which is 19.28% of the total area of the woreda. The yearly rate of change for a bush land over the 15 years is -1397.63 ha. Where as 500.4 Ha of grazing land were being changed in the mentioned period, an over all total of 7506 ha, which is 6.90% of the total area of the woreda.

Table 4.14: Land Use/Land Cover change of Fentale Woreda

Land cover classes	Magnitude of area change (ha)	Rate of change (ha/yr)	Trend of change	Percentage change
Bush land	-20964.5	-1397.63	-19.2769	-67.9339
Farm land	1353.452	90.23015	1.244502	63.90903
Grazing land	-7506	-500.4	-6.90178	-19.5557
plantation	323.6816	21.57878	0.297626	3.030349
Rock	25776.51	1718.434	23.70156	108.6849
Water body	1016.856	67.79039	0.935001	33.94247

The positive changes are more significant on bare rock and farm, which have shown an aerial increase of 25,776.51 ha and 1353 ha respectively. While the yearly increase of area for both land cover types; bare rock and farm land are 1,718.43 ha and 90.23 ha respectively.

4.4.3 Accuracy Analysis

To assess the classification accuracy, confusion matrix was used. And the overall accuracy and Kappa coefficient were produced. The minimum level of interpretation accuracy in the identification of Land use/Land cover categories from remote sensor data should be at least 85 percent (Anderson, 1972). And the overall accuracy of the 1986 land use/land cover classification is 87.3% where as the kappa coefficient is 82% (Annex 1). And the accuracy level for 2000 is 90.3% while the kappa coefficient is 0.86 (Annex 2).

4.5 The Links between Livelihood Diversifications and Changes in Land use/Land Covers

From integrated analysis of land use/land cover change and types of livelihood diversification in the study area, it is understood that the there are significant changes in size of most of the land cover classes in the study area. While the water body,

plantation, bare rock and farming land has shown an increase in size, bush land and grazing land have decreased significantly.

Lake Beseka, the major water body in the study area, has been ever expanding in volume as a result of which serious social, economic and environmental factors (Tenalem, 2005b; Bedilu, 2005; Tamiru, 2000; MoWR, 1999). During the last four decades the lake level and surface area have been increasing continuously (MoWR, 2000). While the increase in commercial plantation land is explained by the continuous expansion of sugar plantation by the Metehara Sugar Factory. The massive increase in bare rock cover can be caused by both natural and anthropogenic activities. And from Figure 2 and Figure 3, it is evident that the expansion of bare rock observed on 2000 classification map was largely covered by bush on 1986th map. Particularly, the degree of bush land decline is higher around Mount Fentale, which is known as locally the source of firewood and charcoal burning for a long time. It is inconclusive to state that exhaustive extraction of firewood and charcoal are the sole driving force to the decline of bush land, since it can be caused by both natural and anthropogenic activities. Given that, the purpose of this study is to understand the anthropogenic activities causing respective changes in land use/land cover. The high degree of conversion of bush land in to bare rock land around settlements can be explained by diversification of the Karrayu livelihood in to firewood and charcoal burning from the predominant livestock production system.

Where as the decline grazing land is concomitantly seen where farming was being expanding during period of 1986-2000. Particularly, these changes are strongly seen near the bank of Awash River and Karrayu settlements adjacent to the Metehara Sugar Factory plantation irrigation scheme. It is clear to see that these changes in land use/land cover are caused by the transforming livelihood strategies of the Karrayu from pure pastoralist to an agro-pastoralist.

It is not the condition that livelihood diversification causing a change in land use/land cover, the contrary is also true since a change in land use/land cover might result a transformation in livelihood strategies. To check the vise versa reaction, if changes in land use/land cover lead to changing the livelihood strategies of the Karrayu, it is

better to look at the recently introduced livelihood strategies like sand mining in Dhegadu kebele and stone mining in Gelcha kebele. These strategies are adaptation techniques for declining productivity of livestock as a result of decreasing grazing land through overgrazing. Areas classified as grazing land on the 1986 map were converted in to bare land as a result of overgrazing, which clearly show that these lands have a lesser value in the livestock based livelihood system. The aforementioned change in land cover opened up an opportunity for a whole new livelihood activity such as mining. Another example for a reverse reaction between land use/land cover and livelihood is the recent intensification of firewood and charcoal burning in kebeles highly invaded by *Prosopis Juliflora.* Particularly in Golla kebele the invasion of *Prosopis Juliflora* over grazing land has led to the intensification of firewood gathering and charcoal burning and significant decrease in the potential of livestock capital.

