THE ROLE OF FARM POWER IN ACCELERATING AGRICULTURAL PRODUCTION IN HETOSA WEREDA, ARSI ZONE

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The Role of Farm Power in Accelerating Agricultural Production in Hetosa Wereda, Arsi Zone

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ABSTRACT

This study examines the role of farm power in accelerating agricultural production. It focuses on farm power sources, their amount, role and integration on the one hand and problems constraining their wise and efficient use on the other.

The research made use of both secondary and primary data sources. The secondary data are used for macro level analysis while the primary data served the project level evaluation. The primary data sources are 221 households, i.e. 189 smallholder farmers and 32 tractor-hire service owners from 6 PAs and the whole wereda, respectively. The results indicate that there are three sources of farm power (human, animal and mechanical) each of them having their own problems and prospects in accelerating agricultural production.

Regarding human farm power, the study shows that farm households are sources of agricultural power and labor requirement varies across seasons, type of crop mix, farm implements used and farming systems with labor shortage and surplus periods. Added to these, the mechanism of labor allocation which is based on sex and age appears to be rational.

As to animal farm power, the survey reveals that animal traction is creeping towards a deepening crises because of a serious of consequences such as rapid population growth, need for more production, lateral expansion of agricultural land by swallowing grazing lands, animal feed scarcity in quantity and quality, emaciation of animals and low animal performance, coming one after another. The end results of these phenomena have been low farm power input and production output. With regard to mechanical farm power, the

research indicates that there is a need for adoption in the face of efficient resources use, declining traction power and the desire to get agriculture moving. However, the environment for adoption of mechanization has not sufficiently matured.

Finally, the study concludes by suggesting the need for active family planning systems and affordable services, rational livestock management and efficient use, and creation of enabling environment for gradual adoption and development of mechanization.

1. INTRODUCTION

1.1 Statement of the Problem

General

Accelerating agricultural productivity is the central concern of all developing countries. This objective has a special attention in Ethiopia as well, for slow growth in agricultural production has been a serious problem since the 1960s (Web, 1994), and agriculture has many tasks to perform, being the backbone of the economy. Thus, past development strategies and efforts have been directed towards promoting agricultural productivity in the face of increasing production of food enough to feed the ever-growing population, supplying raw materials to agro-based industries and increasing foreign exchange earnings (PMGSE, 1984).

However, in spite of untiring efforts, and the desire of the people to achieve food self-sufficiency, this goal is still a long way off, with abject poverty deep rooting and constant dependency on food aid and commercial grain imports. More worse is that the food situation is still precarious. The central issue of concern to be posed here is, thus, the reason why agriculture is far from improving to meet production requirements. A number of factors such as, rapid population growth, lack of skilled labor, traditional technology, limited agricultural resources, environmental degradation, shortage of farm power, etc. are to blame for the low agricultural productivity. However, this paper attempts to examine the last mentioned one, i.e. the role of farm power in accelerating agricultural production.

In agricultural production, many components, among which farm power is the prime one, are involved. Without efficient and sustainable farm power, it is not possible to satisfy the constant and ever-increasing needs of agricultural production. In the face of all these, farm power sources have been improved and evolved over time ranging from operating by mere human power in the primitive age to hoe-culture, use of draft power, and the modern engine power.

Empirical evidences have, however, indicated that this development scenario has not been even and universal. The mix of farm power, implements used, sequences of transformation and the rate of adoption vary in time, place, level of development, culture, farming systems, agro-climate, and type of agricultural activities (Mcintire, (1992). Thus, farm power elements operate in diverse spatio-temporal variation intricately interacting with a specific socio-economic setting. During this interaction and transformation there are trade-offs which, if not comprehended and wisely managed, could limit the contribution of farm power sources to the sector. This research is intended, therefore, in view of this general background and the present problems of farm power observed in Hetosa Wereda.

The Study Area

As in other parts of the Ethiopian highlands, agricultural production system in Hetosa is mainly based on traditional biological (human and animal) sources of farm power which is not only contributing to low production but also to reducing labor productivity. In contrast, the population of the *wereda* which was 118,568 in 1984 (CSA, 1988), has escalated to 174,360 in 1994 (CSA, 1996), growing at an average alarming rate of 2.9 percent per annum. The implication of this rate of increase in the face of fixed land and traditional

agricultural inputs has been a simultaneous rise in food demand to the extent that the sector is not able to cope up with.

In attempts to meet this challenge, historically, production increases have relied heavily on expanding land under cultivation rather than adopting modern yield-increasing inputs. As a result, large tracts of grazing lands have been brought under cultivation and many traditional farming practices that formerly allowed soils to regain its fertility are disappearing. The consequences of these changes as Zerihun (1990) and Getachew (1995) have argued, been degradation of land resources and thereby poor quality and scant quantity of pasture which lead to emaciation of animals and decline in draft power, all central to low agricultural production.

Hence, agriculture in the area is recently faced with twin problems of feeding the rapidly increasing population and declining draft power, both of which call for efficient and sustainable source of farm power in order to respond to the growing needs of agricultural production.

Recent observations and investment records indicate that state and private tractor-hire services are operating in Hetosa to cope with the farm energy deficits and accelerate agricultural production. These initiatives appear to be a good start. However, a look into the past experiences of agricultural mechanization in the area, illuminate a rise during the Imperial Period and a fall during the Derg Regime, under different development stages and policy systems without significant contribution to the progress of the sector. Added to this,

there are conflicting views on how agricultural mechanization can affect the development of poor and over-populated areas (World Bank, 1991) such as Hetosa.

To sum up, the picture of the study area indicates an ever-increasing demand for agricultural production on the one hand, and inefficient traditional farm power system with declining draft power accompanied with low level of engine-based farm power system constrained with lack of favorable support systems and services on the other. This mismatch between the tempo of demand for agricultural production and the means of ensuring this requirement necessitates a comprehensive assessment of farm power sources and their problems so as to propose possible solutions.

Despite the visible draft power problems in most parts of the Ethiopian highlands (Dessalegn, 1984; Yared, 1995; Assefa, 1995; Markos, 1997), the research is limited to Hetosa *Wereda* due to time and budget constraints. In addition, the coexistence of traditional and modern farm power sources, accessibility, and diverse agro-climatic conditions of the study area best serve the research purpose.

1.2 The Study Objectives

Keeping the statement of the problem in view, the present study has set the following objectives:

- to examine farm power sources (human labor, animal power, & engine power), their linkages, and functional systems,
- to identify the role, and contribution of farm power elements to the agricultural sector,

- to explore farm power problems, notably related to their interaction, composition, efficiency and policy issues,
- to assess and suggest ways of efficiently using farm power sources ensuring their steady growth for sustained agricultural production.

1.3 Research Questions

Under the statement of the problem, the central issues of the research have been elucidated explicitly. Thus, based on these issues the following research questions which revolve around the three farm power sources, notably human labor, traction power and mechanical power, have been formulated.

a) What are the demographic characteristics of the agricultural labor force in Hetosa? How is the size of labor force and associated productivity? How do peasants use their labor force during slack and peak agricultural periods?

b) What roles do livestock play in the agricultural production? What are the causes for the recent declining tendency of traction power per capita? How do farmers respond to this problem so far?

c) Despite the failure of the capital intensive mechanized state farms of the Derg Regime, why are private Tractor-hire services recently expanding? Is there an enabling politico-socio-economic environment which sustains their steady growth? What are the reasons for small-holder farmers' use of Tractor-hire services? Could mechanization serve as an alternative solution to the existing traction power problems?

1.4 Methodology

1.4.1 The Study Approach

Realizing that the aim of the research is to carry out a micro-level study on the role of farm power in accelerating agricultural production, the first task at the initial stage was to define the area for which the investigation is sought. This was followed by elaboration of the research problem and questions, as well as establishment of the research variables on which data would be required. To crystallize these initiation through a deeper understanding of the current farm power conditions of the study area, and also obtain information which later became helpful in the design of the research instruments, a pilot field visit was carried out for three days in July 1997 and the research thus conceived.

1.4.2 Research Design

To achieve the research objectives and adequately answer the research questions, the study was designed to involve primary and secondary data sources. The primary data were obtained through structured questionnaire from a survey that addressed peasant household heads and Tractor- hire service owners. The data collection system was one-shot, which is not sufficient to show changes over time. In the face of this, some retrospective questions were designed and included to suit the aim of the study.

Besides the application of scheduled questionnaire, unstructured in-depth discussions were made by the researcher with community elders, Peasant Association (PA) leaders,

development agents and investors to gather the necessary information. These were supplemented with field observations for a number of times during different data collection in each PA.

The secondary data were collected from published and unpublished materials of relevant government and non-governmental institutions, and library sources. In addition, the research conditions for the collection and analysis of data were arranged in such a way that relevance to the study purposes met with strict consideration of costs and time.

1.4.3 The Questionnaire

The design of the questionnaires took account of the research's need for both quantitative and qualitative data. In view of this, both formal and informal interviews in which closed and open-ended questions were asked have been employed. For each of these categories, relevant questions were framed in such a way that their analysis would ultimately provide appropriate answers to the specific research objectives and also enable the researcher make conclusions. At the household level, for it is the unit of analysis for the most part of the research, two sets of questionnaires (one for peasant household heads and the other for investors in Tractor-hire services) were employed. Contents of the questionnaires include information on land, and the three major farm power elements.

Thus, the land section comprises data on size of land holdings, land use, fragmentation, major crops grown and production. Under the human aspect, information such as population size and characteristics, size of labor force and use, labor wages and disengagement from

farm activities included. The animal sector incorporates data on livestock population, use, management, traction power, and animal feed. Finally, under the engine power, number and types of farm machines available, ownership, spatial distribution, use, capacity, availability, service cost and affordability included. These give a highlight of the content of coverage of the survey which is pertinent to the research questions.

1.4.4 Sampling Design

Firstly, selection of the study *wereda* was made on purpose for traditional and modern farm power sources operate therein and, thus, fit the research objectives. Secondly, a look into the physical and economic conditions of the *wereda* exhibit a wide variation in altitude, climate and crop husbandry. Hence, it was felt appropriate to select the sample PAs and household heads according to agro-ecological differences. To this end, the *wereda* was mapped based on the broad local agroclimatic zones. This revealed that about 40% of the *wereda* is *dega* and the rest 60% falls within *weyna dega* which comprises about 38 and 58 PAs, respectively. Since 1997, a new administrative reorganization has been under way. However, as data are non-existent on the new PAs, the former administrative division was used.

With these background, a two-stage sampling design was found to be appropriate to determine the participating households. The first stage involved selection of primary sample units, which in this case are six PAs (according to the former administrative division) two from *dega* (Adarie and Debeya) and four from *weyna dega* (Tedo, Bulchana, Kilisa and Jango). The recent administrative reorganization combined the former two PAs to form one

PA known as "Waji" while "Tedo" was made to envelop Bulchana, Kilisa and Jango. Both Waji and Tedo resemble those PAs in their respective agro-ecological zone in land holding, climate, farming systems, type of crops grown, and production. In view of the need to maintain representation, accessibility, cost and time limit, the aforementioned PAs were selected purposely as primary sample units (Figure 3).

The second stage involved preparation of a list of household heads for each of the selected PAs and sampling of ten per cent of the household heads from the sample frame with probability proportional to size, size being the number of household heads in each PA. This sampling procedure is supposed to give a representative image of the smallholder farmers. In case of the tractor-hire service owners, statistics were based on complete enumeration of private and state tractor and/or combine harvester owners in the *wereda*. This resulted in a sample of 189 smallholder farmers and 32 Tractor-hire service owners. Data were gathered over a period of 30 days mainly in February 1998.

1.4.5 Data Collection

During the second visit to the study area in January 1998, twelve grade complete 5 interviewers were recruited and trained. Furthermore, questionnaire pre-test was conducted by the researcher and the enumerators in two PAs that were not selected for the actual survey. In addition, in-depth discussions were also made with community leaders and development agents to have recent information on the possible answers of the questions in order to control irrelevant responses. This exercise was found extremely useful to revise the research design, on the one hand, and further train the interviewers on the other.

For the actual survey, a research team consisting of six persons including the principal researcher was formed. The team was grouped into two work forces each of which involved three interviewers, the researcher intermittently shifting from one work force to the other.

Both the work forces had to work in the same PA at the same time, but in different villages, so that the researcher could closely manage the data collection processes. As the data collection system was based on house to house enumeration, each work force was guided by a village coordinator assigned by the PA administration. Initially, as the reliability of some of the responses were highly questionable, it was necessary to persuade the respondents to give the true figures. Since the researcher and the interviewers employed were from the locality and most of the respondents knew them, reliability of the data increased.

In addition, training of the interviewers continued during the survey period too. Every evening the team was spending sufficient time to discuss problems encountered during the day. Interviewers were also constantly reviewing and editing their work in the evening. Thus, the survey has been closely monitored and the data is believed to be sufficient in terms of coverage, scope and content to answer the research questions.

1.4.6 Data Analysis

Collected data was carefully summarized in the form of master tables; and calculations were made. The results of the data in these tables were analyzed and the highlights were presented through tables, graphs and/or diagrams.

1.5 Limitations

As it is necessary, the researcher had treated the respondents politely and tactfully. However, as it was a period of tax collection, the respondents were suspicious of the research, thinking the interviewers to be government agents. They thought that information was being collected as the government had decided to impose tax increase or punish for under performance of loan repayment for agricultural inputs. Thus, every body was inclined to undersize himself particularly on topics such as production and informal land holdings.

1.6 Outline of the Study

In this study, both secondary and primary data sources are made use of. The secondary data sources have been mainly applied to present the extent of farm power conditions at national or *wereda* level while the primary data deal with the issue at PA and household levels. Accordingly, the outline of the study has been structured to suit presentation of the macro and micro level analysis of the data.

Chapter one of the study as indicated earlier is introduction. Hear under, statement of the problem, objectives, research questions, methodology, limitations and outline of the study are presented. In chapter two, extensive review of the literature on the various types of farm power is given. In chapter 3, an overview of Ethiopian agriculture is provided. This includes discussion on the role of agriculture in the Ethiopian economy, and major factors of agricultural production which provide a better picture serving as background or point of

departure for the actual case study. Chapter 4 introduces the physical and demographic characteristics of the study area.

Chapter 5 discusses farm power of the study area. This chapter gives a detail account of human, animal and mechanical farm power sources. In chapter 6, farming systems and production processes are discussed profoundly. Chapter 7 is devoted to evaluation of major impediments to the integration and efficient use of the various types of farm power. Finally, there is conclusions and recommendations chapter in which the study results and recommendations are discussed.

2. REVIEW OF THE LITERATURE

2.1 Conceptual Issues

The term "farm Power" and "agricultural mechanization" are repeatedly used in this research. At the onset, it is worthwhile to clearly state what is meant by these terms in the context of traditional agriculture.

Farm power includes three sources of farm energy (BISR 1980). These are human labor, animal power and mechanical power. The former two are most often known as biological sources of farm energy. Among the three sources of power, human labor is a common element to all. Without human labor engagement, there would be no meaningful use of farm power sources in agriculture.

The other characteristics of farm power is that it combines power and implements to efficiently perform the production tasks. For instance, man and the digging hoe, oxen and the plow, tractor and the disc could be cited. Thus, farm power may be defined as the biological and/or mechanical energy together with the associated tools used in agricultural production processes.

Agricultural mechanization may seem to imply the use of tractor, i.e. motorization alone, but actually it also includes any hand or animal powered implements. Mechanization indicates the process of increased development, use and management of mechanical aids for various

system, their contribution to draft power, their milk and milk products as well as their financial contribution. Conversely, M.Cohen (1987), Zerihun (1990), Tlahun, (1995), Mekete, (1997), and J.Terrence, (1997) have argued that the Ethiopian livestock sector contributes very little to the farm income as compared to their size, due largely to the scarcity and poor quality of the feed and the fact that they are kept as an asset for risk aversion than for a steady income. Apart from subjective description, except in the case of Mekete, the other authors have not provided objective and quantitative information on the contribution of livestock. These literatures have also signaled that the feed scarcity has recently become worse to the extent that animals' number are being threatened to be on the decline. As these studies have been conducted in different parts of the country, it gives a clue that the problem is widespread.

The other source of farm energy in Hetosa is engine power, mostly in the form of tractors and combine harvesters. A look into the past experiences of Ethiopia during different socio-economic periods indicates that mechanization has been characterized by decrease and peaks in utilization without significant contribution to agricultural development. These have been conditioned by a variety of complex social, economic and political factors of each development stage. Added to these, the development of mechanization is location specific depending on physical factors such as topography, climate, soil types, ...etc.

The past two socio-economic periods (the Imperial Regime, and the Derg period) had their own strengths and weaknesses in relation to the adoption of mechanization. Experiences from these periods bear a lot of lessons, if there is willingness to learn, and assimilate the

knowledge with the future development efforts of mechanization in order to accelerate agricultural productivity.

A perusal of literature by Cohen (1973) and Ellis (1972) indicates that mechanization had been introduced to Ethiopia during the early 1960s. In those days land was privately owned and tractors were exempt from import duties. In addition, fuel tax exemptions and cheep credit systems stimulated mechanization and a number of land lords took this advantage to establish commercial farms (Cohen, 1987). The farms were operated on commercial principles and there was a remarkable increase in productivity.

However, on the contrary, it had also its own side effects. More than 5,000 households were evicted, in Arsi, several major rural paths which were used for watering animals and inter village interactions were closed and illegal pressures were put on the near by smallholder farmers (Cohen, 1973).

