ECONOMIC ANALYSIS AND POLICY IMPLICATIONS OF FARM AND OFF-FARM EMPLOYMENT: A CASE STUDY IN THE TIGRAY REGION OF NORTHERN ETHIOPIA

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To the memory of my parents
Woldehanna Kahsay (1905-1985) and
Tsehaynesh Hadgay (1928-1986)

ABSTRACT

The central item of this research is the impact of off-farm employment and income on farm households and agricultural production. The interaction between farm and non-farm activities, the adjustment of labour demand and supply, the performance of the labour market, and wage determination are analysed using a farm household model with liquidity constraints. The analysis provides a new insight into the role of off-farm income in risky and less dynamic agriculture (as opposed to dynamic and less risky agriculture).

The study shows that off-farm income can be complementary to farm income if farm households are constrained in their borrowing. Imposing liquidity constraints into the standard farm household model proves this theoretically. This is tested empirically using farm household survey data collected from Tigray, Northern Ethiopia. Farm households with more diversified sources of income have a higher agricultural productivity. Expenditure on farm input is dependent not only on agricultural production, but also on off-farm income because of capital market imperfections (borrowing constraints). Farmers involved in better paying off-farm activities such as masonry, carpentry and trading are in a better position to hire farm labour.

The wage rates for off-farm work vary across agricultural seasons and skill requirements. Hence, wage rates respond to forces of demand and supply. Increased expenditure on variable farm inputs is found to increase the demand for and supply of farm labour. The farm households have an upward sloping off-farm labour supply, but the supply of off-farm labour is wage inelastic. Due to entry barriers, relatively wealthy farm households dominate the most lucrative rural non-farm activities such as masonry, carpentry and petty trade.

Although the study focuses on Northern Ethiopia, most conclusions can have a wider application in the other parts of the country and in many of the Sub-Saharan African countries where agriculture is not dynamic and the capital market is highly imperfect.

Keywords: off-farm employment, labour market, wage determination, liquidity constraint, crop choice, marketing surplus, growth linkages, farm household model.

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CHAPTER 1. INTRODUCTION

1.1 Background

In most of the world historically, and in much of the world today, the economics of agriculture is the economics of subsistence. It is about the effort of the rural people who try to obtain the food necessary for survival from limited (and uncertain) resources such as soil, water, etc. The focus of economics is, therefore, on how individuals carry out such efforts (and how families, villages or other social entities organise their members for doing so). Economic development begins when agriculture generates production in excess of farm family requirements. Historically, the ability of agriculture to generate surplus food is credited for the creation not only of markets but also of such elements of civilisation as cities. Key innovations relating to crop and animal production, mechanisation and information, and trade and specialisation form an important part of agricultural economics research.

One of the most striking, and still to some extent controversial findings, in the economics of traditional agriculture is the wide extent to which farmers in the poorest circumstance (in the least developed countries) act consistently according to basic microeconomic principles (Schultz, 1964). Schultz shows that farmers in traditional agriculture follow economic rationality in the sense of getting the most economic value possible with the resources at hand; but innovation and investment that would generate economic growth are missing. In his view, farmers can break out of the poor but efficient equilibrium by means of investment in high-income streams – mainly physical, capital and improved production methods embodying new knowledge and investment in human capital (Schultz, 1961; Becker, 1964) that would foster innovation in technology and the effective adoption of innovations.

It is a long debated issue whether agriculture is an 'engine of growth' in which investment is an important source of economic development (Johnston and Mellor, 1961); or the other way round, whether agriculture is an economically stagnant 'sink' of labour to mobilise more productively elsewhere as the economy grows (see Timmer, 1988 for a survey). The latter issue is explicitly addressed in a dual economy model (Lewis, 1954). The dual economy approach has evolved towards a neo-

classical general equilibrium approach in which agriculture differs only in possessing a specific factor, land, resulting in price and income inelastic output, and a possibly different rate of technical progress (with no presumption that agriculture's is lower). Such a neo-classical model can account for the observed huge out-migration from agriculture (traditional sector), as has occurred in all the industrial economies (such as Japan, Taiwan and Denmark), together with increases in wage and income levels in rural areas rising towards that of urban levels (Hayami and Ruttan, 1985). But they do not provide useful guidance about the underlying stimuli to growth, or for fostering economic development in least developing countries.