Complementary integration of household survey and GIS in this study reveals that there was a two way interaction between livelihood strategies and changes in land use/land cover. No matter which driving force starts this chain reaction it will continue to bring respective change in the state the other, together with other natural forces.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

At the beginning of this study, it is stated that there is a need to understand the various livelihood strategies of the Karrayu people. In this view, it is set out that livelihood diversification is conventionally considered as a remedy for the decreasing feasibility of pastoral livelihood system. Studying how they diversify their livelihood and trying to understand the respective challenges they face in their quest for sustainable livelihood.

There are sound evidences that income diversification is currently becoming an important aspect of the pastoral livelihood dynamics when compared to the past. Centrally driven by external shocks and trends in the system, the Karrayu household livelihood diversification is generally characterized by a growing shift of surplus labor to farming, firewood and charcoal burning, waged labor, brokering and petty trade. Some of these activities place a heavy pressure on the natural resource base of the pastoral system. The poor resort to cultivation, firewood gathering and charcoal burning mainly for survival. Where as the better of further diversify their livestock, more mechanized farming and waged labor.

The other principal part of this study is to generate land use/land cover classification map for Fentale Woreda and to determine the trend, rate, and magnitude of land use land cover change. In this regard, the study integrated approach to understand past and present condition of the study area by utilizing remote sensing data and GIS tools, direct field observation and review of previous works. The major findings of the study in this regard are; Thematic land cover map of the study area for the years 1986 and 2000, analysis of land cover dynamics such as trend, rate, and magnitude of land cover change show that the study area has experienced significant changes in land use/land cover as a result of livelihood strategies employed by the Karrayu. For example the decline of bush land as a result of continued extraction of firewood and charcoal, particularly in the kebeles around Mount Fentale. And the expansion of farm land

around the banks of Awash River and near the irrigation scheme of Metehara Sugar factory plantation is at the expense of grazing land.

The decline of grazing land and expansion of farm land has continued up to the very present and it is inevitable that it will continue in the future even more considering the current irrigation expansion projects implemented by the Woreda Agro pastoralists Office.

The reverse reaction of livelihood strategies of the Karrayu as a result of changes in land use/land cover was seen by the recently introduced livelihood activities like sand mining in Dhegadu kebele and stone mining in Gelcha kebele, when the productivity of grazing land declines and the land is degraded. These strategies are adaptation techniques for declining productivity of livestock as a result of decreasing grazing land through overgrazing and change of land cover. And invasion of *Prosopis Juliflora* in Golla kebele over grazing land led to the intensification of firewood gathering and charcoal burning.

5.2 Recommendations

A great deal of knowledge has been learnt in this study regarding, livelihood diversification and respective changes in land use/land cover in Fentale woreda. Regrettably, the household survey was spatially limited to part of the woreda, which is just only three kebeles out of twenty. Hence, it is my strong believe that the other kebeles should have been studied to fully incorporate the two outputs. And I like to put forward recommendations for policy implications and future studies as follows:

- The livelihood diversification pattern of the karrayu pastoral community portray that their opportunities for diversification are constrained to extraction of natural resources and waged labor because of the low level of human capital of the community. Hence, to improve that expansion of education (mobile schools) and occupational trainings needs to be implemented.

- The observed land use/land cover change from the classification scheme, particularly the change of bush lands in to bare rock land deems strong policy intervention or implementation for the control of firewood and charcoal production in the area.
- Interventions and projects regarding the control of human population growth and provision of better family planning is of to utmost importance considering the population increase in the woreda and rate of land cover changes.
- Undertaking a study on identifying livelihood diversification on a wider scale, especially in to the very remote kebeles of Fentale woreda may provide better understandings.
- Assessment of each livelihood options based on their respective sustainability potentials in respective of indigenous knowledge of the Karrayu people and the environment they live in may enable us to understand the perfect combination for livelihood sustainability.
- Assessment of the invasions of *Prosopis Juliflora* on the livelihood of the karrayu and the environment needs to be studied.
- Future study on land use/land cover could improve the findings of this study if it can incorporate more recent satellite image than 2000, which is the most recent image that could be attained currently.

REFERENCES:

Anderson, James R., Hardy, Ernest E., and Roach, John T., 1972. A Land Use Classification System for Use with Remote Sensor Data: U.S. Geological Survey Centre, U.S.A

Ayalew Gebre, 2001. Pastoralism under Pressure; Land Alienation and Pastoral Transformations among the Karrayu of Eastern Ethiopia, 1941 to the present. Shaker Publishing, The Hague.

Barrett, C., Reardon T. and Webb P. 2001. Non-Farm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics, and Policy Implications. Food Policy, 26, pp. 315-331.