During the Derg Period, the private commercial farms and equipments were confiscated and brought under state and service cooperative farms with the objective of expanding mechanization and large scale production.

In the state and cooperative farms, as Brune (1990) and Eshete (1995) have argued, the direct participants in the farm operations do not benefit more than their monthly salary for working long hours during peak seasons to maximize the number of hectares tilled, or to keep tractors in good condition. In addition, Dessalegn (1990) and Pausewang (1990) indicated that the objectives of the state farms were not clear. They were not based on

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commercial principles. Social objectives were more dominating, and not also well conceived as most of them had no feasibility studies. They were capital intensive which incurred huge foreign exchange for purchasing the machines and spare parts, which most often were in short supply. All these factors and others combined together aggravated the failure of the state farms and stunted the development of mechanical power during the Derg Period. As a result, most of the state farms have been closed after the change of government in 1991.

With regard to mechanization, the unemployment creating character is the central issue in the farm literature. Pausewang (1990) strongly opposes the labor replacing nature of mechanization. He has argued by saying that " 'peasants' work, not mechanization, is the basis of Ethiopian agriculture." However, several studies (BISR, 1980; W.Mellor, 1987; Campbell, 1990) agree on the point that mechanization does not initially result in displacement of agricultural labor. These authors further indicate that mechanization hastens agricultural operation, relaxes time constraints in the cultivation cycle, increases cropping intensity and enhances agricultural output. Campbell (1990) particularly emphasizes that mechanization affects the social norms and patterns in the rural family, which, in turn, have an effect upon the social fabric of the community in which they reside. Nevertheless, mechanization is a system-dependent technology and requires favorable policy, financial, technical, marketing and infrastructural conditions which most often developing countries are lacking and its adoption is impeded (BISR, 1980; Campbell, 1990.)

In addition to these literature on different countries, there are the works of M.Cohen (1973), Aregay (1975) and J.Gill (1977) who have done their Ph.D. Dissertations on Chilalo Awraja, the then central area of CADU (Chilalo Agricultural Development Unit) in which

the study area is also located. These broad research materials entail some information on farm power conditions of the area. Nonetheless, as the farm power conditions change over time and across policy systems, they have limited use in solving the current farm power problems. It can also be remarked that the earlier studies have not probed exclusively into the farm power sources and problems in accelerating agricultural production.

3. AGRICULTURE IN ETHIOPIA: AN OVERVIEW

3.1 The Role of Agriculture in the Ethiopian Economy

Several literature such as by Assefa (1995); and Yared (1995) indicated that agriculture has been the major economic base of Ethiopia for more than 2000 years. Currently, agriculture accounts for about 55% of the country's GDP, 60% of the merchandise exports, and 80% of the employment (World Bank, 1995). It has also the tasks of feeding the rapidly growing population; supplying industries with considerable quantities of raw materials, contributing to government recurrent revenue through taxes on exports as well as on its resources; alleviating poverty and improving household food security. Furthermore, agriculture has the role of creating backward and forward linkages between industries, and services through inputs, consumption and employment, thereby stimulating growth. Thus, it is the backbone of the economy closely linked to macro-economic variables than any other sector, and its sustainable growth is indispensable for the achievement of higher standards of living for the people.

However, despite its overwhelming importance, the overall growth rate and linkage effects to the rest of the economy is always far below the expected. With a mean farm size of close to one hectare, agriculture is dominated by smallholder farmers who retain 80% of their produce for their home consumption and for seeds (Brune, 1990). Brune further indicated that farmers who have the basic task of providing food for the broader community have failed to produce sufficient food even for their own home consumption and more than 60% of the total population in Ethiopia live under the level of chronic food insecurity.

According to Webb (1994), during the 1960s, agricultural growth averaged 2.2%, but dropped to 0.7% in the 1970s and mere 0.5% in the 1980s. Crop yields have stagnated at about one ton per hectare since the early 1970s while the population has doubled between 1970 and 1990. As a result, there was a sharp decline in per capita food availability and, a massive food aid imports since early 1970s in response. During the 1980s the country annually received 505,830 MT of food aid on the average (TGE 1993).

These imply the country's high dependency syndrome on external food assistance. What is more worse is, in spite of these immense external food injection, the structural problem of the country has never been changed and a closer comprehensive inward look into the agricultural sector is required.

3.2 Major Factors of Agricultural Production

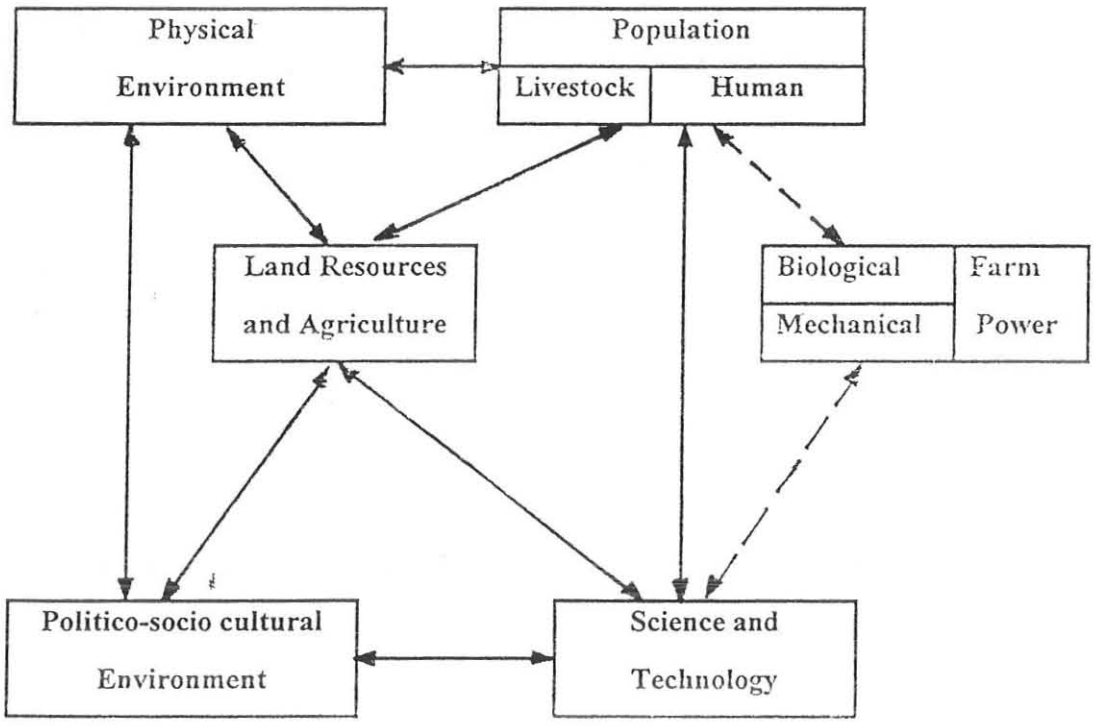
Before the discussion of the topic of this research, farm power, it is important to indicate where it is located among the factors of agricultural production. Added to this, knowledge of the elements included in the factors of agricultural production and information on how these constituents operate during the production processes, enable to clearly understand what farm power is, and what roles it plays in the production processes.

Agricultural environment involves five major sub-systems each of which has some elements. These subsystems are: land resources, physical environment, science, technology and organization, politico-socio-cultural environment and population. These sub-systems interact across one another and within themselves during the process of production.

In the process of agricultural production, human labor, animal power, farm implements and the experience of knowledge so far acquired on agricultural production combine together and act up on land resources to effect production. At different stages of the process, the physical environment, and the politico-socio-cultural conditions of the specific area have their own negative or positive impact on the process of production. The nature of this interaction, among many others, determine the progress or failure of agricultural productivity. Thus, a comprehensive knowledge of these elements and their functional linkages deserve due attention in order to understand agricultural problems and seek for the solutions.

Regarding the location of farm power, it is situated in two factors of agricultural production. These are population, and science and technology. Population comprise biological farm power while under science and technology we find mechanical power.

Figure 1 Major Factors of Agricultural Production and Location of Farm Power



4. PHYSICAL AND DEMOGRAPHIC CHARACTERISTICS OF THE STUDY AREA

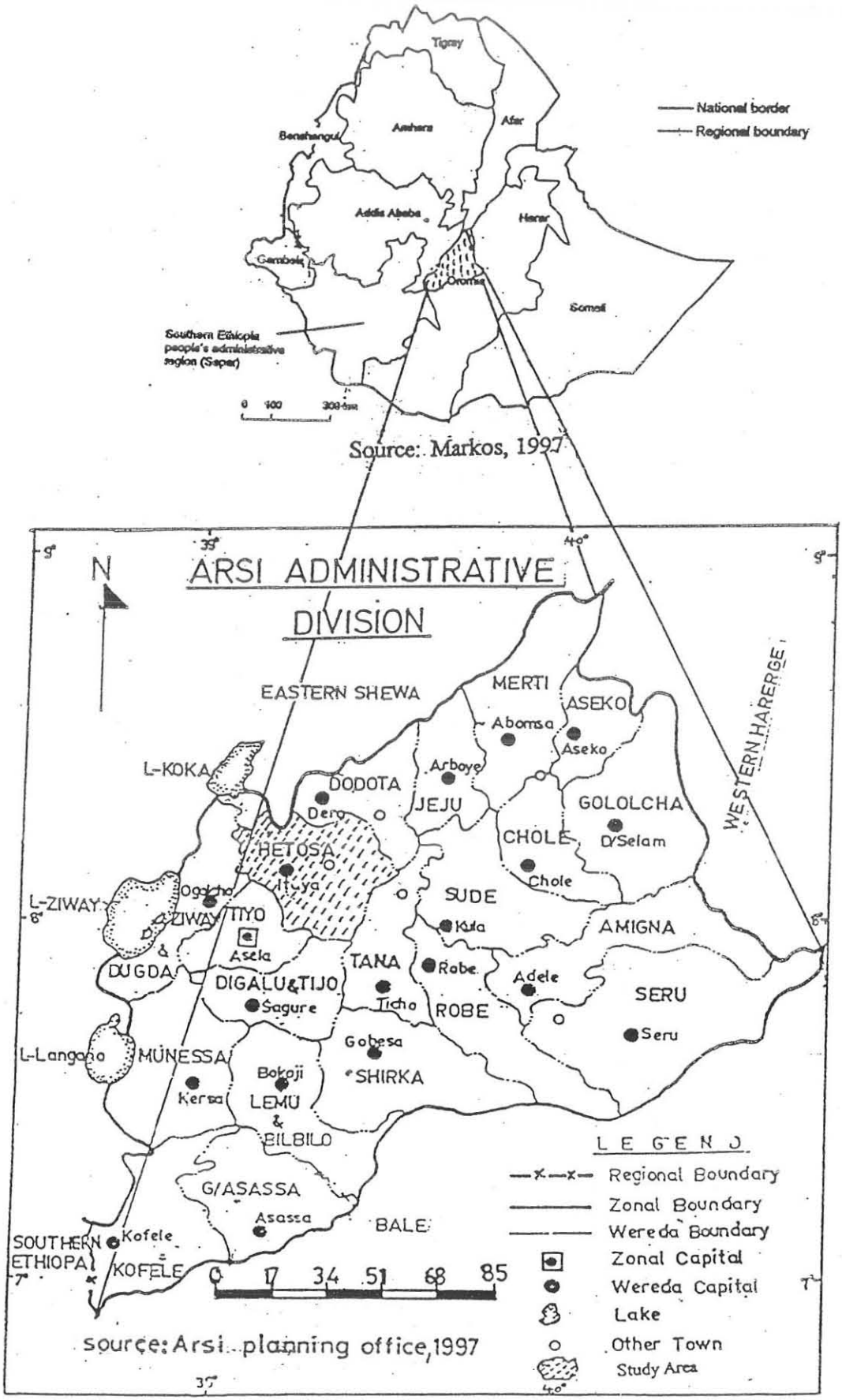
4.1 Physical Setting

4.1.1 Location and Size

Hetosa *Wereda* is located in the northern part of Arsi Administrative Zone (district) of Oromiya Regional National State. The *Wereda* comprises a total land area of 1553 km^2 (OPEDB, 1997) bordered by Awash river and Dodota *Wereda* in the north, Ziway and Dugda *Wereda* in the west, Tiyo and Digalu and Tijo *weredas* in the south and Tena *Wereda* in the east.

According to the 1997 administrative reorganization, Hetosa is divided into 42 Administrative units of which 37 and 5 are Peasant Associations (PAs) and Urban Keble Administrations (UKA), respectively. However, the reorganization process was not finalized during the survey and basic data were non-existent on the newly formed PA units.

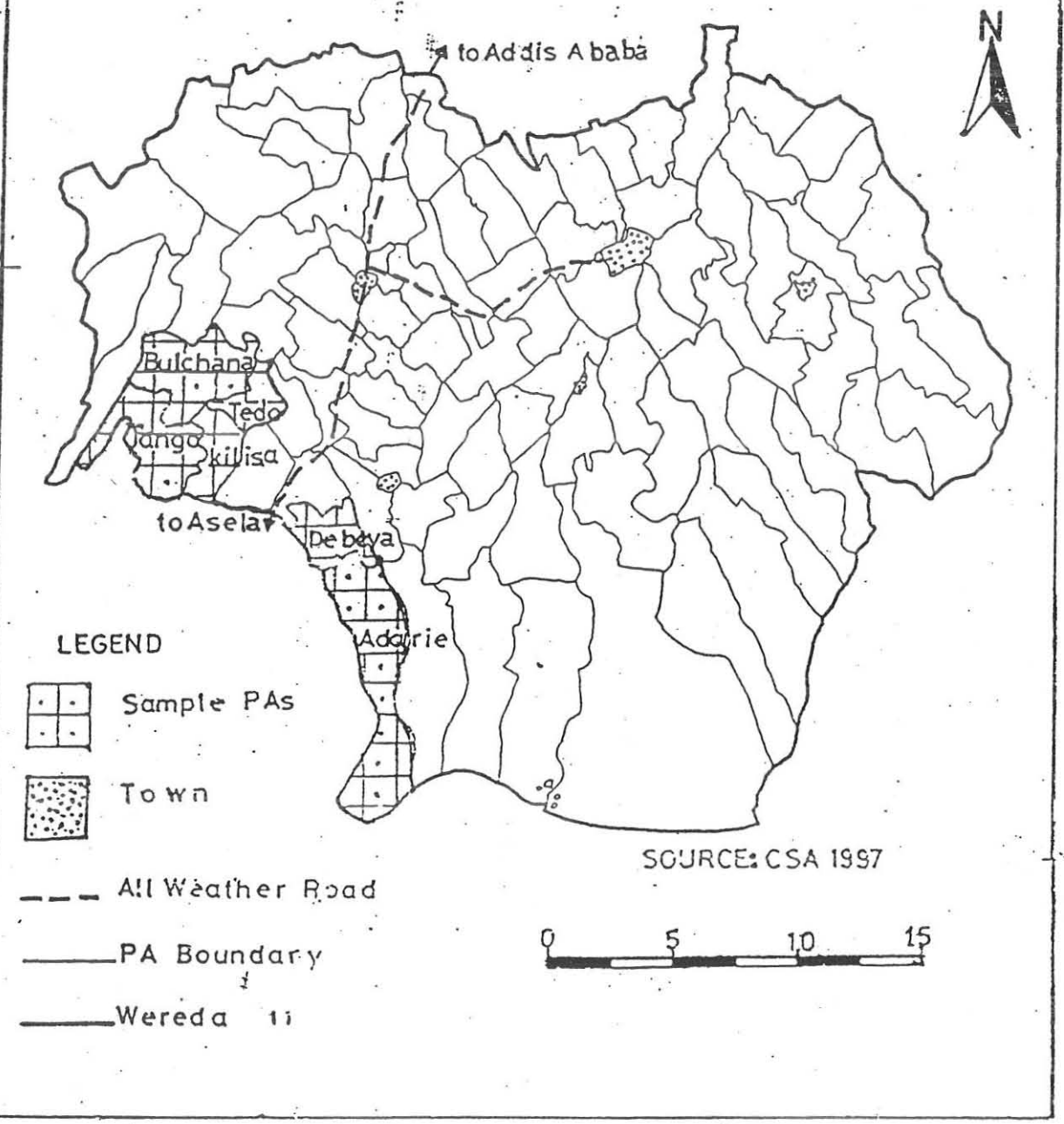
Figure 2 Location of the Study Area



Source: Markos, 1997

Thus, the present administrative division was used as a primary sample frame to select one PA which is Waji from *dega* and the other one from *Weyna dega* which is Tedo. These PAs according to the former administrative division included two (Adarie and Debeya) and four (Tedo, Kilisa, Jango and Bulchana) PAs, respectively.