In the dual economy model[1], emphasis is given to the role of a capital-intensive large-scale industry, and mechanical and commercial agriculture which results in the accumulation of capital in the modern sector and withdrawal of labour from the traditional sector. This creates a growing imbalance between agriculture and industry. It leaves little direct place for peasants, small-scale non-farm enterprises, or the poor. Agriculture is not considered to be a high priority sector for fostering growth in developing countries[2].

Because of the experience from the Indian green revolution, export pessimism and the balanced growth theory (Nurkes, 1953), agricultural development has become a priority sector in economic development. It is now considered (at least) to have equal priority with the industrial expansion (balanced growth) in the sense that agricultural and industrial development are both simultaneously to be promoted (Mellor, 1976). The purchasing power of the rural people as a valuable means to

[1] In a dual economy model (Lewis, 1954; Fei and Ranis, 1964), an economy is divided into a traditional sector (which is mainly agricultural, but also includes the rural manufacturing and trading - rural non-farm- activities) and modern (*capitalist*) sector (which includes industrial and large-scale commercial agriculture). The dual economy model argues that the transformation of the traditional sector must occur by absorbing the traditional sector into the modern sector, which is often called *transformation by displacement* (Bruton, 1985). In fact, Fei and Ranis do see a positive role for the traditional sector to play if productivity in the traditional sector can be increased, in which case expansion of the modern sector is easier and the transformation process can occur much more rapidly.

[2] This is espoused mainly by the unbalanced growth theory (Hirschman, 1958) which proposes public investment in the non-agricultural sectors, which is thought to have greater production linkages with rest of the economy. Early studies on economic linkages between sectors focused on production linkages only, namely forward and backward production linkages. Agricultural growth (subsistence agriculture) was thought not to have strong backward and foreword production linkages, hence it stimulates little new demand for intermediate inputs or new investment in down stream activities. Rural non-farm activities (traditional manufacturing and services giving activities) faced the same problem as the traditional agriculture. An anti-agriculture attitude was also encouraged by the elasticity pessimism debate on the export of agricultural products. The Malthusian concern with diminishing marginal productivity in agriculture was also a factor for the investment bias against agriculture.

stimulate industrial development (Johnston and Mellor, 1961) is recognised[3]. As a result, the attention of policy makers has shifted from a capital-intensive strategy to a rural led employment-oriented strategy (Mellor, 1976). The rural led employment-oriented strategy is intended to increase employment in agriculture (rather than withdrawing labour from agriculture) and leads to the growth of industry and trade through production (backward and forward) and consumption linkages with agriculture. This approach places agriculture at the centre of economic development. The roles of traditional sector rural non-farm activities in the development of agricultural sector via backward, forward and consumption linkages (Delgado et al., 1998; Haggblade and Hazell, 1989; Haggblade, Hazell, and Brown 1989) are also well recognised.

Linkages can also run from the traditional sector rural non-farm activities to agricultural production (Ranis and Stewart, 1987; Reardon, 1997; Evans and Ngau, 1991): demand, supply, motivational, and liquidity related linkages. Expansion of rural based manufacturing stimulates the development of markets for agricultural production, and as these markets expand, it allows agricultural producers to diversify into non-food agricultural production (*demand linkage*). Production of manufacturing goods in the traditional sector will provide the supply of inputs necessary to increase agricultural production (*supply linkage*). If farmers are engaged in rural based non-farm activities (such as manufacturing and trading), they are likely to intensify production efforts and increase agricultural productivity to provide the resources necessary for investment in the rural based non-agricultural activities. In areas where agriculture is risky, income diversification (into rural non-farm activities) for farmers will reduce the risk associated with innovation (*motivational linkage*). In a situation where insurance and credit markets are limited (or do not exist), income diversification for farmers will help to finance agricultural production (*liquidity linkage*). Hence through the interaction of farm and non-farm activities, a virtuous circle of traditional sector development can arise, but this requires further empirical evidence.