Bedilu Amare 2005. Assessment of Water Quality Changes in Awash River. MSc Thesis, School of Graduate Studies, Environmental Science Program, Addis Ababa University.

Belay Tegene. 2002. Land Cover/Land Use Changes in the Derekolli Catchment of the South Welo Zone of Amhara Region, Ethiopia. Eastern African Social Science Research review 18 (1):1-20.

Block, S., and Webb, P. 2001. The Dynamics of Livelihood Diversification in Post-famine Ethiopia. Food Policy 26, no. 4:333-50.

Breman, J. 1996 Footloose Labour: Working in India's Informal Economy, Cambridge: Cambridge University Press.

Bryceson, D.F. 2000. 'Disappearing Peasantries? Rural Labour Redundancy in the Neo-liberal Era and Beyond'. In Bryceson, D.F., Kay, C., Mooij, J. (Eds) Disappearing Peasantries? Rural Labour in Africa, Asia and Latin America, Intermediate Technology Publications, London.

Campbell, J.B. 1987 Introduction to Remote Sensing. The Guilford Press, New York.

Carney, D., ed. 1998. Sustainable Rural Livelihoods. What Contribution can we Make? Department for International Development, London.

Carswell, Grace. 2002. Livelihood Diversification: Increasing in Importance or Increasingly Recognized? Evidence from Southern Ethiopia. Journal of International Development 14, no. 6:789-804.

Chen, X. 2000. Using Remote Sensing and GIS to Analyze Land Cover Change and its Impacts on the Regional Sustainable Development. International Journal of Remote Sensing, 23(1), 107-114.

Demissie Damite and Workneh Negatu, 2006. Determinants of Rural Livelihood Diversification: Evidence from Southern Ethiopia. Quarterly Journal of International Agriculture. DLG-Verlag publishing.

Dercon, S., and Krishnan, P. 1996. Income Portfolios in Rural Ethiopia and Tanzania: Choices and Constraints. Journal of Development Studies 32, no. 6:850-75.

De Sherbinin, A. 2002. Land Use and Land cover Change, A CIESIN Thematic Guide. Center for International Earth Science Information Network (CIESIN) of Columbia University, Palisades, NY, USA.

Diday, E., Lechevallier, Y., Schader, M., Bertrand, P., & Burtshcy, B. 1994. New Approaches in Classification and Data Analysis. Berlin: Springer- Verlag.

DFID, 1999. Sustainable Livelihoods Guidance Sheets. Department for International Development. London: DFID.
http://www.livelihoods.org/info/info_guidancesheets.hml

Drèze, J. and Sen, A. 1989. Hunger and Public Action. Oxford University Press, Oxford and New York, 1989.

EEA 2004/05. Transformation of the Ethiopian Agriculture: Potentials, Constraints and Suggested Intervention Measures. REPORT ON THE ETHIOPIAN ECONOMY. Volume IV. Ethiopian Economic Association (EEA) Addis Ababa:

Ephrem Haile. 2008. Land Use/Land Cover Dynamics and Erosion Susceptability Analysis: A case Study of Basso Werena Woreda. MA Thesis, Addis Ababa.

Ellis, Frank. 1998. Household Strategies and Rural Livelihood Diversification. The Journal of Development Studies, 35, pp. 1-38.

Ellis, F. 2000. Rural Livelihoods and Diversity in Developing Countries (New York: Oxford University Press).

GDI 2003. Pastoralism and Mobility in Drylands. Global Drylands Imperative (GDI) Challenge Paper, Draft 8.

Gete Z and Hurni, H. 2001. Implication and Land Use Land Cover Dynamics for Mountain Resources Degradation in the Northwestern Ethiopian Highlands. Mountain Research and Development 21 (2):184-191.

Gibson, C., Ostrom, E., Mackean, M.A. 2000. Forests, People, and Governance: Some Initial Theoretical Lessons. In C.G Gibson, M.A. Mackean, and E. Ostrom (eds) People and Forest: Communities, Institutions, and Governance. The MIT press: Cambridge

Girum Getachew. 2007. Pastoralists' Perception of Risk and Coping Strategies: A Case Study of Karrayu in Oromiya Region, Ethiopia. MA thesis, Addis Ababa.

Girmay, Kassa. 2003. GIS Based Analysis of Land Use/ Land Cover, Land Degradation and Population Changes: A Study of Boru Metero Area of South Wello, Amhara Region, MA thesis, Department of Geography, Addis Ababa University.pp110

Goerner, A., Jolie, E., and Gloaguen, R., 2006. Non-Climatic Growth of the Saline Lake Beseka, Main Ethiopian Rift, Journal of Arid Environments. 73(3), 287-295

Holden, S., Bekele Shiferaw, and John, P. 2004. Non-Farm Income, Household Welfare, and Sustainable Land Management in a Less-Favored Area in the Ethiopian Highlands. Food Policy, 29, 369-392.