Figure 3 Location of Sample PAs



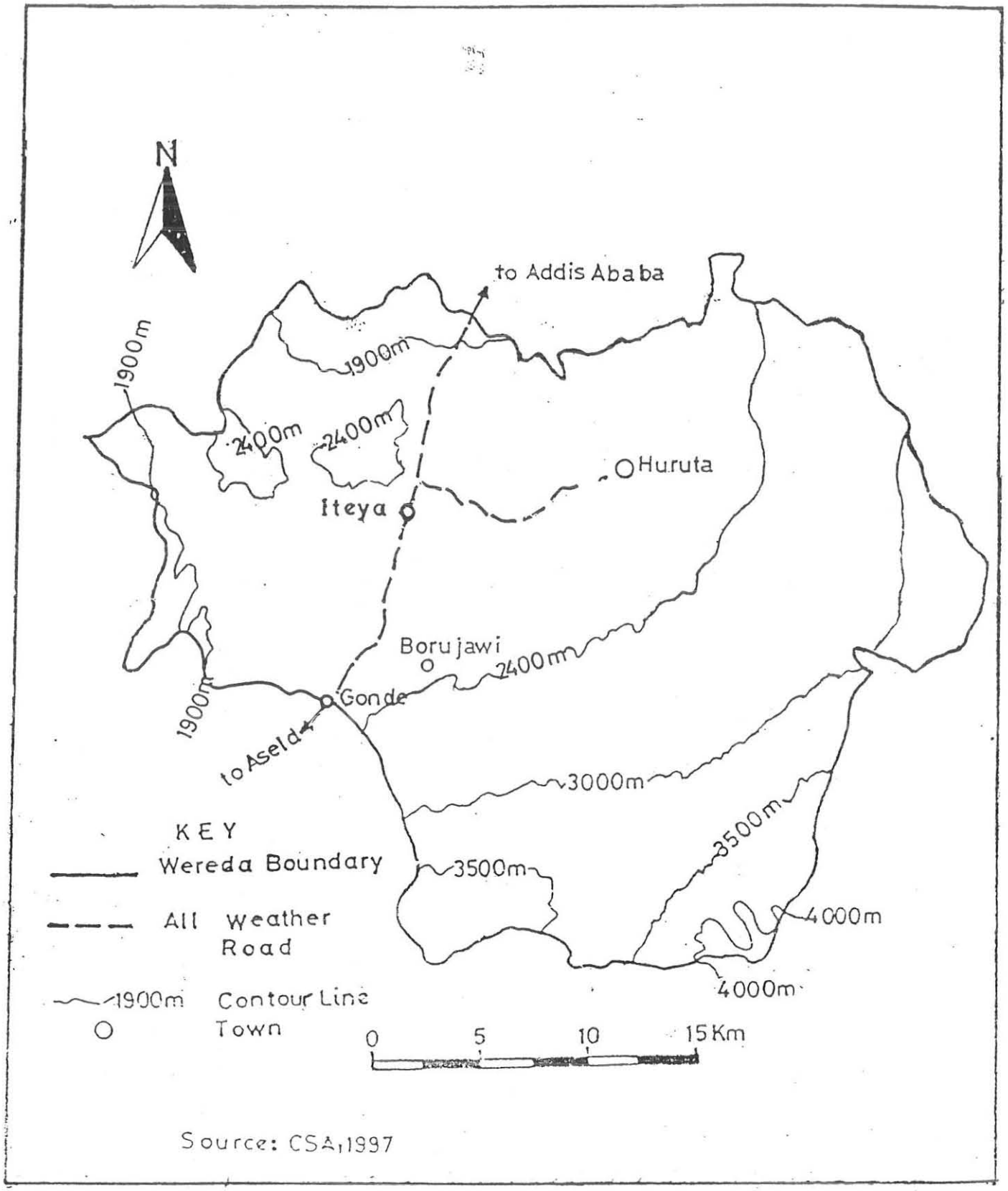
4.1.2 Topography and Climate

Hetosa stretches from the eastern edge of the Great East African Rift Valley at Lake Koka in the west to the top of Mount Chilalo about 45 kms in the east. Similarly, its elevation ranges from about 1750 masl in the former to more than 4000 masl in the latter (EMA 1981). The most prominent features in this area are the western uneven edge of the Great Rift Valley, the Highland Flat Plain, and the Eastern Sloping Foothills of Mount Chilalo.

Based on altitude and temperature the EMA (1981) revealed that the *wereda* is divided into two broad traditional agroclimatic zones; namely *weyna dega* (1500-2300) and *dega* (2300-3200 masl). However, the difference in topography, climate, soil and types of crops grown warrant the treatment of the *weyna daga* zone further under lower and upper *weyna dega* agroclimatic sub-zones.

The lower *weyna dega* sub-zone is below 2000 masl, characterized by irregular land topography with scattered hills while the upper *weyna dega* sub-zone is almost flat land settled and has been cultivated for many years. In the lower *weyna dega*, rainfall is erratic with mean annual rainfall ranging between 600 and 800 mm. In contrast, the upper *weyna dega* receives sufficient rainfall of more than 800 mm. Similarly, the *dega* zone is characterized by gradually sloping land to the east, stripped by small streams at a high altitude of above 3000 masl. The zone receives mean annual rainfall of more than 1000 mm.

Figure 4 Topographic Map of the Study Area



Source: CSA, 1997

The mean annual temperature in the two main agroclimatic zones (*dega* and *weyna dega*) varies between the dry season (October-March) and the main rainfall season (June-September). Average temperature ranges between 10-15°c and 15-20 °c for *dega* and *weyna dega* agroclimatic zones, respectively (EMA 1981).

4.2 Demographic Characteristics

According to CSA (1996), Hetosa was inhabited by 174,360 persons in 1994. Of this total population, 86930 (49.9%) were males and 87430 (50.1%) females. About 88% of the population live in the rural areas while the remaining 12% are urban dwellers. The ethnic composition of the population illuminates that 80.7%, 17.8% and 1.5% are Oromos, Amharas and other ethnic groups, respectively. A further evaluation of the literacy rate of the population shows that 63% are illiterate and 37% literate. Based on the population census of 1994, the *wereda* has a density of 112.3 persons per km^2 which is more than double as compared to 50 persons for the whole country (Markos, 1997). On top of this, the population is currently growing at an alarming rate of 3 per cent per annum.

5. FARM POWER OF THE STUDY AREA: THEIR ROLE IN AGRICULTURAL PRODUCTION

5.1 Human Farm Power

People are the major source of farm power for crop production and play an important role in the traditionally operated agriculture of Hetosa. In view of these, analyses of the source, size, age and sex composition, distribution and literacy rate are taken to be the major indicators of the problems and prospects of the agricultural labor force of the study population. Thus, the preceding section is devoted to the discussion of the results.

5.1.1 Source and Size

Farm households are the basic sources of human farm power. Hence, this survey was conducted on 189 sample households from 6 PAs. As of January 1998, the households comprised a total population of 1,435 persons. Of this total, 756 were males and 679 females (Table 1).

Table 1 Size and Distribution of the Study Population by PA, Sex and Household Size (HHS)

Name of PAs	No. of HHs	Population			Average HH Size
		Total	Male	Female	
Adarie	54	416	215	201	7.7
Debeya	25	182	90	92	7.3
Bulchana	32	298	161	137	9.3
Jango	30	200	113	87	6.7
Kilisa	24	168	95	73	7.0
Tedo	24	171	82	89	7.1
Total	189	1435	756	679	7.6

Source: Survey data, 1998

The average household size of the study population was 7.6 persons although it varies from one PA to another as shown in Table 1. The lowest and highest average household size of 6.7 and 9.3 were registered in Jango and Bulchana, respectively.

This difference is even wider between the Christian and the Moslem households. The respondents consisted of 40% Christians and 60% Moslems. The average household size for the Christians was 6.7 persons, while that of the Moslems peaked to 8.2 persons.(Table 2). Moslems have more desire for large sized of families than Christians, and thus, polygamy is a common practice. The largest average household size of Bulchana also testifies this argument for all of the households were Moslems except one.

Table 2 Distribution of the Study Population by Religion and Household Size

Name of PAs	Christians			Moslems		
	No. of HHs	Total Pop.	Average HH Size	No. of HHs	Total Pop.	Average HHs
Adarie	19	129	6.8	35	287	8.2
Debeya	21	151	7.2	4	31	7.8
Bulchana	1	8	8.0	31	290	9.4
Kilisa	13	77	5.9	11	91	8.3
Jango	12	70	5.8	18	130	7.2
Tedo	10	73	7.3	14	98	7.0
Total	76	508	6.7	113	927	8.2

Source: Survey data, 1998

5.1.2 Age-Sex Structure

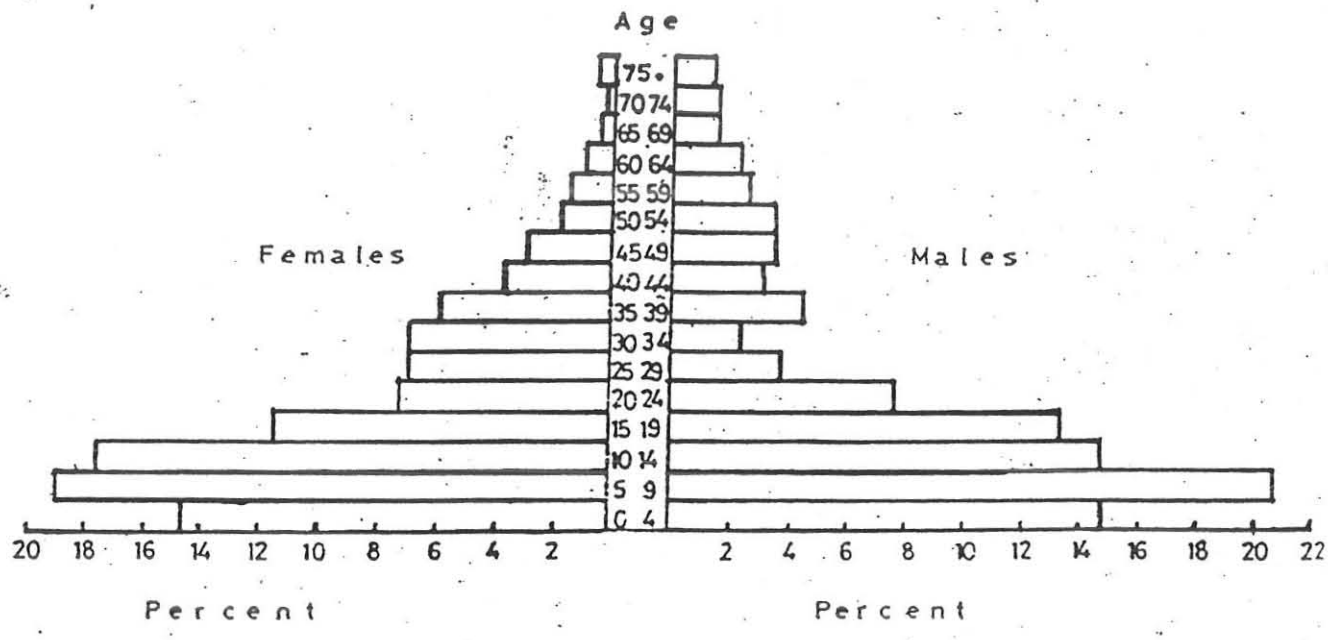
The age-sex structure of the study population was derived from the survey data and analyzed. The results were presented in Figure 5. As the data indicate, the households consisted of (52.7%) males and (47.3%) females. The sex ratio, i.e. the number of males per 100 females is about 111. This implies the existence of more males than females which is mainly accounted for high female migration between the ages of 15-25, and high female mortality rate for 45 years and above.

Furthermore, evaluation of the age-sex structure indicates that there were more males as compared to females under the age of 10. Further up the age ladder, males outnumber females by 10.6% between the age of 15-24. This is accounted for the fact that females most often marry earlier than males within this age group.

In the contrary, the number of males radically fall short of females between the age of 25-44. The significant short fall of male population by 21.8% below that of female population in the same age group could be attributed to the past civil war as most male youths left for military service in those days and hardly returned home.

At the upper stage of the age-sex structure, starting at the age of 45, the number of females show decline faster than the number of males. This attests the general truth that mortality is higher among females than males at higher ages.

Figure 5 Population Pyramid of the Study Population



5.1.3 Labor Force and Dependency Ratio

From the age-sex structure of the study population, the activity rate; the ratio of the economically active population to total population was calculated, based on ILO classification (convention No. 138) which sets the limit for the economically active population above the age of 14 and under 65. The result pointed out that 50.2% of the study population were below 15 years of age and 2.5 percent 65 years and older in 1998. Altogether, 52.7% of the population were dependent on 47.3% of the labor force. This is a typical shape for high dependency rate which is 113.5% in this case. It suggests a high reproductive potential and a continuing high population growth rate for some decades to come.

However, on the contrary to this widely accepted economically active population age boundary, in the study area, children take part in the working life starting at the age of seven and make substantial contributions to their parent's welfare. The details would be presented under section 6.1.2.3.

5.1.4 Literacy Rate

The educational status of communities is measured by literacy rate. Literacy rate is defined as the proportion of all people above the age of ten years who can read, comprehend and write a small information in his or her language (CSA 1997).

As most of the population at this age participate in one or the other farm activities, this classification is suitable for analysis. Among the sample population, 942 persons were 10 year and over. (Table 3). Of this total 53.8% and 46.2% were literate and illiterate, in the order given. This shows a better literacy ratio as compare to the national rural literacy rate of 15.2% (CSA 1997). Evaluation of the educational status of the household heads has indicated that 52.4% of the household heads are literate.

Table 3 Educational Characteristics of the Study Population Aged 10 year and Over

Level of Literacy	PAs						Total	% Total
	Adarie	Debeya	Bulchana	Jango	Kilisa	Tedo		
No of observation	250	118	205	137	117	115	942	100
Illiterate	164	51	90	51	36	43	435	46.2
Literate	86	67	115	86	81	72	507	53.8
% PA Literate	34.4	56.8	56.1	62.7	69.2	62.6	53.8	-
Grade Completed								
Read & Write	27	21	18	21	11	11	109	21.5
1-6	47	36	79	51	38	47	298	58.8
7-12	7	8	13	14	26	11	79	15.6
12 +	5	2	5	-	6	3	21	4.1
Total	86	67	115	86	81	72	507	100

Source: Survey data

When the total literacy rate is seen across grades completed, about 58.8% of the literates were at the primary school level while about 19.7% were enrolled in post primary school education. Further evaluation by PAs indicates that there is variation in literacy rate depending on the proximity of schools. The highest literacy rate (69.2%) was observed in Kilisa while Adarie had the least score of 34.4%. The low literacy rate in Adarie is mainly accounted for distance and the intervening difficult terrain between the PA and the schools in the area.

Added to the limited number of educational institutions and the inaccessibility due to distance, the age at which a child joins school is as late as 10 years and over. This reduces not only the rate of literacy rate but also the opportunity of children to join school after they have joined the working life and their labor has been tasted.

In an aggregate, the formal educational level of the study population is far below what their duties and responsibilities demand. However, as non-formal training is important as formal, the problem is not as would be expected.

In the absence of formal education and technical training, transfer of knowledge and development of skills take place mainly through on the job training. The child learns traditional farming activities through apprenticeship under his father or through observations and own experience. Thus, most often, the experienced farmer may have available knowledge about the timing of planting, spacing of inputs, handling of tools, seed selection and pest control among others. This implies that both formal and informal education are indispensable in accelerating agricultural production.

5.2 Animal Farm Power

Ethiopia has had centuries of experience in traditional farming system and animals are the major sources of power. Specifically, draft and pack animals have played and still play an important role in meeting the power requirement of farming systems in addition to their multiple economic and social functions.

The preceding section is devoted to evaluation of the size, role, management, and problems of animal power in view of accelerating agricultural production.

5.2.1 Sources and Size

Livestock are indispensable means of production and livelihood. Thus, every household in the study area, strives to own a minimum of a pair of oxen, one or two cows, a pack animal and few small ruminants. On the scale of importance, cattle tend to be the draft animal of choice, followed by donkeys and far behind horses. Donkeys, horses and mules are the major means of transportation. As a result, the study households, as of 1998 owned 1232 cattle, 333 equines and 675 goats and sheep. Average household animal per capita was in an order of 6.5 cattle, 1.8 equines, and 3.6 goats and sheep. Likewise, oxen household per capita was 2.4.

A look into the number of owners indicates that 92.1%, 89.4%, 76.1% and 91.5% households own oxen, donkeys, cows and sheep in that order (Table 4). These are the most important animals in the peasant economy.

Table 4 Total Number of Animals by Number of Owners

Animal Type	Animal Number		Number of Owners	% of owner Households
	Individual	In group		
Oxen	452	Cattle	174	92.1
Cows	311		145	76.7
Bulls	141	1232	91	48.1
Heifers	172		109	57.7
Calves	156		96	50.8
Horses	56	Equine	47	24.9
Donkeys	269	333	169	89.4
Mules	8		8	4.2
Goats	241	Goats & Sheep	63	33.3
Sheep	434	675	173	91.5

Source: Survey data.

Similarly, a detailed evaluation of oxen ownership shows that 7.9% of the households do not own a single ox and 13.2% have only one ox. Significant number of the households (44.4%) possess two oxen while the remaining 34.5% have three and more oxen (Table 5).

Table 5 Oxen Ownership Among the Sample Households

No. of Ox Owned	No. of Households	% Distribution Among the Sample
None	15	7.9
1	25	13.2
2	84	44.4
3	19	10.1
4	37	19.6
5+	9	4.8
Total	189	100

Source: Survey data.

As compared to the national average, where about 29% of households do not own a single ox (Yared 1995; Assefa, 1995), the study area is in a good position in number of heads of oxen. Although, they are substantially large in number they are in most cases weak. On top of these only a pair of oxen means as a tool with no spare part, for the farmer could not afford to buy an ox when he is in need of as the price has escalated to 1,000 Birr.

5.2.2 Distribution

The spatial distribution of the animals reveals the impact of climate, income, and availability of pasture. Regarding the distribution of cattle, donkeys, goats and sheep, pasture has a significant impact. Those PAs located at high or low land margins, Debeya at the foot of

Mount Chilalo, Bulchana and Jango at the edge of the Great African Rift Valley have stocked more Tropical Livestock Unit (TLU) per capita than PAs situated on the flat plain such as Tedo and Kilisa (Table 6). Household grazing land per capita is relatively higher in those peripheral PAs, and at the same time they have better advantages of grazing the marginal lands.