[3] The purchasing power of peasants and their families could increase when labor productivity of agriculture improves. Increases in labor productivity will increase the marketing surplus of agricultural production, which can be diverted to industrialization and development of infrastructure (through fiscal and monetary policies such as taxation or encouraging saving through monetary polices) essential for the economy as a whole at the early stages of economic development.

The concentration of non-farm sectors in a few urban areas, and the wage gap between rural and urban areas result in a huge rural-urban migration and concentration of unemployed workers in urban areas (Todaro, 1980)[4]. The rapid urbanisation and growing number of unemployment in urban areas necessitates finding a way to create jobs outside agriculture and outside cities focusing on a growth process that would boost the demand for rural non-agricultural activities. Hence creating demand in rural areas for locally produced non-food goods and services becomes an important element in the process of economic development (Bell and Hazell, 1980; Mellor, 1976).

1.2 Problem statement

Considering agriculture as the centre of economic development, governments in developing countries may intervene in the rural economy (farm and non-farm sectors) through pricing policies and investment projects. Such policies can influence production and consumption (the livelihood) of farm households. However, the manner in which agricultural households respond to such interventions and the magnitude and nature of the linkages that exist between the rural non-farm activities and the industrial sector on the one hand and the farm sector on the other hand are crucial in determining the relative merits of these policies (Singh et al., 1986; Strauss and Thomas, 1995; Strauss and Thomas, 1998).

Two main policies can be identified with a view to increasing employment and reducing poverty in Ethiopia (TGE, 1991). The first policy is to improve productivity in agriculture and promote self-sufficiency in food. Second policy is to promote investment in the rural non-farm sector in order to provide alternative income earning opportunities. The success of investments in the agricultural and industrial sectors and the extent to which the benefits trickle down to the landless and/or poor households depend on the adjustment of labour supply and demand, the smooth functioning of the labour market, and wage determination (Collier and Lal, 1986). Whether the introduction of an improved technology increases the demand for labour and whether the increased demand for labour is met from the household's own resource or from

[4] Unemployment in urban areas is also the result of wage rigidity imposed by minimum wage legislation and efficiency wage (Stiglitz, 1988).

hired labour depend on the microeconomic behaviour of farm households and the extent of market imperfection in general and on the demand and supply of labour in particular. If the labour market is highly imperfect, the transaction costs of hiring and selling labour (such as supervision and search costs, and shirking) will be very high. This will retard or hinder investment or make capital relatively cheap and eventually results in lower employment opportunities. If the transaction costs of labour make capital cheap relative to labour, investment will be more capital-intensive, which is not appropriate to the factor endowments (factor proportions) prevailing in developing countries. If the capital market is highly imperfect such that farmers are constrained with respect to liquidity and credit, the use of purchased inputs and hired labour will be very limited. This has negative repercussions on the expansion of employment and the transfer of income from landed (large farm size) to landless (small farm size) households.

Off-farm employment is thought to have a negative impact on farm income at the household level. It increases the cash resources of farm households and decreases the availability of family labour for farming activities (Burger, 1989). The demand for leisure increases (and farms income decreases) when off-farm income increases due to both a substitution effect and an income effect. However, if there is surplus labour (or farming is not able to absorb the idle family labour), off-farm employment may not have a negative impact on farming activities. In the case of surplus labour, off-farm employment may not be able to compete with farming activities for labour. If the capital market is highly imperfect and farmers are liquidity constrained, off-farm employment may help farmers to diversify their income sources and break the financial constraints they face in hiring labour and purchasing capital farm inputs (Collier and Lal, 1986). In the cases of capital market imperfection and liquidity constraints, therefore, off-farm employment may increase farm income.