Hurni, H. 1990 Degradation and Conservation of the Soil Resources in the Ethiopian Highlands. In African Mountains and Highlands: Problems and Perspectives, (Messerli, B. and Hurni, H.ends). Marceline, Missouri (USA).

Jensen, J. R., Ramsay, E. W., Mackey, H. E., Christensen, E. J., and Sharitz, R. P., 1987, Inland Wetland Change Detection Using Aircraft MSS Data. Photogrammetric Engineering and Remote Sensing, 53, 521–529.

Kebrom Tekle. and Hedlund, L. 2000. Land Cover Changes between 1958 and 1986 in Kalu, Southern Wollo, Ethiopian. Mountain Research and Development 20 (1)42-51.

Kejela Gemtessa, Bezbih Emana, and Waktole Tiki. 2005. Livelihood Diversification in Borana Pastoral Communities of Ethiopia- Prospects and Challenges

Lamb, A. L., Leng M. J., Lamb H. F. and Mohammed U.M. 2000: A 9000-Year Oxygen and Carbon Isotope Record of Hydrological Change in a Small Ethiopian Crater Lake. The Holocene, Hodder Arnold, 167-177.

Lane C. R. (ed.) 1998. Custodians of the Commons: Pastoral Land Tenure in East and West Africa. Earthscan Publication Ltd., London.

Lillesand T. M. and Kiefer, R. W. 2000. Remote Sensing and Image Interpretation, Wiley &Sons, New York etc, 724 pp.

Little PD, Smith K, Cellarius BS, Coppock DL and Barrett CB. 2001. Avoiding Disaster: Diversification and Risk Management among East Africa Herders. Development and Change 32:401–433.

Little PD. 2001. Income Diversification among East African Pastoralists. PARIMA.

Lu, D. Mausel, P. Brondi´zio, E. And Moran, E. 2004. Change Detection Techniques. International Journal Remote Sensing, Vol. 25, No. 12, 2365–2407

McClelland, D.G. 1998. U.S. Food Aid and Sustainable Development: Forty Years of experience. U.S. Agency for International Development, USAID Program and Operations Assessment Report No. 22. 90 pp.

McPeak JG and Barrett CB. 2001. Differential Risk Exposure and Stochastic Poverty Traps among East African Pastoralists. American Journal of Agricultural Economics 83(3):674–679.

Meyer, W.B. 1995. Past and Present Land-use and Land-cover in the U.S.A. Consequences. p.24-33.

MoFED 2006. Ethiopia: Building on Progress: A Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) Five Year National plan. Ministry of Finance and Economic Development (MoFED), Draft Document. Addis Ababa. Ethiopia.

Moshen A, 1999. Environmental Land Use Change Detection and Assessment Using with Multi – temporal Satellite Imagery. Zanjan University.

MoWR 1999. Study of Lake Beseka, Draft Final Report. Vol. 1, Main Report. Ministry of Water Resources (MoWR) Addis Ababa, Ethiopia.

MoWR 2000. The Lake Beseka Design and Tender Document, Ministry of Water Resources (MoWR) Addis Ababa, Ethiopia.

Mulat Demeke 1998. Explaining the Poor Performance of Agriculture: the Structure and Performance of the Ethiopian Agriculture.

Muluneh Woldetsadik. 2003. Impact of Population Pressure of Land Use/Land Cover Change, Agricultural System and Income Diversification in West Gurage Land, Ethiopia. Norwegian University of Science and Technology (NTNU), Trondheim.

Niehof, A. 2004. The Significance of Diversification for Rural Livelihood Systems. Food Policy. 29, pp. 321-338.

Nori, M. and Davis, J. 2007. Change of Wind or Wind of Change? Climate Change, Adaptation and Pastoralism. Contribution to WISP e-conference, 2007.

Oxfam. 2008. Survival of the Fittest, Oxfam Briefing Paper, August 2008

Pimentel, D., 1993 World Soil Erosion and Conservation. Cambridge University Press, 1993, 349 pp.

Reardon, T. 1997. Using Evidence of Household Income Diversification to Inform Study of the Rural Non Farm Labour Market in Africa. World Development, 25, pp. 735-747.

Reardon, T., Berdegué, J. and Escobar, G. 2001. Rural Non Farm Employment and Incomes in Latin America: Overview and Policy Implications. World Development, 29, pp. 395-40

Riebsame, W.E., Meyer, W.B., and Turner, B.L. II. 1994. Modeling Land-use and Cover as Part of Global Environmental Change. Climate Change. Vol. 28. p. 45.