In case of horses altitude has a significant impact. They are highland animals and mostly found in Adarie and Debeya where the altitude is more than 2300 masl. Mules are insignificant in the study area, for their price and roles in the farming system of the area do not encourage their prevalence. They are replaced by horses and donkeys at lower costs. Goats require warm climate and plant species for browsing, and thus, most of them are located in Bulchana and Jango where these requirements are relatively available.

Table 6 Types and Number of Animals Distributed by PA (in TLU)

Number of PAs	Animal Type										TLU*	Livestock per capita
	Oxen	Cows	Bulls	Heifers	Calves	Horses	Donkeys	Mules	Goats	Sheep		
Adarie	111.1	71.2	19.8	24.0	7.6	29.6	20.9	-	2.9	17.6	304.7	5.6
Debeya	82.5	34.4	12.0	9.0	4.0	8.8	12.9	-	0.2	9.1	172.9	6.9
Bulchana	86.9	62.4	19.8	20.0	7.6	4.8	20.5	4.8	6.9	2.4	236.1	7.4
Kilisa	68.2	20.8	7.2	7.0	3.2	-	11.2	1.6	4.1	2.2	125.5	5.2
Jango	80.3	36.0	16.2	17.5	5.6	-	18.0	-	5.9	3.6	183.1	6.1
Tedo	68.2	24.0	9.6	8.5	3.2	1.6	13.3	-	1.7	4.2	134.3	5.6
Total	97.2	248.8	84.6	86.0	31.2	44.8	96.8	6.4	21.7	39.1	1156.6	6.1

Source: Survey data, 1998; Yared, 1995

* TLU is a way of standardizing animals so that the total animal stock owned by a household can be easily summed up. A TLU is taken to be an animal of live weight of 250 kgs. The units equivalent to each animal are: oxen 1.1, cows, horses and mules 0.8, bulls 0.6, calves 0.2, donkeys 0.36, heifers 0.5, sheep and goats 0.09.

respectively during non-calving and lactating periods. Likewise, 14.8% and 52.7% of donkey owner respondents have indicated that they use them, for plowing and threshing in this order (Table 7).

Table 7 The Role of Animals in Different Farm Activities by Number of Users Among Sample Population

Animal Type	No. of Owners	Farm Operations					
		Plowing		Threshing		Transportation	
		Users	% of Users	Users	% of Users	Users	% of Users
Oxen	174	174	100	174	100	29	16.7
Cows	145	37	25.5	141	97.2	-	-
Bulls	91	67	73.6	90	98.9	-	-
Heifers	109	8	7.3	84	77.1	-	-
Horses	47	-	-	9	19.1	47	100
Donkeys	69	25	14.8	89	52.7	169	100
Mules	8	-	-	1	12.5	8	100

Source: Survey data.

This increase in the type of farm power animals is a manifestation of local copping mechanism with farm power shortages and the growing resource use efficiency. The type of use and the seasonal variation and duration of activities determine animals that are put to work. Oxen are most intensively used between April and August for land preparation. From November through January they are used for threshing. In both plowing and threshing they worked on average for about five hours a day.

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Horses	47	-	-	9	19.1	47	100
Donkeys	69	25	14.8	89	52.7	169	100
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Furthermore, attempts were made to calculate the number of days an ox is put to work per annum. In the computation process, average size of cultivated land for major crop types and the number of times the land is plowed for the given major crop types in the combination were taken into account in the first place. Moreover, the number of animals required each time, average number of days needed for threshing the given crops in the combination and average number of animals involved during threshing, were considered. The results revealed that under crop combination wheat, barley, and beans in *dega* agroclimate, an ox was worked for about 80 days, which is 400 ox-hours in a year. On the other hand, in the *Weyna dega* argoclimate; with crop combination wheat, barely and maize, the animal is involved in farm operations for 86 days (340 ox-hours) in a year. Oxen in the *Weyna daga* zone are over worked than in the *dega* for differences in household land per capita between the two zones. With regard to annual working days, assuming 22 days as ideal working days in a month, the number of days, an ox is put to work is limited to 30% and 33% of work days in a year in *dega* and *weyna dega*, respectively.

On the contrary, the animals are fed year-round and incur significant management costs. Nonetheless, other uses of the animal level the disadvantages in view of the peasants. The work performed by a pair of draft oxen depends, among many others, on animal and soil types, design of implements used, and animal health conditions.

5.2.4 Livestock Management

Animal management usually includes the provision of adequate feed, shelter and disease protection. The aim is to ensure that animals are capable of expressing their full potential for food supply (meat and milk), reproduction and earning cash income.

Apart form these, livestock management objectives of the traditional smallholder peasant economy, should involve efficient management of the power itself, both when it is required in seasonal tasks and over the rest of the year so that the resources of animal power is not wasted. Nonetheless, the management of the livestock in the study area is largely traditional with more emphasis on number of animals than a steady income.

When one observes the condition under which animals pass the night, it is impressive. Only horses, goats and sheep have sheds at night. Other animals are kept in a pen near the homestead. They bear the nuisance of the night cold, rain, and the muddy ground. Especially, the condition is worse during the rainy season when the ground is wet and muddy, and temperatures fall.

Animals under such harsh climatic conditions use their stored energy and their live weight declines resulting in the animal's physical weakness and thereby limited output. Added to these problems, the animal health services are also very poor in the study area. Only limited services are provided by Zonal Office of the Ministry of Agriculture.

Up until early 1980s, peasants in Hetosa used to experience transhumance in their livestock feed management. The practice of transhumance was mainly determined by climatic conditions and availability of grazing grass, crop residues and\or stubble.

As the *wereda* includes *dega*, upper *weyna dega* and lower *weyna daga* agroclimatic zones, pasture availability and climatic conditions seasonally vary within the *wereda*. Thus, these natural conditions used to guide livestock movement within the area. Starting from July to September, cold and a heavy rainy is experienced in the *dega* zone. This harsh climatic condition is not suitable for the animals and grazing is also not economical as animals mix the grass with mud. Thus, farmers used to move their animals during this period, to the lower *weyna dega* agroclimatic zone where the grass is palatable and the climate suitable.

When the rain is over, and the temperature is relatively warmer, they bring back their animals at the end of September to the *dega* agroclimatic zone. From October-November it is an ideal period to graze in the *dega* zone. In December, when crop harvest is nearing completion, farmers again start to send their animals to the upper *weyna dega* zone to feed them with crop stubble in the farm fields, up until March, when land is plowed for sowing. From April to June, animals disperse extensively all over the agroclimatic zones. In this system of livestock movement, lactating cows, and work animals during farm operations are excluded. This indicates lowland, highland, middle altitude and disperse system of animal movement.

Figure 6 Pattern of Animal Movement Before 1980s

Position	→	Lowland	→	Highland	→	Mid. Altitude	→	Disperse
Time	→	July-Sept.	→	Oct-Nov.	→	Dec.-Mar.	→	Apr.-June

The last two decades, this inter zonal livestock movement has been declining and currently disrupted for the marginal grazing lands in the *dega* and lower *weyna dega* zones have been claimed by plow share because of population pressure from the nearby central plain. Thus, recently, peasants keep their animals on their own plot the whole year-round. The confinement of animals in their locality has resulted in severe feed scarcity. Asked whether they have sufficient feed for their animals or not, all of the households indicated that they have been facing animal feed shortages. Among the households 18.5% have no grazing land at all and 42.9% have no sufficient feed and purchase grass for their animals. About (81.5%) have some grazing land but have been compelled to use often over utilized grazing, with limited access to crop residues during the dry and winter months.

Table 8 Distribution of Grazing Landless, Grazing Land Owners and Grazing Land Purchaser Households by PA

Name of PAs	Grazing landless	Grazing land owners	Grazing land purchasers
Adarie	5	49	15
Debeya	3	22	12
Bulchana	8	24	18
Kilisa	7	17	13
Jango	5	25	12
Tedo	7	17	11
Total	35	154	81
% of total households*	18.5	81.5	42.9

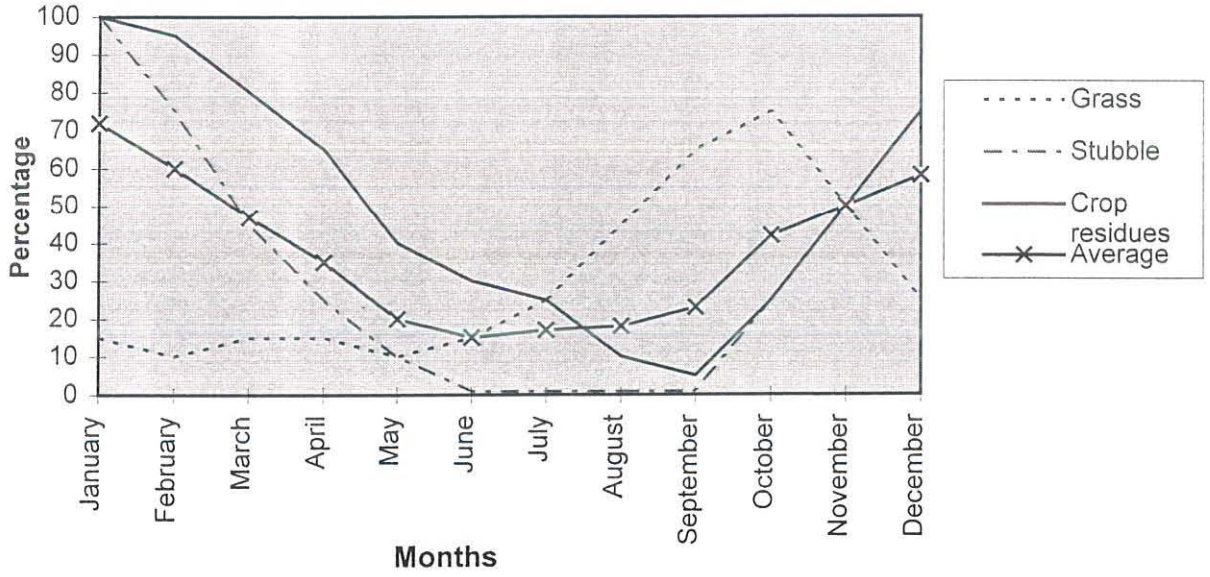
Source: Survey data.

* The per cent do not add up to 100 for some respondents own grazing land and also purchase.

The survey has further revealed that changes have occurred in animal feed quality, quantity and type. Formerly, pasture and crop residues were the major feed types. However, recently, weeds, maize and sorghum leaves and thinning have also been included in the animal nutrition. These feed types are more often in short supply due to the high stocking rate of 6.1 Tropical Livestock Unit per 0.4 hectare of grazing land. While the demand according to the respondents is estimated to about 1.5 hectares for the size. In addition seasonal fluctuations of rains also lead to variation in feed availability, quantity and quality. Thus, feed problem has a seasonal character. There are four major feed types used in the study area. These are: grass, stubble, weeds, and crop residues. Each of these feeds has optimum period of availability. For instance, grass grows, and attains its maximum in September and

November. There is sufficient crop stubble after crop harvest from November to March. Crop residue peaks in November and empties in August. However, it is not used through out, but kept for period of feed shortage, especially, from May to September. Weeds and Maize and Sorghum leaves are provided to animals during the main rainy season, mostly in July and August. The most important point to be mentioned here is the sharp fall of animal feed availability from March-September. During this period, it is estimated that animals obtain less than 50% of their feed requirement. On the contrary, this is a peak agricultural period when more energy is required for plowing and seeding.

Figure 7 Availability Estimate of Various Types of Animal Feed Across Months (in %)



Source: Survey data

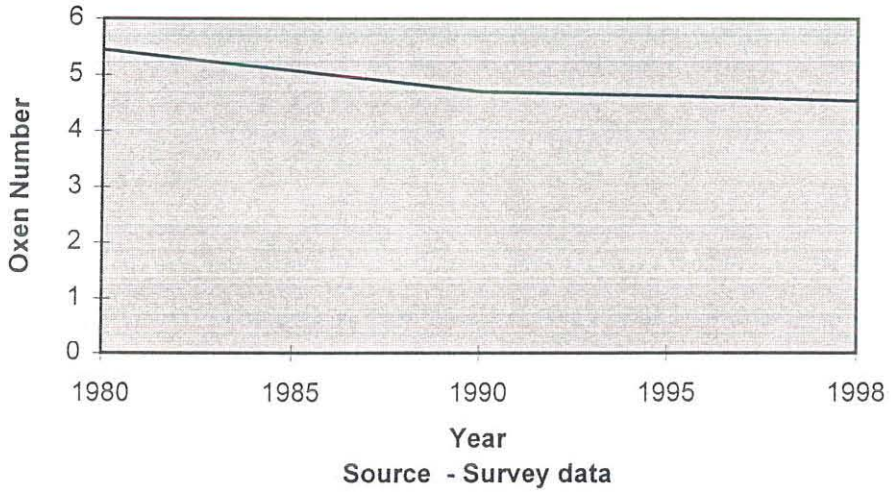
5.2.5 Problems of Animal Power Development

The past two decades, crop production has been placing pressure on grazing lands more than ever before. As a result, grazing land has been receding by 0.3 per cent per annum between 1980-1998. Moreover, changes in the type of animals used for power, the escalating animal

prices, the physical emaciation of animals and significant loss of weight at the end of the dry season, signal the emerging transitory traction power problem.

The consequence of the continuous fall in animal feed, was not only a decline in number of oxen owned by the sample households by 0.9% from 1980-1998 per annum, but also reduced farm output per existing animals.

Figure 8 Trends in size of oxen possession among sample households from 1980-1998 (in 100)



Source - Survey data

Animal feed shortage problem is often severe from March-September. During this time, animals lose weight and become physically weak. In contrast this is a peak farm operational season when oxen have to be engaged in heavy and continuous work. Thus, there is no fitting between farm power demand and animal power supply in spite of the fact that caring for the animals is a year-round task and adds to the family work load and feed expenditure, which is a considerable opportunity cost.

According to the respondents, feed inadequacy does not only impede farm power but also causes low milk yields, elevated stock mortality and extended parturition intervals.

In addition, shortage of animal feed also has imposed more difficulty on the farmer's efforts to maintain the breeding stock required for replacement. In an aggregate, there are problems of insufficient inputs and resulting low outputs which means low income for the farmer. In view of these, it appears that feed scarcity and inefficient animal use are keeping the issue of animal power shortage and low output alive threatening the farmers' life.

In the process of coping with draft animal problem, farmers use their animals for shared work known as *Mekenajo* or rent out (*Minda*). *Mekenajo* is a system where two farmers who own one ox each join their animals and work on their fields in turn until cultivation is completed. *Minda* refers to ox rent in cash or in kind for a crop season. The latter practice is, nowadays, limited as the animals are most often overworked.

5.3 Mechanical Farm Power

5.3.1 Type and Amount

The dynamics of rapid population growth has been illuminating a danger signal through declining per capita crop production, since the 1960s, in Ethiopia (Webb, 1994). This suggests that per capita food production must grow rapidly, if consumption levels have to be maintained.

In the past, responses to this signal, among many others, included extensive farming. However, recent evidences indicate that the possibility for extensive farming is limited as

suitable lands have already been put under cultivation. Thus, the only alternative left for choice is intensification.

Intensification, on the other hand requires more power input in order to increase productivity. To this end, the central question to be posed would be, which type of farm power source or mix of power sources is/are suitable for current Ethiopian condition to be developed and promoted to ensure accelerated agricultural growth.

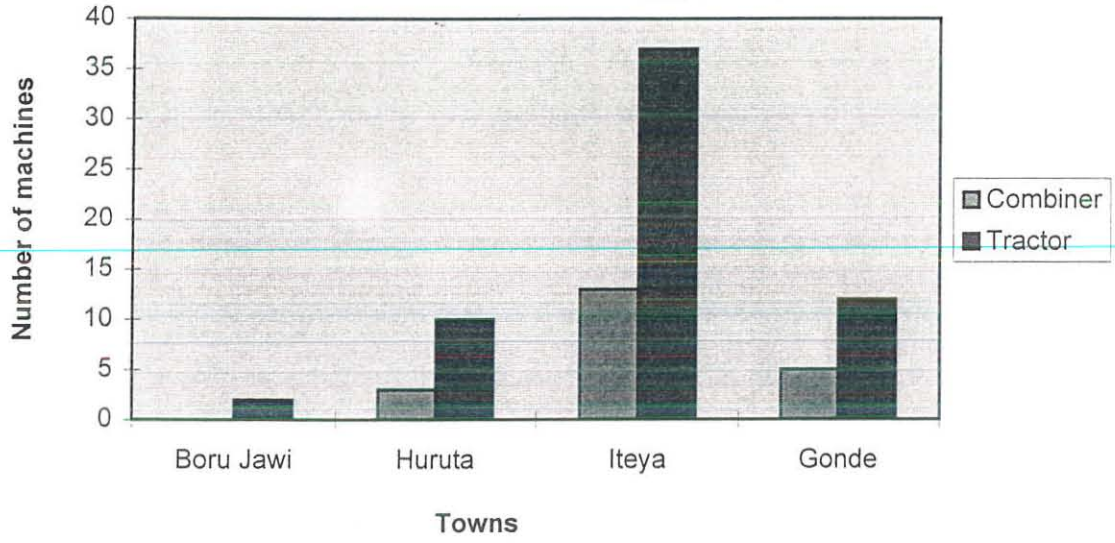
Therefore, this section is devoted to evaluate if mechanization would be an appropriate farm power technology to be adopted in the present traditional farm setting of the area.