One of the basic assumptions of diversifying income sources into off-farm activities is to supplement farm income for the poor and reduce income inequality in rural areas. This is because the motivation to diversify income sources into off-farm activities is higher for poor than for rich farm households (Reardon, 1997). However, if there is an entry barrier in the off-farm labour market, diversifying income sources into off-farm activities will be more difficult for poor farm households than for rich farm households. Off-farm activities may require investment on equipment purchase or rent, skill acquisition and license fees. Because of collateral requirements and

differences in repayment capacity, the credit constraint is more severe for poorer farm households than for richer farm households. The poor households face a binding credit constraint, and so can not afford the investment required in the off-farm labour market, while this would not be a problem for rich. As a result off-farm employment may exacerbate income inequality rather than reducing it.

Previous studies in Africa focus more on characterising rural micro enterprises (Liedholm, McPherson, and Chuta, 1994), and on the impact of agricultural growth on the rural non-farm economy (Haggblade, Hazell and Brown, 1989; Delgado et al., 1994; Delgado et al., 1998). The attention is on the effect of agricultural growth on rural non-farm activities rather than on the effect of off-farm income on farm income. Literature on the effect of off-farm employment on farm income mainly discusses theories and postulates hypotheses about the contribution of off-farm income to farm income (Reardon, 1997). Empirical evidence based on actual data of farm households is scarce in the literature. Empirical studies done on the effect of off-farm employment on farm income are concerned with a dynamic agricultural sector where cash crops are grown widely (Burger, 1994; Evans and Ngau, 1991). Despite the general scarcity of literature on farm and non-farm linkages, there has been no systematic study done on marginal areas in the Ethiopian context. Furthermore, analysis of the rural labour market and wage determination in Africa are scarce in the literature (Reardon, 1997), especially in Ethiopia. This forms the motivation to analyse the interaction between farm and non-farm activities, the adjustment of labour demand and supply, the performance of the labour market and wage determination in the context of Ethiopia, with particular focus on Tigray. Although the main focus is on Northern Ethiopia, most conclusions can have a wider application in the other parts of the country and in many of the Sub-Saharan African countries where agriculture is not dynamic and capital market is highly imperfect.

1.3 Objective of the book

The objective of this study is to analyse farm non-farm linkages at the household level, particularly focusing on the impact of off-farm employment on agricultural productivity and marketing surplus and on the role of off-farm employment in alleviating rural poverty. The study identifies the microeconomic determinants of labour use and allocation and assesses the factors that affect labour productivity. The

determinants of on-farm and off-farm labour demand and supply including social, cultural and economic determinants are investigated as well. The labour market is assumed to be a non-separable link between the consumption and production decisions of an agricultural household.

Specifically the objectives of the book are summarised as follows.

1 To determine the magnitude and direction of the relationship between off-farm employment on the one hand and farm income, factor inputs, marketing surplus and crop choice on the other hand.
2 To identify the factors determining farm households' demand (for total and hired farm labour) and supply of labour for farm and off-farm activities and the relative importance of these factors.
3 To evaluate the functioning of the farm and non-farm labour markets and the wage determination process.
4 To enumerate and quantify the production, consumption and labour market linkages between the farm and non-farm sectors.
5 To assess the development of and the constraints of rural small scale and micro enterprises (SME).
6 To integrate and generalise the results obtained in separate chapters, and derive policy implications.