Reid, R.S., Kruska, R.L., Muthui, N., Taye, A., Wotton, S., Wilson, C.J. and Woudyalew Mulatu (2000). Land-Use and Land-Cover Dynamics in Response to Changes in Climatic, Biological and Socio-Political Forces: The Case of Southwestern Ethiopia. Landscape Ecology 15: 339-355.

Scoones, I. 1998. Sustainable Rural Livelihoods. A Framework for Analysis. IDS Working Paper No. 72. IDS, Brighton.

Sen A. 1981. Poverty and Famines: An Essay on Entitlement and Deprivation. Clarendon Press. Oxford

Seyoum G/S. 1994. The Problem of Population and Environment in Ethiopia: Population and Development. The National Office of Population and Development. The National Office of Population, Addis Ababa, Ethiopia.

Singh, A. 1989. Digital Change Detection Techniques Using Remotely Sensed Data. Journal of Remote Sensing, 10(6), 989.1003.

Soares, V. P., and Hoffer, R. M. 1994. Eucalyptus Forest Change Classification Using Multi-Data Landsat TM Data. Proceedings, International Society of Optical Engineering (SPIE), 2314, 281–291.

Solomon Abebe, 2005. Land Use/Land Cover Change in Headstream of Abbay Watershed, Blue Nile Basin, Ethiopia. MA Thesis, Addis Ababa.

Solomon Abate, 1994. Land Use Dynamics, Soil Degradation and Potential for Sustainable Use in Metu Area, Illubabor Region, Ethiopia. African Studies Series No. A 13. Ph.D. Thesis, University of Berne, Switzerland. 135 pp.

Start, D and Johnson, D. 2004. Livelihood Options? The Political Economy of Access, Opportunity and Diversification Overseas Development Institute Working Paper No.233 ODS, London.

Tamiru Alemayehu 2000. Water Pollution by Inorganic Chemicals in the Central Part of the Main Ethiopian Rift. SINET: Ethiop. J. Sci 26(2): 197-214.

Tenalem Ayenew. 2005a. Changes in the Hydrogeological Setting of Lake Beseka, Ethiopian rift. Journal of Hydrology (in press).

Tenalem Ayenew 2005b. Changes in the Hydrogeological Setting of Lake Beseka, Ethiopia.

Tewolde Berhan, 1991. Diversity of the Ethiopian Flora. In Plant Genetic Resource of Ethiopian, PP 75-81. In J.M.M. Eagles et all. (eds). Cambridge university press, Cambridge.

Turner, B. L. II, 1989. The Specialist-Synthesis Approach to the Revival of Geography: The Case of Cultural Ecology. Annals of the Association of American Geographers 79: 88-100.

Turner B.L.II., Meyer WB, II. 1994. Changes in Land-Use and Land-Cover: A Global Perspective. Cambridge, UK: Cambridge University Press.

Turner, B. L.II., R. H. Moss, and D. L. Skole. 1993. Relating Land Use and Global Land-Cover Change: A Proposal for an IGBP-HDP Core Project. Report from the IGBP-HDP the Human Dimensions of Global Environmental Change Programme (Report No. 5). Stockholm

Vanacker, V. Govers, G. Barros, S. Poesen, J. and Deckers, J. 2003. The Effect of Short Term Socio Economic and Demographic Change on Land Use Dynamics and its Corresponding Geomorphic Response with Relation to Water Erosion in a Tropical Mountainous Attachment, Ecuador. Landscape Ecology 18:1-15.

Verbyla, D.L., 1995. Satellite Remote Sensing of Natural Resources. Lewis Publishers, Boca Raton, FL.

Wassie Berhanu, David Colman, and Bichaka Fayisa. 2008. Diversification and Livelihood Sustainability in Semi-Arid Environment: A Case Study from Southern Ethiopia. Department Of Economics and Finance Working Paper Series. July 2008.

Woldenhanna, T. and Oskam A. 2001. Income Diversification and Entry Barriers: Evidence from Tigray Region of Northern Ethiopia. Food Policy, 26, pp. 351-365.