With a density of more than two times, as compared to the national (Section 4.2), Hetosa is one of the densely populated *weredas* in Ethiopia. As a result, population has been putting much more strain on grazing land in the process of extensive farming to meet the increasing food production needs. The consequences of the declining grazing lands have been manifesting creeping traction power decline since 1980s (Figure 8, and 11).

Thus, encouraged by the free market economic policy and investment promotions, which exempt from 15% payment of import duties and taxes on spare parts and machines and three years of income tax (proclamation No. 15/1992 and No. 37/1992) on the one hand, and persuaded by induced traction power shortages, on the other, private tractor-hire services have been emerging since 1992. During the last six years 32 tractor-hire services have been established in the *wereda*. Of these service schemes 29 were private while 2 are state and 1

is service cooperative owned. Under these three ownership types, there were 82 machines of which 61(74.4%) were tractors and the remaining 21(25.6%) combine harvesters.

Figure 9 Types and Number of machines available by Town



Source: Survey data

5.3.2 Types of Ownership and Distribution

Evaluation of ownership type indicated that 49 and 33 machines were respectively private and state owned. The services were spatially distributed centering four small towns, namely: Iteya, Gonde, Huruta and Boru Jawi. More than half of the tractor-hire services were located in Iteya for it is situated on the main highway from Addis Ababa to Asela and has basic services such as a fueling station, garage and tire repair. The tractors altogether had a capacity of plowing 324 hectares per day. Similarly the combine harvesters had a capacity of harvesting about 6300 quintals per day. Service costs of tractor per hectare were; 70-80

Birr, 130-140 Birr and 150-160 Birr for seeding, secondary, and primary tillages, respectively. Similarly, harvesting cost per quintal was 12 Birr as of 1997.

Regarding users, about 25% of the respondents have used tractor and/or combine harvester during the last crop season. Among the tractor users, 98% used for primary tillage. Asked why they use tractor service, 85% responded that oxen are weak to do primary tillage. Similarly, more than 70 % of the combine harvester users revealed that they use machine for lack of enough animals for threshing and to escape rain distraction.

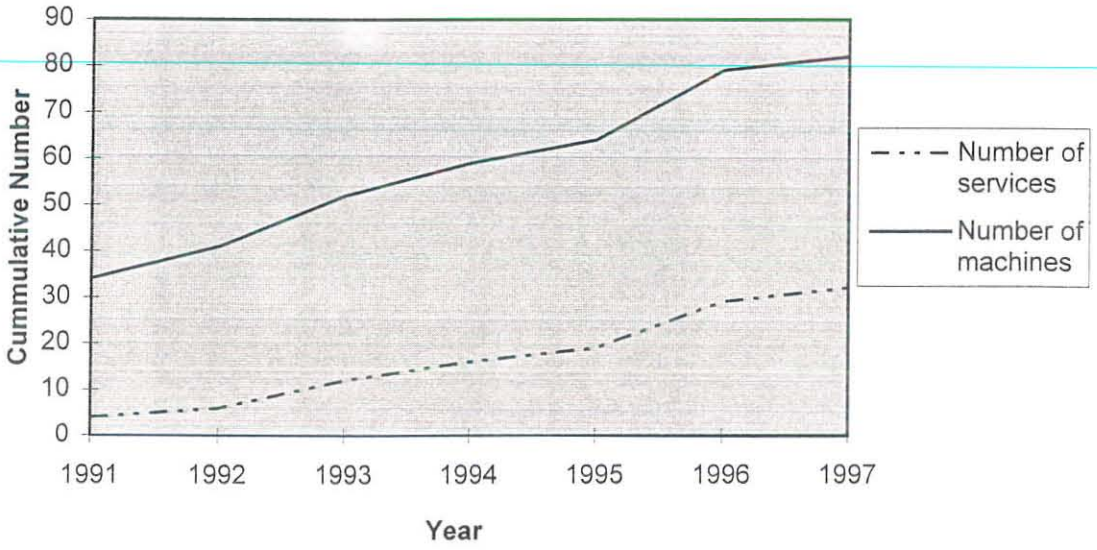
Among the tractor-hire service owners, 25 use the machines for their own production and hire services while the remaining seven use only for hire. However, during the slack period, almost all respondents indicated that the machines were idle except few informants who used them occasionally for transportation. Although some respondents indicated that they use the machines for their own production, they have no land of their own, but use the machines on land rented to them by farmers with weak draft power position. These new patterns of land ownership and the family interest in the farm business suggests, on the one hand, an adaptability but, on the other, a declining level of managerial control over capital assets by the occupier farmer.

Regarding job opportunities, the service schemes altogether involved 29 permanent and 251 temporary workers. About half of the permanent workers were family members of the investors. This reveals that there were 3.4 workers per machine. Apart form these investors operating in the *wereda*, a significant number of other tractor- hire service owners cross administrative boundaries to take advantage of differences in growing season serving in the

wereda. Data on these seasonally migratory tractor-hire service owners was difficult to obtain.

To sum up, the number of investors in tractor- hire services and the number of machines have been progressively increasing since 1992.

Figure 10 Development trends of tractor-hire services and number of machines from 1991-1997



Source: Survey data 1998

5.3.4 Problems of Mechanical Farm Power

In view of the importance of agriculture in the national economy, the ever increasing demand of production needs and the declining traction power, owing to feed shortages in the *wereda*, and the inefficient traditional plow system, the progressive increase in mechanization is indispensable.

Nonetheless, past experiences depict that the success of mechanization depends on various politico-socio-economic factors. Several literature (Mulat, 1989; World Bank, 1987) have indicated that adoption of mechanization in developing countries has adverse as well as positive effects.

Thus, before the adoption of mechanization the advantages and the disadvantages have to be clearly drafted, and solutions sought for the problems, and an enabling environment must be brought into existence. Without an enabling environment, the emerging tractor-hire services would decline in few years to come and the efforts would be resource mis-use and repetition of past mistakes. In view of this, the advantages and disadvantages of adopting tractorization as well as other relevant problems were summarized to provide a general over view.

Advantages of tractorization

- Promotes expansion of agricultural areas
- Makes farm operations easier
- Saves time and labor
- Enables carrying farm operations when desired
- Contributes to increased land productivity
- Raises labor productivity
- Provides sufficient farm power inputs
- Opens up new opportunities such as irrigation development, and intensify cropping
- Makes the farmer free from year-round care of animals.

Disadvantages of tractorization

- It is expensive to purchase, repair and maintain (fixed cost for a tractor including accessories ranges between 120,000-150,000 Birr)
- Requires foreign exchange for machinery and spare parts
- Disemploys labor
- Requires technical knowledge, efficient management and use on commercial principle
- Agricultural operations are seasonal and machines are most often under-utilized for the rest of the year.

Apart form these general advantages and disadvantages, there are other many location specific socio-economic problems which are very important in the success or failure of mechanization.

For instance, in the study area the major problem has been found to be lack of integration. Land and farm experiences belong to the smallholder farmer and, on the contrary, the machines are owned by private investors. Therefore, the tractor-hire service owner is only interested in earning reasonable cash income from his service. He is not concerned about the improvement of agriculture, timeliness ...etc. On the other hand, farmers are concerned more with the economic impact of technology and agricultural productivity. They have no opportunity of using the machines when they need them for others also need them too.

On the other hand, the output from agricultural production do not affect the service provider. Thus, they do not worry if the desired level of operation is met or not. In this regard, all of

the user respondents noted that tractor service providers under work quality in order to save time. They further informed that the costs of machine-hire services were too expensive that they could not afford to use them.

On the contrary, tractor owners argued that small and fragmented farms do not justify provision of service, for a tractor has constantly to make turns on small farms which is waste of time and energy.

Aside from the claims of both sides, a serious problem is that most of the tractor owners have no their own land to plow, except some rented land. Added to this, peasant farms are not only small but also scattered to discriminate tractor service. On top of these most of the farmers (98%) use tractor services for primary tillage. The latter situation indicates that farmers use the machines less for increase in production but more to solve traction power problems. As a result of all these conditions, the machines were under utilized for most of the year. On the other hand, capital intensive investment such as this, has to be efficiently utilized on commercial bases to return the inputs and sustain the service.

To sum up, although this system of coordination where the tractor-hire service owner, takes a responsibility of performing some farm operations benefits both sides in the short-range, as each of them have contrasting objectives and their own problems, long-term successes appear to be bleak.

6. FARMING SYSTEMS AND PRODUCTION PROCESSES IN THE STUDY AREA

6.1 Farming Systems

Farms are complex agricultural systems. They involve the physical environment, farm power, capital and land functioning as a unit. The systematic interaction among the various farm components to produce outputs is termed as farming system. Farming systems indicate what the farmers are doing in the given resource and physical setting, with their managerial know-how, to maximize the attainment of their goals (Norman, 1982). Other components being as they are, farming system in Hetosa is based on mixed production where animals and livestock are raised side by side, supplementing one another.

6.1.1 Land Resource

Land is a scarce farm input in Hetosa wereda and its efficient utilization deserves special attention. Each household, on the average, has 2.1 hectares of land of which 1.7 hectare is utilized for crop production and 0.4 hectare is used for grazing. The average family size for the households is 7.6 people. Thus, land per person in the family is about 0.28 hectare. (Table 9).

Table 9 Major Land Use Types and Household Land Per Capita by PA

Name of PA	No. of Household Heads	Land use types (ha)		Total (ha)	Household Hold Land per capita by PA
		Cultivated	Grazing		
Adarie	54	63	27	90	1.7
Debeya	25	40	9	49	2.0
Bulchana	32	65	15	80	2.5
Kilisa	24	50	3	53	2.2
Jango	30	57	13	70	2.4
Tedo	24	49	6	55	2.3
Total	189	324	73	397	2.1
Household land per capita	-	1.7	0.4	2.1	-
% of total land	-	81.6	18.4	100	-

Source: Survey data

Land holding varies across PAs and among households. The lowest (1.7 ha.) and the highest (2.5 ha.) household land per capita are in Adarie and Bulchana, respectively. This is accounted for variations in population density. Adarie is densely populated owing to its favorable climate as compared to Bulchana where the climate is hot and water is scarce for human and animal consumption. Difference in landholding among households is accounted for earlier land distribution based on household size. On the average, the lowest and highest holdings range between 0.5 hectare and 3 hectares. The former and the latter land size holdings were 3.2% and 5.3% among the sample households. The majority of the households (65%) seized between the range of 1.51-2.5 hectares (Table 10).

Table 10 Distribution of Households by Land Size Category, PA and Per Cent Distribution of Households

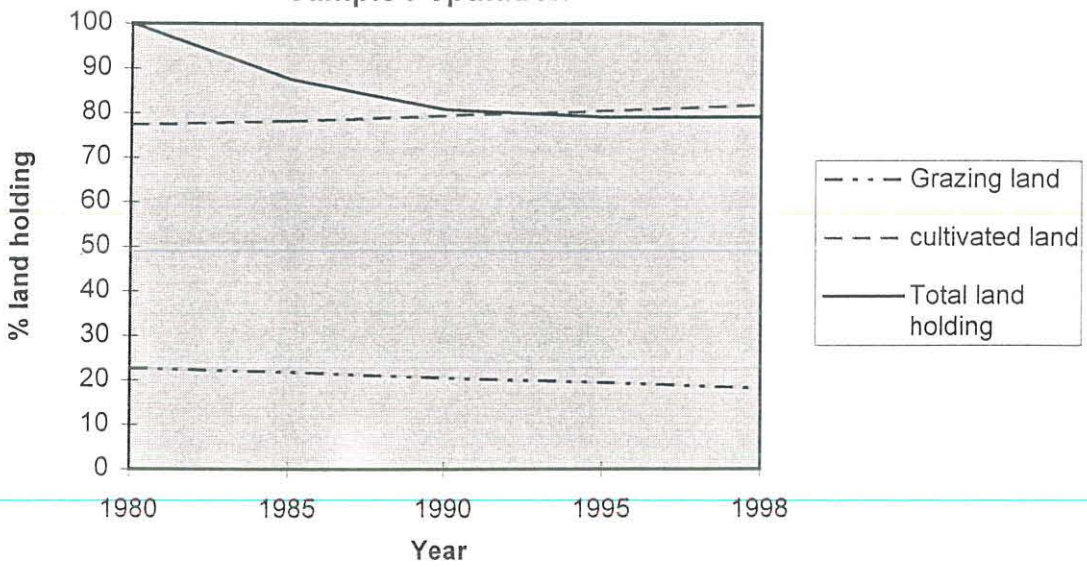
Number of PAs	Land Category in hectare							HHHs**
	≤0.5	0.51-1.0	1.1-1.5	1.51-2.0	2.1-2.5	2.51-3.0	≥3.1	
Adarie	2	10	13	22	3	4	-	54
Debeya	1	1	5	9	7	2	-	25
Bulchana	-	1	2	11	5	8	5	32
Kilisa	3	-	1	4	8	7	1	24
Jango	-	1	2	8	11	4	4	30
Tedo	-	2	2	6	10	4	-	24
Total	6	15	25	60	44	29	10	189
% distribution of HHs*	3.2	7.9	13.2	31.7	23.3	15.4	5.3	100

* HHs Households ** Household Heads

Source: Survey data

Analysis of the trend of household land holdings from 1980-1998 indicated that there was on the average 1.2% annual decline in size of land possession. However, annual share of cropped land has been increasing by 0.3% at the expense of a similar decrease in size in the share of grazing land annually (Figure 11).

Figure 11 Trends in percent of land holding of the sample Population



Source: Survey data

During the era of the Derg Regime, farmers' landholdings used to be redistributed by PA, but after the 1991 government change, farmers themselves have been forced to share parts of their land to their sons' newly formed households. As these sharings were affecting the size of crop land, farmers had to colonize grazing lands to cope up with their families food requirements.

Among the sample respondents, 52(27.5%) support 62 landless newly formed couples with a total population of 227, which is 32.8% of the sample households and 15.8% of the total study population, respectively.

The respondents were further asked about the sources of income for the landless young households. The survey result indicates about 51, 28 and 22 couples derive their means of livelihood from family support, renting land and casual labor, respectively (Table 11).

These sources of income are not dependable. Therefore, landlessness will remain a serious problem for the foreseeable future as Dessalegn (1994) have argued.

Table 11 Number of Married Landless Households of the Study Population by PA and Sources of Income

PA	Married landless Households		Total	Source of Income		
	HHHs	Dependent		Family support	Casual labor	Land rent
Adarie	22	67	89	15	7	8
Debeya	12	25	37	12	5	3
Bulchana	14	38	52	11	4	8
Kilisa	4	9	13	4	3	3
Jango	4	13	17	3	1	3
Tedo	6	13	19	6	2	3
Total*	62	165	227	51	22	28

Source: Survey data.

* The numbers do not make up 62 for some responded giving more than one reason.

As a result of the redistributions and sharings among family members, the size of land holding per household is too small to meet family requirements. Asked whether their present land holding is enough for their family need or not, about 82% of the respondents indicated that it is not enough. Those who said their holding is just enough (18%) for their requirements were those who have family sizes less than the average (7.6).

Those who have said that resources are incompatible with demands, were further asked their means of fulfilling the short falls. About 64.6% and 35.4% replied that they use their existing resources efficiently and, plow crop sharing and/or rented land, respectively. This

indicates not only that the existing owned land is not adequate to expand farm production but also depicts the existence of occupier renters. Those who dispense their land are farmers who do not have the required means of production (human and/or traction power).

The problem of land in Hetosa is not only landlessness or small land holding but also the small holding itself is highly fragmented. Only 6.3% of the study households own concentrated farm plots. The highest number of plots(6) is possessed by 11.1% of the households. Average number of parcels is in an order of 3.5 with a variation ranging from 2.9 in Tedo to 4.1 in Debeya.

Table 12 Distribution of Households by Number of Parcels they Own and Average Number of Parcels by PA

PAs	Number of Parcels						Total HHs	Total No. of parcels	Mean No. of parcels
	1	2	3	4	5	6			
Adarie	2	17	17	11	3	4	54	170	3.2
Debeya	-	3	18	6	4	4	25	103	4.1
Bulchana	1	1	22	6	2	-	32	103	3.2
Kilisa	4	1	7	1	2	9	24	95	4.0
Jango	1	5	6	12	3	3	30	110	3.7
Tedo	4	3	11	4	1	1	24	70	2.9
Total	12	30	71	40	15	21	189	664	3.5
% of total HHs	6.3	15.9	37.6	21.2	7.9	11.1	100	3.5	-

Source: Survey data

Several authors have indicated the causes of land fragmentation (Dessalegn, 1994; Yibeltal, 1992; Fasil, 1980; Aklilu, 1994; Mulat, 1989). As far as Hetosa is concerned, variation in soil fertility, climatic differences and the need for risk aversion are the major causes of land fragmentation.

6.1.2 Farm Power Resources

6.1.2.1 Sources of Farm Power

As it has already been discussed under chapter 5, human, animal and mechanical power sources are used for agricultural production in the study area. Of these power sources,

human and animal power play the dominant role while mechanical power is used as supplementary when farm power shortages are felt.

Regarding human, family labor is the major source of power for farm operations. The participants are, mainly, husband, wife and children. On the average a farm household in the sample has 3 to 4 persons available for work, including children 10 years and over.

In the case of animals, they are second important farm power sources next to human. Animals are involved in plowing, threshing and transportation (details are presented under chapter 5). With regard to mechanical farm power, one quarter of the interviewee responded that they have used tractor and/or combine harvester during the 1996/97 cropping year.