In answering these research questions, a non-separable agricultural household model (Cailavet, Guyomard, and Lifran, 1994; Singh, Squire and Strauss, 1986; Strauss and Thomas, 1995; Strauss and Thomas, 1998) is developed. The agricultural households model is adopted to handle various problems such as a missing market for capital, transaction costs in the input and product markets and transaction cost and rationing in the labour market (De Janvry, Fafchamps, and Sadoulet, 1991; De Janvry et al., 1992). Econometric estimation of labour demand and supply equations is done accounting for the sample selection biases that might be introduced due to truncation (Maddala, 1983). The farm-non-farm linkages are analysed at a micro level (Haggblade and Hazell, 1989; Haggblade, Hazell, and Brown 1989; Reardon, 1997). In doing so, this study provides microeconomic evidence on the farm-non-farm growth linkages and the adjustment of labour demand and labour supply, which has macroeconomic policy implications (Binswanger and Deininger, 1997).

The study uses data collected from a questionnaire survey of 201 farm households for two years, 1996 and 1997, from two districts of the Tigray Region in

Northern Ethiopia and from a small informal survey of the labour market, labourers and major employers in the towns of *Mekelle*, *Quiha* and *Adigudom* (see Chapter 2 for the set-up of the questionnaire survey and the description of data). Secondary data from the government ministries such as the Central Statistics Authority of Ethiopia (CSA, 1997a, 1997b, 1997c, 1997d) and the Industry, Trade, and Transport Bureau of Tigray Regional State (ITTB, 1998) are also used.

Because of the limited panel nature of the data set, econometric models estimation was done in a cross section context. In fact the data has two observations per household which enables to use e.g. a fixed effect estimator. Fixed effect estimator helps to capture unobserved individual effects (see Deaton, 1997 for a discussion in the context of survey data). Then variables that do not change over the period of observation (such as - in our case - soil depth indicators, soil type dummy, education dummy, income diversification index, family size[5], location dummies, etc.) have to be dropped. Because of the limited panel characteristics of the data, the use of a fixed effect estimator will result in a huge loss of information. The loss of efficiency is the greatest when there are only two observations per household (Deaton, 1997, pp. 105-110). Using a fixed effect estimator means that we can not test all of the hypotheses of the book. Furthermore, fixed effect estimation results in biased estimates for most of the models which involve a limited dependent variable (Chamberlain, 1984).

1.4 Outline of the book

In addition to the introductory chapter, the book contains nine chapters. Chapters 3-8 present the analyses at household level while chapters 9 and 10 present the analyses at the regional level. Particularly chapters 5-8 are brought together to derive policy implications at a higher (regional) level. The details of the estimation results are given in the appendix at the end. The chapters are organised as follows. Chapter 2 is a descriptive chapter that helps to acquaint readers with the Tigray Region, Ethiopia, which is the area under study. It includes an overview of the region's natural, economic, social and policy environments as well as the role of governmental and non-governmental organisations in rural development. The chapter also presents the

[5] Family size changes over the period observation for only three-percent of the sample.

set-up of the sampling strategy and the description of the survey data used for the study.

In chapter 3, a model is developed that reflects the observed patterns in the sample of farm households described in section 2.3.2. A non-separable agricultural household model with missing markets for factors of production such as capital (De Janvry, Fafchamps and Sadoulet, 1991) is used. The model includes rationing and transaction costs in the labour market. Testable implications are derived for off-farm employment, hiring of farm labour and product market under transaction cost, liquidity constraint and rationing in the labour market. The links between liquidity constraints and off-farm employment are analysed.

In chapter 4, the working of farm and non-farm labour markets is analysed. The initial differences in absolute and relative factor endowments such as labour/land ratio and labour/capital ratio among farm size classes are assessed. Then the extent to which the farm labour market equalises the return to labour and land across different farm sizes is analysed. The factors that determine the hiring probability of farm labour and their relative importance are identified. We also see to what extent the seasonal character of agricultural production influences the use of hired labour. The working of the non-farm labour market is analysed based on our observation of the non-farm labour market in formal and informal interviews with labourers and major employers. Recruitment procedures and the criteria used to hire farm labour, information sources in the labour markets, the relative power of employers and employees, and wage determination are discussed. Finally, based on the farm survey data, the factors that determine the farm household members' wages and their relative importance are identified. The concepts from the competitive theory of labour markets accounting for the heterogeneity of labour and efficiency wage theory are used in analysing the labour market and wage determination.