ANNEXES

Annex 1: Confusion Matrix of TM 1986

	Reference						
Classified land use	Bush land	Farmland	Grazing Land	plantation	Rock	Water body	Total
Unclassified	0	0	0	0	0	0	0
Bush land	**62**	0	2	5	3	0	72
Farmland	0	**14**	1	0	0	0	15
Grazing Land	3	5	**91**	0	1	1	101
Plantation	3	2	0	**32**	1	0	38
Rock	3	0	2	0	**48**	0	53
Water body	2	1	1	2	0	**15**	21
Total	73	22	97	39	53	16	300

Overall accuracy = 87.3%

Kappa coefficient = 0.82

Annex 2 Confusion Matrix of ETM+ 2000

	Reference						
Classified land use	Bush land	Farmland	Grazing Land	plantation	Rock	Water body	Total
Unclassified	0	0	0	0	0	0	0
Bush land	**30**	0	0	1	4	0	35
Farmland	0	**22**	2	1	0	0	25
Grazing Land	1	4	**54**	0	0	1	60
Plantation	1	1	0	**37**	1	0	40
Rock	4	1	2	1	**101**	1	110
Water body	1	1	0	1	0	**27**	30
Total	37	29	58	41	106	27	300

Overall accuracy = 90.3%

Kappa coefficient = 0.86

Annex-3 Household Survey Questioner

Linkages between Livelihood Diversification and Changes in Land Use/Cover: The case of karrayu Pastoral community

To be conducted by the researcher assisted by enumerator

Dear Respondents

This questioner has a research purpose. The outcome of this research will help identify the different livelihood strategies practiced by your community and investigate the challenges of these strategies. These outcomes will be incorporated with the finding of land use/land cover study to understand the linkages between them. Therefore, I kindly request the cooperation of respondents in filling out the questionnaire. I confirm you that all data will be treated confidentially.

Questionnaire Number: _____

Date of interview: Day: _____ Month: _____ Year: _____

Interviewed by _____

Date entered: Day: _____ Month: _____ Year: _____

Entered by: _____

Region: _____ Code: _____

Zone: _____ Code: _____

Woreda: _____ Code: _____

Kebele: _____ Code: _____

Neighborhood: _____ Code: _____

Part 1. Household Composition

1.1 Household composition. (Please fill in the given after the table)

No	Name	Sex	Age	Marital Status	Relation to HH head	Age of the HH head

1.2 Household Economic Profile

1.2.1 The main livelihood activity _____

1.2.2 Is the household head involved in more than one livelihood activities _____0= No 1=Yes

1.2.3 If your answer for **question 1.2.2** is No choose or specify the reason why

Lack of the necessary resource _____0=No 1=Yes

Lack of the necessary know how(skill) _____0=No 1=Yes

Specify if any other_____

_____

_____

1.2.4 If your answer for **question 1.2.3** is lack of resource please specify the type of material/ resource that you lack

Access to cultivable land_____0=No 1=Yes

Access to constant water resource_____0=No 1=Yes

Oxen for ploughing_____0=No 1=Yes

Donkey for wood and charcoal courier _____0=No 1=Yes

Seedlings _____0=No 1=Yes

Specify if any other _____

_____

1.2.5 If your answer for **question 1.2.3** is lack of necessary skill please specify the type of skill that you lack

Farming skill _____0=No 1=Yes

Trade skill_____0=No 1=Yes

Specify if any other _____

_____

_____

1.2.6 If your answer for **question 1.2.2** is yes

(Please fill in the given after the table)

No	Type of economic activity	1st	2nd	3rd	4th	5th

1. Livestock raring 2. Cultivating 3. Labor 4. Wood and charcoal 5. Petty trade Others (specify and rank them)

1.2.7 If livestock rearing is one of the livelihood activities practiced by your household, who in your family is/are responsible to look after the livestock?

The household head _____ 0=No 1=Yes

Sons of the household head _____ 0=No 1=Yes

Sons of relative family _____ 0=No 1=Yes

Specify if any other _____

_____

1.2.8 If farming is one of the livelihood activities practiced by your household, who in your family is/are responsible to farm on the farmland?

The household head _____ 0=No 1=Yes

Sons of the household head _____ 0=No 1=Yes

Sons of relative family _____ 0=No 1=Yes

Specify if any other _____

_____

1.2.9 If firewood and charcoal selling is of the livelihood activities practiced by your household, who in your family is/are responsible to gathering and selling firewood and burning charcoal?

The household head _____0=No 1=Yes

Sons of the household head_____0=No 1=Yes

Sons of relative family_____0=No 1=Yes

Specify if any other_____

_____

1.2.9.1 How long do they travel to gather firewood? _____(in hours/KM)

1.2.9.2 How many equines do they use as a firewood courier? _____

1.2.9.3 How many days in a week do they gather firewood? _____

1.2.9.4 Have you ever noticed significant decrease or increase in availability of firewood? _____0=No 1=Yes

1.2.9.5 If your answer for **question 1.2.9.4** is yes, specify weather there is an increase or decrease explain how

An increase in firewood availability_____

_____

A decrease in firewood availability_____

_____

1.2.10 Is there anyone in your household who is/are enrolled in as a waged (hired) laborer? _____ 0=No 1=Yes

1.2.11 If the answer for **question 1.2.10** is yes, please specify who is/ are working and what kind of job they are doing? _____

_____

_____

1.2.12 Is there anyone in your household who is/are enrolled in petty trade?

_____0=No 1=Yes

1.2.13 If the answer for **question 1.2.112** is yes, please specify who is/ are working and what kind of job they are doing? _____

_____

_____

Part 2 Household access to infrastructure and services

2.1 Household access to infrastructure and services Indicate time taken one way (in minutes) from residence to nearest infrastructure and services.