6.1.2.2 Farm Labor Requirement

There are different opinions about the labor composition of the traditional peasant agriculture. Several authors like Dejene (1989); and Yared (1995) have argued that peasant agriculture in Ethiopia comprises surplus labor force. In the contrary, many more others like Jayasuriya, (1986) hold that greater labor absorption in agriculture would be the key to solve the problem of rural unemployment.

However, both sides do not provide a comprehensive account of the type of production system, the farm power and implements used, the specific season of operation and the net labor force composition, efficiency and size of labor force engaged. These are some of the

important variables to be considered in relation to agricultural labor force to support or reject either of the claims.

In view of these diverging opinions and the need to understand labor job balance, the households were asked whether they have labor shortage or not. A significant number (57%) of the households responded that they have labor shortage. Those who have reported labor shortage were further asked to reveal during which period of agricultural activity they face labor shortage. The result indicated that about 49% of the farmers face labor shortage during harvesting, and in the case of threshing, weeding and plowing the shortage level varied from 23-25 per cent. The least number of labor shortage response (12%) was with regard to activities concerning animal care (Table 13).

Table 13 Distribution of Households Who Reported that they Have or Have No Labor Shortage by PA and Type of Activity

Name of PAs	Do you have short age of labor?		No. of HHs who responded that they have labor shortage by type of activities				
	Yes	No	Plowing	Weeding	Harvesting	Threshing	Herding
Adarie	23	31	13	12	20	14	5
Debeya	18	7	7	6	13	5	4
Bulchan	14	18	7	6	12	4	1
Jango	19	11	9	11	18	7	2
Kilisa	18	6	1	2	15	3	2
Tedo	15	9	11	10	15	11	9
Total	107	82	48	47	93	44	23
% total HHS	57	43	25.4	24.9	49.2	23.3	12.2

Source: Survey data 1998

* The percent provided do not add up to 100 because of more than one answers.

These findings of the research reveal not only that labor shortage is significant in the production system but also a common phenomenon during most of the farm activities.

It is evident that, farmers are usually disengaged from farm activities due to religious affiliation and practices. Thus, a further effort has been made to see if disengagements might have created the claimed labor shortage. In this connection the average days of disengagement in a month from farm operations in each PA for total respondents recorded and compared with the average number of days of disengagement in a month for labor shortage claimants.

The comparison indicated that labor shortage claimants were on average disengaged for 6.6 days in a month from farm activities. This indicated a small difference of less than a day when compared to average 5.7 days of disengagement for the study population.

Table 14 Comparison of Average Days of Disengagement in a Month for the Study Population Compared to Average No. of Days of Disengagement for Labor Shortage Claimants

Name of PAs	Average days of disengagement in a month per HH	Average No of days of disengagement for labor shortage claimants
1. Bulchana	4.1	4.0
2. Tedo	5.7	5.9
3. Jango	5.7	6.3
4. Kilisa	6.0	5.9
5. Adarie	6.0	6.3
6. Debeya	6.4	11.4
Average	5.7	6.6

Source : Survey data.

"Religious disengagements" are mostly expressed by a shift of operations in the study area. Farmers are forbidden only to engage in major operations such as crop cutting and plowing. On the other hand, they are engaged in the so called "light works" such as farm constructions, preparation and maintenance of farm implements, crop transportation and other social affairs on holidays. As a result, disengagement is only a relative expression and do not appear to have a significant impact with regard to productivity.

In all the above attempts, none of the variables employed strongly accounted for labor shortage in the area. Nonetheless, what appears more important is, the unquantifiable but empirically observable impact of the seasonality of agriculture. As indicated in Table 16, agriculture is highly seasonal, operated during specific periods of the year. For instance, harvesting generally takes place between October - December. However, crops do not await farmers more than a weak after they have reached reaping period. So is the case for weeding where the operation is done for all crops only during the month of August. In addition, most crops reap at the same time and thus add pressure and time constraint on the farmer.

The impact of seasonality varies across agroclimate. In *weyna dega* (altitude of 1500-2400 masl) and *kolla* (altitude of 500-1500 masl), crops mature fast accelerating pressure on labor, but in *dega* (altitude of more than 2400 masl) they reap slowly and give time for the farmer. That is partly the reason why labor shortage claimants are lesser in Adarie than all other PAs in the study area in spite of a large size of respondents (Table 13).

The other possible reason for labor shortage is assumed to be the age-structure of the population showing that the economically active population is only 47% as compared to the

dependent population of 53%. The deep hole of scar on the population pyramid of males between the age of 20-44 clearly indicates the scarcity of active operational force. These reveal that the population is too many in number but too weak for the tedious farm operations.

In connection with this, although children start contributing to household income at an early age, about 51% of them, between the age of 10-14, were schooling and the active labor force was partly occupied by less important activities like animal care. Added to these, the farming systems and the traditional implements used are to blame since they do not enable efficient performance of agricultural activities. The implements used are the plow, sickle, and fork which need improvement or replacement by better ones. Moreover, the low level of farmers' education also worth mentioning here.

Much has been written praising investment in education as the key to successful economic growth. Wheeler (1980) and psacharopoulos (1991) for instance, argued that education improves the skills and productive capacities of the labor force and contributes to the growth of national income. Psacharopoulos further noted that education may interact with fertility, mortality, health, nutrition and other aspects of development that affect income distribution. Similarly, Hicks(1980) indicated that spending on education should be regarded as a key element of productive investment rather than pure consumption.

According to The World Bank (1995) investment in people can boost the living standards of households by opening up opportunities and increasing earning power. Thus, education

fosters the type of behavioral change that is conducive to economic growth and acts as a vehicle for social mobility and serve the purpose of reducing the absolute level of poverty.

In conclusion, these arguments incorporate the importance of education: (1) in the mental make-up-of a man, his out look towards life and things around him; (2) in the improvement of the socio-cultural fabric of the society; and (3) in the advancement of material life. Hence, education is a productive investment in human capital which can contribute to economic development and raise national income.

Although, the importance of education is of a little doubt in an enabling modernizing environment, the case is not the same in less developed countries such as ours. Many of us may become confused about the economic value of education when we think of most of our higher education graduates are unemployed in such a resource potential but very poor country with limited (15.2%) literacy rate (CSA 1997).

This implies not the uselessness of education but the signal that education is not an end by itself which leads to rapid growth. For human skill to be efficiently harnessed among many others, favorable politico-socio-economic environment, developed self and community experience of job creation, efficient human resources use and management and concomitant progress of other aspects of development are required.

Finally, other things being constant, education also enables rational and efficient use of available resources and opportunities. In view of these, the labor shortage claims may be partly accounted for farmers lack of sufficient management skill.

Thus, empirical evidences suggest the importance of the aforementioned factors in facilitating labor shortage. In conclusion, labor shortage in the study area is seasonal and many factors are involved in aggravating the scarcity.

6.1.2.3 Labor Division

Before discussing the division of labor among family members, it is worthwhile to shed some light on the duties and responsibilities of a farmer in order to facilitate understanding of the depth and breadth of the farm enterprise. Thus, a general summary of duties and responsibilities of a farmer is provided below.

Major duties and responsibilities of the farmer

- Establish and manage farm enterprise
- Devise farm resources(Labor, capital, land) use and management systems
- Ensure availability of farm implements, seeds and other inputs
- Plan cropping system and use of resources taking into account risk aversion measures
- Seek ways and means of promoting and expanding production
- Execute all farm operations
- Supply farm produce to urban population
- Establish farm family, administer and ensure its continuity
- Share experience (train) for young family members
- Keep and manage animal stock for farm power, cash and food supply
- Participate in social obligations and cultural affairs

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- Share experience (train) for young family members
- Keep and manage animal stock for farm power, cash and food supply
- Participate in social obligations and cultural affairs

- Participate in all aspects required by government and government organs
- Implement government laws, regulations and directives
- Enter into farm oriented contracts, and accordingly fulfill conditionalities
- Carry out other activities as are necessary for the attainment of the farm objectives.

As the summary indicates, a farmer has a number of responsibilities to execute. He is an investigator, planner, decision maker, implementer, manager, evaluator, producer, seller and purchaser among others. In addition, he is engaged in tiresome physical works. His role could not be associated only to major visible physical works but also to cultural, social and political affairs too. There is no boundary for the activities the farmer performs in the farm settings.

In order to perform the broad and demanding tasks, farm operations are executed by division of labor on the basis of sex and age. Generally, males are the main actors, in plowing, weeding, harvesting, threshing, herding and farm construction activities.

On the contrary to the field oriented activities of the males, women are mainly engaged in home management, and the services they render are of paramount importance in sustaining the production system. Some of the home production activities of women include: cleaning and grinding of grains, cooking, fetching drinking water, collecting fire wood, child care, marketing and other social obligations.

In addition to these home jobs, they also participate in field operations such as weeding, threshing and crop transportation. The survey data indicates that more than 90% of the housewives participate in field operations. When this is examined across operation types, the majority (81.2% and 81%) were found to have engaged in weeding and threshing respectively. Nonetheless, most often, women are exempted from work in the fields when they do the cooking, and labor is sufficient.

In this connection, it is worth noting that several of the home production activities, in particular cooking, cleaning, and grinding grain, can be and often are, jointly done along with child care. As a result of these overlapping and heavy responsibilities most women work for 10 to 12 hours a day. They rise early at day break and stop working at night fall. There is no drop in their level of work activity.

Children also make substantial contributions to their parents' welfare through the work they perform in the household and on the farm. They begin engagement in household's economic activities from an early age of about seven years (Yared, 1995; Assefa 1995). Although, this is far below the conventionally accepted age level (15 years) it is a widely observed normal phenomenon in most rural parts of Ethiopia.

The work done by children varies with the age and gender of the child. Female children perform most of the home production related tasks such as taking care of their youngers, fetching drinking water and collecting fuel wood. On the other hand, males provide the lions-share of their labor for animal care activities.

The survey indicated that 51% and 82% of the children between the age of 10-14 years participate in threshing and herding, respectively. Conversely, only about 30% and 34% were found to participate in heavy operations such as plowing and harvesting, in this order. It was further found that the duration of labor time depends on age and the nature of the work. With progress in age, the duration of time and the type of work the child is put to increase.

Table 15 Number of Participating Children in Various Farm Operations Aged 10-14 Years

Name of PAs	Farm Jobs				
	Plowing	Weeding	Harvesting	Threshing	Herding
Adarie	17	31	23	47	56
Debeya	8	17	9	18	19
Bulchana	16	28	18	47	47
Kilisa	10	11	10	18	20
Jango	10	16	11	22	22
Tedo	8	19	8	25	25
Total	69	122	79	117	189
% of total population aged 10-14*	30	53	34.3	51.0	82.0

Source: Survey data

* The percentage do not add up to 100 for a child participates in more than one operations.

Apart from this general division of family labor, every working member in the household is involved when the need to complete certain tasks at peak agricultural periods arise.

6.1.2.4 Working Periods and Hours

Agriculture is heavily seasonal and farm operations are at peak during some seasons and low at others. Detailed is presented in Table 16.

Regarding daily hours of work, there is individual differences among farm households. In addition, daily working hours for different activities also do vary. For instance, plowing involves oxen and the working hours depend on the strength of the animals and the type of tillage (primary, secondary or seeding). Primary tillage is actually more difficult than seeding. On the average, daily working hours range between 5-9 for plowing, weeding, harvesting and threshing. In peasant farm operation, the emerging eight hour day is not a clear-cut conventionally accepted practice as in factories and industrial enterprises.

Seasonality also significantly influences the working hour. During dry season, there is little agricultural activity. In the contrary, it is very intense during the rainy season and working hour average up to nine hours.

6.1.2.5 Copping Mechanisms to Labor Shortage

Many factors such as seasonality, type of crop mix, and climatic conditions put pressure on household labor. As a result, farmers fall short of their labor requirement during some peak agricultural periods. Under conditions of labor shortage and time constraints they are compelled to rely on each other in the form of assistance (*debo*) and cooperation (*wenfel*). The *debo* is a one-time arrangement when many people of an area participate for major tasks such as harvesting, breaking in new ground for cultivation, or house building. The *wenfel* arrangement is one in which groups of people work on each other's farms in turn.

The other area of mutual support involves land transfer under rent or share cropping. Households short of draft power or male labor rent out some of their land for a crop season.

In Hetosa these traditional forms of labor exchange were widely used during the Imperial Period. Now-a-days, people are reluctant to use these traditional forms of mutual support as it is thought to be less efficient and other more important means of labor shortage averting inputs such as tractor, combine harvester, herbicide and hire labor are available.

Asked about their copping mechanisms to labor shortage, 74% of the households responded that they use wage labor, while 46% and 42% replied in favor of labor exchange and use of friends and relatives, respectively.

Furthermore, the respondents were asked to reveal the annual and daily wages of a laborer to see the relative demand of labor power. The result indicated that the average annual wage for a herdboy, an adult, and a young farmer were estimated to be 726 Birr, 513 Birr and 305 Birr, respectively. These costs do not include food and shelter which are usually provided by the employing farmer.

Payments are in cash and/or in kind. When it is in kind, the farmer would provide a *timad* of his plot (a quarter of a hectare) for use over one cropping period including some farm inputs for an adult laborer.

In case of the daily labor wages all payments are in cash. Average daily labor wage is 7.80 Birr for harvesting and 5-7 Birr for other operations. The cost for harvesting is slightly higher than that of other activities for it is boring and timeliness is required.

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6.2 Production Processes

6.2.1 Farm Operations and Calendar

Man integrates his labor with animal and\or mechanical power to interact with resources such as land, capital and the physical environment in the quest for producing his means of livelihood. The interaction begins at a specific period, *belg* or *meher* cropping season, following the emergence of rains.

To mention only the major agricultural operations, the process of production starts with plowing. Plowing is a task of scratching the soil for adequate seed bed preparation for plant growth. It is mainly done traditionally, with a wooden beam (plow share) about 3 meters long with a tip of iron or steel and drawn by a pair of oxen.

The bullock share plow is still the only oxen implement being widely used. It is light enough for the farmer to carry to the fields, readily available locally and usually made from local materials by the farmer himself. Thus, production with this traditional implement is relatively inexpensive; and not too complicated but slow in action of tilling the ground. However, there are diverging opinions regarding the use of the bullock plow. Several authors such as Graaf (1994) and Zerbini (1994) have argued that animal traction is an appropriate, affordable and sustainable technology for smallholder farmers while others like J.Gill (1977); and Aregay (1975) claimed that it is a backward implement which retards agricultural productivity.

Different crops have different seed bed requirement. Some soils are easy while others are difficult to cultivate. Therefore, the number of times a plot of land is plowed for a desired level of seed bed varies across type of crop, soil, climate and type of implements used to cultivate the land.

In general plowing is done 4 to 5 times for wheat, 3 to 4 times for barley, maize and sorghum, and once only for flax and chick peas. Usually, plowing takes place from March to July (Table 18). In March and April, the soil is prepared for maize and sorghum in the *weyna dega* agroclimatic zone. During the same time the land is cultivated for barley and chickpeas in the *dega* agroclimatic zone for *belg* (short rainy season) crops. April-June is the period of seed bed preparation for the *meher* (main rainy season) crops in both agroclimatic zones.

Table 16 Cropping Calendar for Major Crops (Main Rainy Season)

Crop Type	MONTHS											
	January	Feb.	March	April	May	June	July	August	Sept.	October	November	December
Sorghum	T		P P	P S S		w w w	w				H H H	T T
Maize	T T		P P P	S S	w w	w w	w w				H	H H H
Wheat	T T			P P	P P	P S	S	w w w w			H H H	H H T T
Barley					P P	P P	S S	w w w w		H H H	T T	T T
Teff	T T			P P	P P	P P	S	w w w w		H	H H	T T
Beans				P P	P P	S S		w w w w		H H	T T T	
Peas						S	S			S S	T T	
Vernier Measure	1 | 2 | 3 | 4		1 | 2 | 3 | 4		1 | 2 | 3 | 4		1 | 2 | 3 | 4				1 | 2 | 3 | 4	

Source: Survey data: 1998

Note: P = ploughing S = sowing w = weeding H = harvesting T = Threshing

*Sub-divisions and numbers from 1-4 are supper imposed at the bottom of each month to serve as a vernier measure in indicating the approximate weak of a month when an activity is executed.

Between the tillage intervals, the soil gets moisture, air and temperature which activate humus materials to decompose and fine seedbed gradually matures for planting. As appropriate seedbed is ensured, the soil is made to embrace seeds. Sowing is done by traditional method of broadcasting seeds by hand. The operation is performed for maize and sorghum as well as *belg* crops in April. For main rainy season crops, sowing is done in June and July.

The combination of seeds, soil and the physical environment condition seeds to germinate and grow. At the early stage of their growth, crops are accompanied by weeds. As these plants share nutrients for the crop, they have to be picked off by hand or destroyed by spraying herbicide. This operation is known as weeding. Weeding for *meher* crops takes place in August.

The crop continues to grow and starts to mature at the end of October. Thus, harvesting begins in October and continues up to January. Crops are mostly harvested by hand using the traditional sickle. Simultaneously, as cutting goes on, threshing of harvested crops may start in November and continue up to January.

For threshing, the crop is spread on a patch of earth floor (*Awdma*) and threshing is done by driving teams of animals over the grain. Wooden shovels and forks are then used to toss the grain into the wind so as to separate the chaff from the grain. Sometimes, when the climate is not favorable, in the *dega* zone, barely is threshed manually by beating the earhead, pounding them with a stick.

Table 16 Cropping Calendar for Major Crops (Main Rainy Season)

Crop Type	MONTHS											
	January	Feb.	March	April	May	June	July	August	Sept.	October	November	December
Sorghum	T		P P	P S S		w w w	w				H H H	T T
Maize	T T		P P P	S S	w w	w w	w w				H	H H H
Wheat	T T			P P	P P	P S	S	w w w w			H H H	H H T T
Barley					P P	P P	S S	w w w w		H H H	T T	T T
Teff	T T			P P	P P	P P	S	w w w w		H	H H	T T
Beans				P P	P P	S S		w w w w		H H	T T T	
Peas						S	S			S S	T T	
Vernier Measure	1 | 2 | 3 | 4		1 | 2 | 3 | 4		1 | 2 | 3 | 4		1 | 2 | 3 | 4				1 | 2 | 3 | 4	

Source: Survey data: 1998

Note: P = ploughing S = sowing w = weeding H = harvesting T = Threshing

*Sub-divisions and numbers from 1-4 are supper imposed at the bottom of each month to serve as a vernier measure in indicating the approximate weak of a month when an activity is executed.

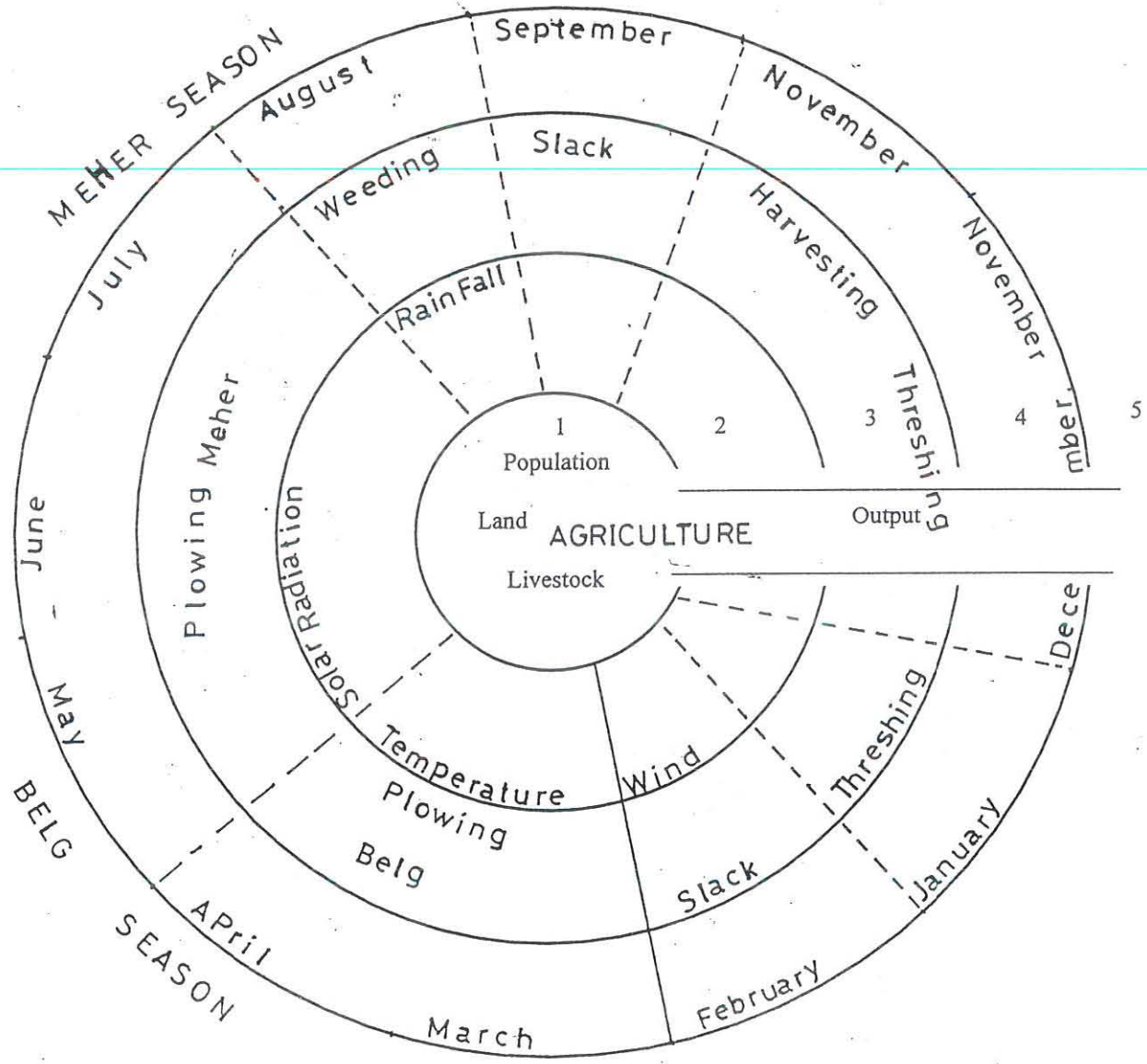
Recently some farmers are also using hired combine harvesters for threshing. Threshing starts in November with barley and pulses, and continues up to the month of January. These traditional methods of threshing cause losses of some portion of the harvest, and lead to over working of both men and animals.

In most cases, the process of agricultural operations would be over at the end of January and February is a period of rest until the cycle starts again in March. In order to summarize this process, the agricultural production process cycle is presented in Figure 12.

The agricultural production process cycle is a model which includes five concentric circles. In the central circle, land (resources), population and livestock are presented. The second concentric circle comprises the physical environment around the core elements. These are the external inputs such as rain, solar radiation, temperature and air important for agricultural production. The third concentric circle includes activities that are progressively operated during the interaction of farm power, the core elements and the physical environment in the process of agricultural production. These operations are plowing, planting (seeding), weeding, harvesting and threshing. In the fourth circle, all the months of the year are accordingly represented clockwise to indicate when each agricultural activity takes place. In the outer most shell, the major cropping seasons (*belg* and *meher*) are shown. At one side of the concentric circles, production flows out at the end of the process.

Figure 12 Agricultural Production Process Cycle

1. Agricultural Resources
2. Physical environment
3. Farm operations
4. Operational calendar
5. Seasons



This being the general process of agricultural production, calendar of farm operations for different crops vary. For example, maize and sorghum are planted in April while June-July is the optimum period for other *meher* crops. (Table 16).

6.2.2 Major Crops Grown

In terms of agricultural potential, the study area is one of the surplus producing *weredas* in the country (Mulat, 1989; Yeshitila, 1988; Amare, 1995). The data presented in Table 17 provide a comparative view of crops grown, area coverage and levels of productivity in the six sample PAs. The main crops produced and consumed by the farm families are wheat, barley and maize which altogether account for 85% and 89% of the total cropped land and production, respectively. The other crops are pulses which occupy only 8.1% and 5% of the total area in the crop and production in that order. Of these crops, wheat is the most important cash as well as staple crop.

Table 17 Types of Crops Cultivated, Farm Size (in ha), Production (in quintal) and Average Production Per Hectare by PA

PA	CROP TYPE																		Average Produc-tion
	Sorghum		Maize		Wheat		Barley		Teff		Beans		Peas		Lentil		Total		
	Farm Size	Produ-ction	Farm Size	Produ-ction	Farm size	Produ-ction	Farm size	Produ-ction	Farm size	Produ-ction	Farm size	Produ-ction	Farm size	Produ-ction	Farm size	Produ-ction	Farm size	Produ-ction	
Adarie	-	-	-	-	18.0	326	36	578	-	-	4	53	1	5	4	25	63.0	987	15.7
Debya	0.4	6	2.1	42	22.6	475	10.1	177	-	-	3.6	55	0.4	4	1.3	9	40.5	768	18.9
Bulchana	4.9	72	13.0	198	29.5	551	11.5	174	0.9	8	3.8	37	1	9	-	-	64.7	1049	16.2
Killsa	4.8	104	7.3	149	33.4	750	1.8	30	0.25	2	2.3	34	-	-	-	-	49.9	1069	21.4
Jango	7.4	116	8.4	164	37.3	637	2.3	38	0.8	5	0.8	11	-	-	-	-	57.0	971	17.0
Tedo	2.6	36	9.3	155	30.0	671	3.6	64	-	-	1.9	29	1.8	16	0.3	2	49.4	973	19.7
Total	20.1	334	40	708	171.2	3410	65.2	1061	1.9	15	16.8	219	4.2	34	5.6	36	324.5	5817	17.9
Production per ha.		16.6		17.7		19.9		16.3		7.9		13.1		8.1		6.4		17.9	-
% of total land	6.2	-	12.3	-	52.7	-	20.1	-	0.6	-	5.1	-	1.3	-	1.7	-	100	-	-
% of total production	-	5.7	-	12.2	-	58.6	-	18.2	-	0.3	-	3.8	-	0.6	-	0.6	-	100	-

Source: Survey data.

In an aggregate, with current average yield level of 17.9 quintals per hectare, average household crop per capita is about 30 quintals. This demonstrates a low level of productivity as compared to Gonde/Iteya basic seed farm average production of about 35 quintals per hectare. Given the existing low farm productivity, a total land holding of 2.1 hectares is small for a mixed farming system and may be inadequate to provide reasonable quantities of food for the family let alone any saving for future investment in agriculture.

A look at the spatial distribution of crops in the study area indicate altitudinal variation. Thus, an attempt was made to see altitudinal variation and associated crop types based on the works of Azene (1993). Azene has classified agroclimatic zones of Ethiopia into *bereha*, *kolla*, *weyna dega, dega* and *wurch* . He further subdivided these agroclimatic zones into dry moist and wet sub-zones. The study area falls within his moist *weyna dega* and *dega* agroclimatic sub-zones. However, his altitudinal demarcation are too general and do not approximate crop limits. Thus, a better agroclimatic altitudinal heights which approximate crop limits have been adopted to the study area (Table 18). The heights 2900 masl and 2400 masl better approximate upper limits for wheat and, maize and sorghum, respectively.

The agroclimatic distributions of the major crops in the study area indicate that wheat and barely cover broader agroclimatic zones whereas sorghum and maize are low altitude cereal crops while beans and peas grow in *weyna dega* and *dega* agroclimatic zones.

Table 18 Agroclimatic Distribution of Different Agricultural Resources

Altitude	Annual Rainfall	Resource Types				Sample PAs
		Wurch				
		Crops	Livestock	Natural Trees	Soils	
More than 2900 masl	More than 1200 mm	Barley (1)	Cattle	Erica	Very dark gray	
		Pulses (rare)	Donkeys	Hypericum		
		1 Crop per year	Horses			
			Sheep			
		Dega				Adarie
		Crops	Livestock	Natural Trees	Soils	
		Barley (1)	Cattle	Juniperus	Very dark gray	
2900-2400 masl	1200-900 mm	Pulses (3)	Donkeys	Hagenia		Debeya
		Wheat (2)	Horses	Podocurpus		
		2 Crop per year	Sheep			
			Goats			
		Weyna Dega				
		Crops	Livestock	Natural Trees	Soils	
		Barley (4)	Cattle	Acacia	Very dark gray	Tedo
2400-1900 masl	900-600 mm	Pulses (5)	Donkeys	Ficus		Kilisa
		Wheat (1)	Mules	Cordia		Bulchana
		Maize (2)	Sheep			Jango
		Sorghum (3)	Goats			
		1 Crop per year				

Source: Azene 1993; Survey data 1998; EMA 1981.

* Crops are listed according to their relative, altitudinal preference.

(1) The number indicates the rank each crop occupies in size of land.

7. IMPEDIMENTS TO INTEGRATION AND EFFICIENT USE OF VARIOUS TYPES OF FARM POWER

7.1 Too Many but too Young Population

Several factors have been found to impede the integration and efficient use of various types of farm power in Hetosa. Thus, this chapter is devoted to the evaluation of the major factors.

People have two major roles to play with regard to agricultural production. These are: a) provision of labor force to the various farm operations and b) replacement of themselves for future human labor requirement. The over-or-under exercise of these roles may have positive or negative bearings on agricultural productivity depending on specific conditions.

For instance, there are diverging opinions regarding the size of labor force in Ethiopian agriculture. Some authors have argued that there is surplus labor force in the agricultural sector which undermines efficient use of resources while the proponents of intensification claimed that the sector could absorb much more labor force than the present stock. Both of these line of arguments have some grain of truth. Nonetheless, operational conditions vary in place, season (slack or peak), type of farm implements used, nature of farming system, and resource use combination (rain-fed or irrigation). The existence of these various operational conditions being as they are; the bulk of the population (88%) of Hetosa is rural, with average household size of about 6.2 persons (CSA, 1996). These

indicate not only that the rural population is large but also each couple is replacing oneself more than two times.

At this juncture, it is worthwhile to evaluate the underlying reasons for farmers desire for more children. Usually, farmers need for more children rests on the reasons that: a) children provide labor b) children ensure family continuity and c) children provide support during old ages.

To evaluate how strongly these reasons are believed recently, the respondents were asked if they want to have more children or not. Most of them (64%) have responded that they want to have more children. Those who have responded to have additional number of children were further inquired the reasons for having more children. About 65.3% have replied that children provide labor, support during old ages and ensure family continuity. The remaining 24% and 15.7% were in favor of support during old ages and securing family continuity, in this order. These reveal that multiple of factors dictate the desire for having more children than single variables such as old age security or labor provision. Added to these, it is also been worth noting to mention that the importance of some of these variables have also changed over time.

In the past, population was relatively smaller than at present and farmers were able to own more land and rear more livestock. Concomitantly, modern education was not a common practice, and thus, children were often put to work. At present, the size of individual land holdings have reduced, and most of the families in Hetosa view education as the most

promising way to better material life and consequently the time children are put to work has diminished.

Similarly, the advancement in modern health facilities and the discovery of medicine for deadly diseases such as malaria, kolera ...etc, have reduced mortality rate and thereby the fear for family discontinuity. Hence, available conditions appear to be favorable than ever before to induce awareness, provide affordable family planning facilities and work against rapid population growth.

Likewise, interesting responses were obtained by asking those who have responded in favor of not having more children, the reason why. About 41%, 31% and 28% have responded due to old age, they have enough children and their income do not enable them bring up more children, respectively.

However, among 68 households who have responded not to have more children due to low income and for they already have the desired number of children, most of them have no sufficient awareness of family planning and practice. Only two families were found to be taking contraceptive measures.

In an aggregate terms, there are favorable conditions for family planning practices both among those who want and do not want to have more children. But there exists a wide gap between desire and lack of awareness. On top of this, affordable family planning services are not in place and the population is currently growing at an alarming rate of 3 per cent per annum. A look into the age structure of the population reveals that the ratio

between the economically active and inactive population is in an order of 1:1.13. This implies not only the existence of large dependent population but also that they require huge resources for skill formation and other services. Thus, the rapidly growing young population under the present traditional farming systems, consume the capital resources for further investment, and increase farm land fragmentation thereby contributing to weak integration of farm power elements. The filling of these gaps have to start today, in order to wisely use agricultural resources in the long-term.

7.2 Land Use Competition Between Crop and Livestock

Animals play the central role in the smallholder farmers' crop production systems in providing traction power to the farm, manure to the soil, food and cash income to the farm family. Conversely, animals could be fed with crop residues, farm stubble, weeds and crop thinnings. Thus, there has been an intimate complementary relationship between crop-livestock production systems of the Ethiopian agriculture.

However, the last two decades, the rapidly growing population initiated spatial expansion to the territory of animal grazing and there has been a strong conflict between crops and animals over land use. As a result, grazing land has been declining at a rate of 0.3 per cent per annum between the period of 1980-1998. Nonetheless, the conflict is not such that one is expanding at the exclusion of the other. But although grazing land is receding at the front combat, it is ambushing farm power for crop production at the back. Thus, the contention appears to be where neither of them would be the winner, but, both crop and livestock production are in the process of deepening crises.

This worst condition would have been improved through intervening by modern mechanization. However, exogenous technologies and enabling environment for mechanization have not yet developed. In view of these, the conflict between crops and livestock over the land use has to be settled to efficiently use traction power and the concomitant opportunities.

7.3 Small Land Holdings and Fragmentation

Land is one of the most important agricultural resources on which the means of existence for most Ethiopians depend. Because of this, there has been intermittent land redistributions to solve the problems of newly married couples coming to the farming life, during the Derg Period. As a result, household land holding had declined by 0.56 hectare between 1980-1998. Moreover, the current small holding of 2.1 hectares are fragmented into 3 to 4 plots.

When evaluated in-depth, the decline in land holdings and fragmentation bear a number of problems. Firstly, as the size of land holding becomes smaller and smaller, it is more and more uneconomical for use of mechanical power and leads to labor intensification. Secondly, human labor intensification implies putting more people to physical work, where machines can do the same work with less energy and time. In other words, small holdings call for labor use and limit farm power choice alternatives. Thirdly, when people are intensively engaged to physical work, they may not have ample time for skill development and leisure. Fourthly, low skill formation prohibits the capacity of

diversifying the base of the economy and leads to large labor concentration in some primary activities. These are the serious problems following one another, gravitating the decline of agricultural productivity.

From these facts it can be safely concluded that small and fragmented land holdings are not only uneconomical for efficient use of traction and mechanical power but also confine the labor force in agriculture and limit the capacity of the economy to diversify.

In conclusion, although small land holdings may serve as a means of subsistence and income distribution for the rural poor, it does not appear to serve long-term overall development objectives and efficient use of farm power alternatives.

7.4 Disparity Between Land and Mechanical Power Ownership

As has already been stated, land to date is a public property in Ethiopia and farmers have no legal right to sell or rent their holdings so that those who have financial power use it for production. On the contrary, most of Ethiopian farmers live under subsistence economy and could not afford to purchase mechanical power and use the land efficiently.