Type of infrastructure or service	Code	2008	
		Walking	Vehicle (if possible)
Input supply store (e.g. fertilizers, seedlings, hand tools, etc)			
Crop market			
Livestock market			
Health center			
School			
Others (specify)			

2.2 Did your water point for household use change in the past ten years? _____ 0= No 1=Yes

2.3 If the answer for **question 2.2** is No, what is the distance from your house to the water point?

Distance_____ (km)

Walking time _____ (minutes)

2.4 If the answer for **question 2.2** is yes, what is the distance from your house to the water point?

Distance_____ (km)

Walking time _____ (minutes)

2.5 How about the previous water point?

Distance_____ (km)

Walking time _____ (minutes)

2.6 Did your water point for livestock change in the past ten years? _____ 0= No 1= Yes

2.7 If the answer for **question 2.6** is No, what is the distance from your house to the water point?

Distance_____ (km)

Walking time _____ (minutes)

2.8 If the answer for **question 2.6** is yes, what is the distance from your house to the water point?

Distance_____ (km)

Walking time _____ (minutes)

2.9 How about the previous water point?

Distance_____ (km)

Walking time _____ (minutes)

2.10 Did your water point for farming change in the past ten years? _____ 0= No 1= Yes

2.11 If the answer for **question 2.10** is No, what is the distance from your house to the water point?

Distance_____ (km)

Walking time _____ (minutes)

2.12 If the answer for **question 2.6** is yes, what is the distance from your house to the water point?

Distance_____ (km)

Walking time _____ (minutes)

2.13 How about the previous water point?

Distance_____ (km)

Walking time _____ (minutes)

Part 3 Crop production and use

3.1 List major crops, in order of importance, those easily grow on your farm (Rank)

1. _____
2. _____
3. _____
4. _____

3.2 Do you or any other member of your household own a land? _____0=No 1=Yes

3.3 If your answer for **question 3.2** is yes how many hectares _____0=No 1=Yes

3.4 If your answer for **question 3.2** is No how do you get access to land?

Get free access to someone else's land _____0=No 1=Yes

Rent a land from someone else _____0=No 1=Yes

Sharecrop with someone else _____0=No 1=Yes

Other (Specify) _____

_____

3.5 Did the total size of your farm change from year to year _____ 0= No 1= Yes

3.5.1 If yes, state the change

Increase_____

Decrease_____

3.6 If it increased or decreased, state the reason(s):

1. _____
2. _____
3. _____
4. _____

3.7 Do you perceive that the soil fertility is declining? _____0=No 1=Yes

3.8 If your answer for **question 3.7** is No, how did you know there is no decline in fertility?

1._____
2. _____
3. _____
4. _____

3.9 If your answer for **question 3.7** is Yes, how did you know there is no decline in fertility?

1._____
2. _____
3. _____
4. _____

3.10 What measures do you take when the productivity of your land (farm) declines?

Look for additional land _____0= No 1= Yes

Fallow _____0= No 1= Yes

Improve the fertility _____0= No 1= Yes

Other (specify) _____

3.11 If your answer for **question 3.10** is "**look for additional land**", what kind of land do you opt for?

1. _____
2. _____

3. _____

3.12 If your answer for **question 3.7** is to practice "**fallow**", how long should it rest before being used again?_____ (years)

3.13 If your answer for **question 3.7** is "**improve the fertility,**" how do you do it?

Use manure_____0= No 1= Yes

Add commercial fertilizer _____0= No 1= Yes

Rotate crops_____0= No 1= Yes

Other (specify) _____

_____

3.14 Please provide the following information on your crop production on all operated land (i.e. owned, sharecropped in, rented in, and borrowed) (2006-2008).