Under such a condition it was found that private investors have started to purchase mechanical tools and provide hire services for the small holders. In this relation, the interest of the machine owner is to economize the use of his machines as inputs and earn most out of the service he renders. Thus, he is less concerned with the quality of work as compared to his benefits. During the survey, mechanical power user informants have

reported that they were provided with low quality work at an expensive price. On the contrary, farmers are interested in machine performance and productivity. Thus, there is a conflict of diverging interests between land and machine owners. Had the land and machines been owned by the same person, both resources would have been efficiently utilized.

7.5 Insufficient Enabling Environment for Development of Mechanical Power

Under the land proclamation of 1975, most of the arable lands have been distributed to small holder farmers. Thus, it is unlikely to find unoccupied land or means of securing large tract of land in the highlands which guarantee the development of modern mechanical power. On the other spectrum, Ethiopian farmers who own land have no financial power, technical and managerial skill, to own, operate and run such capital intensive equipments.

Added to these, although the Investment Proclamations of 1992 promise to allocate sufficient farm land at the periphery and provide exemptions from import tax of agricultural machines and spare parts, as mechanization is capital intensive and guided by commercial principles, it is more attracted by availability of socio-economic services and market forces and land security. Because of these, responses during the last five years were limited to these incentives. Thus, sufficient enabling environment for sustainable development of mechanical power has not yet matured.

7.6 Traditional Farm Implements

The traditional farm implements include tilling plow, harvesting sickle and fork for winnowing. These equipments have prevailed for thousands of years with little or no modification. Production with these implements is boring, labor and time consuming. They contribute not only to inefficient use of labor and time but also to reduced productivity.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

This study explores the types of farm power sources in Hetosa, the study area, and the roles they play in accelerating agricultural production. It seeks to look into the problems encountered to integrate and efficiently use the various farm power sources and farmers' response to those problems so far.

Regarding human farm power, the research revealed that the total rural population is large (88%) as compared to 12% urban, and too young with 47.3% of economically active labor force against 52.7% of dependent population. As this is a characteristic feature of the study area the results were in demand for more agricultural production and concomitant claim of grazing lands. The final effects of these measures were decline in animal feed, number of farm animals and power which ultimately affect agricultural productivity.

Furthermore, the survey revealed that as population increases so does land fragmentation due to progressive sharing of land to newly married couples. These small land holdings were found to attract more human labor than mechanical power and hampered efficient use of farm power sources. In general, the population which is growing at a staggering 3 per cent per annum holds mainly responsible for inefficient use of farm power sources and reduced productivity.

In view of these, the research has also assessed the factors initiating the need to have more children. The results indicated that a combination of reasons which are related to demand for children, support during old ages, using as source of labor and considering having children as a securing mechanism to family continuity, dominate the responses. It was further found out that the importance of the reasons children provide labor, ensure family continuity and provide support during old age have reduced and there are better conditions for family planning interventions. However, on the contrary, gaps were observed between desire, awareness and availability of affordable family planning services.

Added to these, the educational level of the farmers is very low as serious consideration is taken with regard to their duties and responsibilities, skill and management capacity, as well as to the variety and intensity of modern farm inputs requirement. Similarly, the traditional implements being used by them are not only inefficient but also contribute to reduced labor productivity. All these factors, combined with other factors together contribute to the low agricultural productivity.

With respect to animal farm power, the study has focused on the size, distribution, and its management. The research has shown that livestock are the fundamental farm power sources and an integral part of the Ethiopian agricultural production.

However, triggered by crop production claim of grazing land and weak animal management, there has been a precipitating decline in feed resources and traction power. Because of these, farmers have been compelled to various problems such as land renting, crop sharing and thereby low agricultural income.

In view of these, it can be safely concluded that traction power deficit will persist in so far as better forage production, and management are not instituted.

As to mechanical farm power, evaluation of the existing environment for adoption, types and number of machines available, ownership type, and problems of adopting mechanical farm power has been made. Accordingly, the results illuminate that, although there is a need for mechanical farm power, the adoptive environment appears to be poor because of the existing land tenure system, low financial, technical and managerial capacities of smallholder farmers', land fragmentation, huge employment in the agriculture sector, ...etc.

Added to these, the working and fixed capital altogether rise to more than 120,000 Birr for a tractor. Thus, the effective use of the machines under commercial principles and acquisition of superior pay off are crucial to the economic prospects of the owner and the sustainablity of mechanical power.

However on the contrary smallholder farmers have no paying capability, and most of them (98%) use tractor services for primary tillage. On the other hand, the tractor owners have no land of their own. Thus, there is no favorable condition to use the full capacity of the machines.

Recommendations

The study shows that Hetosa has ample human and animal farm power. However, these resources are not being efficiently utilized. A host of factors such as rapid population growth, poor animal feed and management, insufficient enabling environment for adoption of mechanization and land tenure insecurity were identified responsible for the limitations. Therefore, they invite future research.

In particular, rapid population growth leads to land fragmentation and animal feed shortages which altogether contribute to low agricultural productivity. Hence, an active family planning systems should be in place at national and local levels.

A workable family planning system must involve schools. Students are the future family heads and important means of rising family planning awareness in most households. Thus, the educational system should incorporate population and resource studies at various educational levels. Added to these, affordable family planning services should be provided where required.

Shortage of animal feed between March-September was identified as one of the major bottlenecks for reduced draft efficiency, overgrazing and soil degradation and low productivity. These necessitate the introduction of new and available forage production and management systems to the study area so that farmers could cope up with dry season animal feed shortages. Added to these, a system of proper animal management and their concomitant optimum utilization require immediate attention.

Regarding mechanical farm power sources, they are capital intensive and require skilled management on commercial bases in order to return the costs. This in turn demands for enabling environment. The enabling environment should include; integrating resources and power, incentives of credit, and land tenure security.

To sum up, the deepening crises of traction power call for immediate actions to reverse the dismal state of affairs to a better. The strategic means of combat should involve, among many others, a combination of wise development, management and optimum use of biological and mechanical farm power sources, effective family planning measures and concomitant development of other economic and service sectors.

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APPENDICES

Questionnaire Form No. 1 To be completed by farmers

a) Name of interviewer _____

b) Date of interview _____

c) Name of PA _____ Code _____

I) Human Aspect

1. How many family members do you have including yourself? _____

2. We would like you to provide us the following characteristics of your family and their labor contribution to different farm activities;

	Demographic characteristics					Labor contribution to farm activities in hrs\day				
Name of h.h. members	age	sex	literacy	religion	ethnic group	ploughing	Weeding	Harvesting	Threshing	Herding
a) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____
b) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____
c) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____
d) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____
e) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____
f) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____
g) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____
h) _____	___	___	_____	_____	_____	_____	_____	_____	_____	_____

3. Do you like to have more family members (children)? Yes, because they: _____

   provide labor = 1 support during old ages = 2 keep family continuity = 3 others (specify)

   _____

   No, because _____

4. Do you have shortage of human labor in farm activities? _____ Yes = 1 No = 2

5. If yes, for which of the following activities? (rank if more than one) _____

   Ploughing = 1 Weeding = 2 Harvesting = 3 Threshing = 4

6. Which of the following have you used for your farming activities? ____ wage laborer = 1

   friends and relatives = 2 labor exchange such as *debo* and *wenfel* = 3

7. How much is an average wage for a laborer per day for the following ?

   a) ploughing (____) b) weeding (_____) c) harvesting (____) d) Threshing (____)

8. How much is an average wage for an agricultural employee per year?

   a) for adult farm worker ____ b) for Young farm worker ____ c) for herd boy ____

9. Do you think applying more labor than you actually used would have increased your

   grain output? Yes, because _____

   No, because _____

10. For how many monthly saints' days are you out of work in a month? _____

11. What are other occasions which makes you out of work? _____

    _____

12. What are the activities you are engaged in during slack agricultural periods?

    _____

II) Land

13. What is the nature of your land holding? _____ concentrated =1 Fragmented =2

14. If fragmented, how many separate plots are they? _____

15. What is the size of your smallest and biggest plot in *timad*?

    a) the smallest _____ b) the biggest _____

16. How many of your farm plots are rectangular in shape? _____

17. What was the size of your land holding and use in the following years in timad?

Year	Land cultivated	Use grazing	Types total
1980	_____	_____	_____
1985	_____	_____	_____
1990	_____	_____	_____
1998	_____	_____	_____

18. Crop cultivated, farm size, and man-days used for different activities in 1996\97?

Crop type	Farm size in ha	Labor allocation per participating household in man-days ploughing	weeding	harvesting	threshing	production (Qts)
Sorghum	_____	_____	_____	_____	_____	_____
Maize	_____	_____	_____	_____	_____	_____
Wheat	_____	_____	_____	_____	_____	_____
Barley	_____	_____	_____	_____	_____	_____
Beans	_____	_____	_____	_____	_____	_____
Peas	_____	_____	_____	_____	_____	_____
Flax	_____	_____	_____	_____	_____	_____
Others	_____	_____	_____	_____	_____	_____

19. We would like you to tell us the major crops you grow, and their cropping calendar.

ploughing(p) cropping(c) weeding(w) harvesting(h) threshing (t)

Month	Jan.	Feb	Mar	Apr.	May	Jun.	Juy	Aug.	Sep	Oct	Nov	Dec
Sorghum	___	___	___	___	___	___	___	___	___	___	___	___
Maize	___	___	___	___	___	___	___	___	___	___	___	___
Wheat	___	___	___	___	___	___	___	___	___	___	___	___
Barley	___	___	___	___	___	___	___	___	___	___	___	___
Beans	___	___	___	___	___	___	___	___	___	___	___	___
Peas	___	___	___	___	___	___	___	___	___	___	___	___
Flax	___	___	___	___	___	___	___	___	___	___	___	___

20. Over the last five years has the level of your total grain output increased?

    Yes, because_____

    No, because_____

    Remained unchanged _____

21. Do you have landless family members above the age of 18? _____ Yes = 1 No = 2

22. If yes, how many are they? a) Married ____b) Dependent _____

23. How do landless persons earn their means of living? _____

24. Is your land holding sufficient to meet your family basic needs? ___ Yes = 1 No = 2

25. If no, how do you meet your family needs? _____

    _____

III) Livestock

26. How many of the following animals do you own?

    1. Oxen _____ 2. Cows _____ 3. Heifers _____ 4. Bulls _____ 5. Calves _____

    6. Donkeys ____7. Horses ____ 8. Mules _____ 9. Sheep ____ 10. Goats ____

27. How many oxen did you own in the following years?

    1998 _____ 1990 _____ 1980 _____

    1995 _____ 1985 _____ 1975 _____

28. Over the last ten years how do you comment on the size of your livestock? _____

    Increased = 1 Decreased = 2 Remained unchanged = 3

29. If your answer for no. 29 is decline, what are the reasons for the decline of livestock?

30. For which type of farm activities do you use the following animals? (Give in hrs\day)

Animals\ Activity	Ploughing	Threshing	Transportation
Oxen	_____	_____	_____
Cows	_____	_____	_____
Heifers	_____	_____	_____
Bulls	_____	_____	_____
Donkeys	_____	_____	_____
Horses	_____	_____	_____
Mules	_____	_____	_____

31. For how many days in a month do you use the following animals ?

Ploughing (P) Transportation (T) Threshing (Th)

Activities	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ox	___	___	___	___	___	___	___	___	___	___	___	___
Cow	___	___	___	___	___	___	___	___	___	___	___	___
Bull	___	___	___	___	___	___	___	___	___	___	___	___
Heifer	___	___	___	___	___	___	___	___	___	___	___	___
Horse	___	___	___	___	___	___	___	___	___	___	___	___
Donkey	___	___	___	___	___	___	___	___	___	___	___	___
Mule	___	___	___	___	___	___	___	___	___	___	___	___

32. For what purpose do you use oxen during slack agricultural periods? _____

_____

33. Do you have farm animal power problem? _____ Yes =1 No = 2

34. If yes, which animals ? _____ farm animals = 1 Pack animals =2 Both =3

35. What are your practices of solving draft power problems? _____ machine hire = 1

leasing land = 2 using ox pairing with others = 3 exchanging labor for oxen = 4

other (specify) _____

36. What are your practices of solving transport animal problems? ___ Human portage =1

Borrowing animals from friends or relatives = 2 hire = 3 others _____

37. What is the source of grazing land for your animals? _____ own plot = 1

land rented = 2 communal land = 3 other (specify)_____

38. Which of the following feed do you use for your animals? _____ Pasture =1

Stable =2 Straw =3 Hay =4 Weed and leaves =5 Others _____

39. How do you see the oxen you use presently for ploughing as compared to those of 20 years ago? These ones are stronger = 1 They are equal = 2 These ones are weaker = 3

40. Do you have animal feed problem? _____ Yes = 1 No = 2

41. How much does one timad of pasture costs ? _____

42. Seasonal variation of different feeds in volume and palatability.

(Fill using the number indicating the condition Poor = 1 Moderate = 2 Good = 3)

Feed	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pasture	___	____	____	___	____	___	____	____	____	____	____	____
Straw	___	____	____	___	____	___	____	____	____	____	____	____
Stable	___	____	____	___	____	___	____	____	____	____	____	____
hay	___	____	____	___	____	___	____	____	____	____	____	____
weeds	___	____	____	___	____	___	____	____	____	____	____	____

43. How do you respond to the feed problems of your animals? _____

_____

44. What are the effects of diminishing animal feeds? _____

_____

IV) Mechanization

45. Do you use agricultural mechanization services? _____ Yes = 1 No = 2

46. If yes, which of the following? _____ tractor = 1 thresher = 2 both = 3

47. For which type of agricultural operation do you use tractor? _____ first ploughing =1 second ploughing = 2 seeding = 3 For all = 4

48. Why do you use tractor for ploughing? _____ No oxen = 1 too large plot for oxen =2 to reduce time & labour = 3 oxen are weak =4 for better production = 5

49. Why do you use thresher? _____ Have no enough labor for cutting = 1 have no enough animal for threshing =2 to reduce time & labor =3 for better production = 4

50. How is the availability of the services? _____ More than enough = 1 Just enough = 2 too small = 3

51. How do you comment on the cost? _____ expensive = 1 moderate = 2 cheap = 3

52. Have you faced any problem in using mechanization? _____ Yes = 1 No = 2

53. If Yes, specify _____

54. If you use tractor and thresher what do you do during ploughing and harvesting?

_____

55. In what ways do you think mechanization helps farmers? _____

_____

56. What do you think are the negative effects of mechanization? _____

_____

Questionnaire form No. 2. To be completed by tractor - hire service owners

1. Name of investor _____ _____

2. Bio-data of investor a) age __b) sex __c) education ____ d) ethnic group _____

3. What type of mechanization service do you provide? a) tractor b) thresher c) both

4. When have you started giving service? _____

5. Have you got any incentive from the government in establishing the service? _____

Yes = 1 No = 2

6. If Yes, specify in what form you have received _____

7. How much land have you been allotted for the following uses? a) office _____

b) production _____ c) others _____ d) not at all _____

8. Have you faced any problem in establishing this service? _____ Yes = 1 No = 2

9. If yes, what were the problems? _____

10. How much was your a) initial _____ b) present _____ investment capital?

11. How many of the following machines do you own? a) tractors ____b) threshers _____

12. What for do you use the machines? _____ Own production = 1 Hire = 2

Both = 3 Other (specify)_____

13. We would like you to tell us the types of your machines?

I) **Tractors** Type H.P Average ploughing capacity per week (in ha)

1. _____ ____ _____

2. _____ ____ _____

3. _____ ____ _____

II) **Combiners** types H.p Average threshing capacity per week (in quintals)

1. _____ ____ _____

2. _____ ____ _____

3. _____ ____ _____

4. _____ ____ _____

14. Which type of the tractors is the best? _____

because, _____

15. Which type of the threshers is the best? _____

because, _____

16. Who operates the machines ?_____Your self =1 Family members =2 Paid driver =3

17. Where do you go to get fuel?_____Assela =1 Eteya =2 Dera =3 Own tanker =4

18. Do you have any mechanism of reducing trip to fuel the machines? If yes, specify

_____

19. Do you have your own garage for repair? _____ Yes = 1 No = 2

20. If no, where do you obtain repair and maintenance services? _____

21. Do you have spare part problems ? _____ Yes = 1 No = 2

22. If yes, how do you solve the problem? _____

23. How much was the cost of ploughing per hectare in 1996\97? a) first

ploughing _____ b) second ploughing _____ c) cropping _____

24. How much was the cost of threshing per quintal in 1996\97?

a) for cutting & threshing _____ b) for stationary threshing _____

25. How many farmers have benefited from your service in 1996\97 ? a) from tractor _____

b) from combiner _____

26. What for do you use the machines during lack agricultural periods?

a) I use tractors for _____

b)I use threshers for _____

27. In what ways do tractors and combiners contribute to the improvement of the agricultural sector? _____

28. What are the problems hindering efficient use of mechanization services? _____

Lack of access roads to plots = 1 Farm fragmentation = 2 odd shape of plots = 3

Topographic irregularity = 4 Obstacles such as stumps = 5

29. Do you have any other problem in running the service? Specify, _____

_____

30. How many workers are engaged in running your service?

Employee	male	female	total
a) Permanent	_____	_____	_____
b) Contract	_____	_____	_____
c) Daily laborers	_____	_____	_____

DECLARATION

Except where otherwise indicated, this thesis is my original work.

Name Gemeda Aleme

Signature

Date 16/6/98