Crop type	**Code**	**Area/Size**	**2006**			
			Production (qt)	**Consumption (qt)**	**Sale (qt)**	**Carry over (qt)**

Crop type	**Code**	**Area/Size**	**2007**			
			Production (qt)	**Consumption (qt)**	**Sale(qt)**	**Carry over (qt)**

Crop type	Code	Area/Size	2008			
			Production (qt)	Consumption (qt)	Sale (qt)	Carry Over (qt)

3.15 Do you use fertilizer for crop production? _____0= No 1= Yes

3.16 If the answer for **question 3.15** is no, why?

1._____

2._____

3._____

3.17 If the answer for **question 3.14** is yes, please fill your fertilizer use (kg) for 2008

Type of produce	Number of plots Area	Area/Size of land	DAP	Urea

3.18 If the answer for **question 3.12** is Yes, how much did you use from 2006 to 2008? (Kg)

	2006	2007	2008	Remark
DAP				
Urea				

3.19 Do you have any knowledge of the following soil conservation methods?

Tree planting _____0= No 1= Yes

Terracing _____0= No 1= Yes

Check dam _____0= No 1= Yes

Contour hedges_____0= No 1= Yes

Ploughing across the slope_____ 0= No 1= Yes

3.20 If the answer for **question 3.16** is Yes, did you take any conservation measure to correct it? _____0= No 1= Yes

3.22 If the answer for **question 3.16** is Yes, what measures did you take to correct the problem?

1._____

2._____

3._____

3.23 Do you think the conservation measures you took were enough? ____0= No 1= Yes

3.24 If the answer for **question 3.23** is No, what other measures could be taken?

1._____

2._____

3._____

3.25 Which of the following are problems of crop production (rank according to their importance, 1 as very important)

Kinds of Problems	**Significance/Rank**
Shortage of cultivable land	
Lack of oxen	
Deterioration of soil fertility	
Drought	
Weeds	
lack of cash/credit	
Others (Specify)	

Part 4 Livestock Production

4.1 Livestock Capital (2008) = the sum of number livestock owned in the beginning of the year 2008 and changes during the same year.

4.2.1 Fill out the following information for the year 2008

Type of the animal	Stock at the beginning of 2008	Died/lost during 2008	Bought in/Gift in 2008	Sold/Gift/Raid out or slaughtered in 2008	Born in 2008	Total capital	Code
	A	**B**	**C**	**D**	**E**	**F=A-B+C-D+D**	
Cow							
Oxen							
Camel							
Donkey							
Goat							
Sheep							

4.2 Livestock products

4.2.1 What livestock products does your household consume or sell in 2008 excluding live animals?

Livestock type	**Products**	**Production**			**Code**
		Qty	**Unit Price**	**Value**	
Cattle	Milk				
	Hide				
Sheep &goat	Milk				
	Skin				
Camels	Milk				

4.3 Feed fluctuations

4.3.1 Mark the following months in terms of availability of feed or severity of feed shortage.

Availability	**Code**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Abundant													
Sufficient													
Moderate shortage													
Sever shortage													

4.3.2 What measures do you take to alleviate feed shortage? (List or rank in order of importance)

Measure	**Code**	**Rank**
De-stocking		
Planting productive forages(mobility)		
Conserving hay and straw		
Purchasing feed		
Renting grazing land		
Transferring stock to other pastoralists		
Others (specify)		

4.3.3 Which of the following are problems of livestock production (rank according to their importance, 1 as very important)

Problem	**Code**	**Rank**
Shortage of feed		
Parasites and diseases		
Drought		
Lack of cash/credit		
Poor productivity of local breeds		
Shortage of labor		
Others (specify)		

Annex-4 Checklist for Key Informants Interview

General Features

- Climate condition
- Access to natural resources
- Infrastructure and services (roads, schools, health centers, market places…)
- Ethnic groups and religion

Socio-economic Characteristics

- Population dynamics (human and livestock)
- Livelihood systems and strategies
    - Challenges and prospects
    - Changes in strategies (historical practices)
- Gender roles and division of labor (in female headed and male headed households)

Environmental Changes and Degradation

- Changes in land use/land cover
- Land degradation
- Overgrazing

Annex-5 Checklist for Focus Group Discussions

The Karrayus' perceptions towards the causes of change in livelihood activities

- Decline of grazing land size and productivity
- Human population increase
- Decline of livestock size and production
- Growing demand for certain resources and services in urban towns
- Introduction of commercial plantations and expansion of towns

The Karrayus' perception towards challenges and constraints in various livelihoods activities and their respective responses

- Livestock rearing
- Farming
- Firewood and charcoal burning
- Waged labor
- Mining and extraction
- Petty trade
- Brokering

The Karrayus' perception towards the changing environment and their responses

- How do different groups perceive environmental change and respond
- What livelihood activities are emerging as a response to environmental change

DECLARATION

I the undersigned declare that this Thesis is my original work, has not been presented for any degree in any university and all the sources used for this Thesis has been duly acknowledged.

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