Chapter 5 deals with the link between farm and non-farm income. Specifically, it looks at the impact of off-farm income on production technology and on the financing of farm activities. To see the impact of income diversification on production technology, Simpson's index of income diversification is constructed and used as an explanatory variable in the production function. To assess the impact of off-farm income on the financing of farming activities, the demand for variable inputs, with off-farm income as an explanatory variable, is estimated. Off-farm work participation

and off-farm labour supply (without dissagregating off-farm labour by sex or by type of off-farm activities) are also estimated in this chapter.

In chapter 6, the structural equations of demand as well as the on and off-farm labour supply of family labour, dissaggregated into male and female household members, are estimated. The demand equations for total farm labour and hired farm labour are estimated. The shadow wages of family farm labour is derived from a Cobb-Douglas production function. Finally own and cross wage elasticities and income elasticities of labour supply are calculated.

Chapter 7 deals with off-farm work dissaggregated into wage employment and self-employment. It assesses the impact of off-farm income on income inequality. The income category includes crop income, livestock income, non-labour income, and off-farm income. Off-farm income is sub-divided further into off-farm wage employment and off-farm self-employment. Off-farm wage employment is further categorised into paid development work (food for work program), non-farm unskilled wage work and non-farm skilled wage work. The Gini index of inequality and the relative contribution of income sources to total inequality for total household income and various categories of household income are calculated. The Gini elasticity of various income sources is also calculated. The factors that determine a farm household's choice among different types of off-farm work and the relative importance of these factors are analysed using a multinomial logit model. The supply of labour for off-farm wage employment and non-farm self-employment is estimated.

In chapter 8, crop choice and land and labour allocation decisions of farm households, market participation and its relation to off-farm employment are analysed. The crop choice decision is analysed using a binomial logit model for each crop. Tobit models of labour and the proportion of land allocated to each crop are estimated for each crop. In the labour allocation model, non-farm labour hours supplied is used as an explanatory variable. In the land allocation model, the level of off-farm income earned by a farm household is used as an explanatory variable. The output marketing decision of farm households is modelled in order to assess the factors that determine the probability and level of participation in the product market. In this model, farm households face a two-stage decision problem. The first is a discrete decision whether or not to trade (depending on the cost of market participation) and in which direction (either as buyer or as a seller). The second (continuous decision) is how much to trade conditional on participation as a buyer or

seller. Therefore, first the bivariate probit equations of participation as a buyer and as a seller in the product market are estimated. Using the selectivity term derived from the probit equations, the level of sales and purchase equations are estimated using 3SLS estimation method. In all cases off-farm income and farm outputs are considered as endogenous variables.

Chapter 9 brings two different, but similar issues together in order to complete the discussion of farm-non-farm income linkages. The first part deals with the problem and development of small and micro enterprises (SME) as well as the link between the farm and non-farm sectors in the Tigray Regional State. The analysis of the farm-non-farm linkages and the constraints and the development of SME is done using secondary data collected by the Central Statistical Authority of Ethiopia and the Tigray Regional Bureau of Trade and Transport. The second part deals with enumerating and quantifying the production and consumption linkages that exist between farm and non-farm sectors. For this purpose the survey data collected from a sample of 201farm household in the two districts of the Tigray Regional State is used.

In chapter 10, the link between farm and off-farm income is explicitly determined using the results from Chapter 5 to 8. The relationship between farm inputs, farm labour and marketing surplus on the one hand and off-farm employment on the other hand is analysed. The impact of an increase in family size on various categories of labour, and the role of education in the farm household's earnings and labour supply are summarised. The program and policy implications of the main findings, and suggestion for future research are discussed. Finally, the general conclusion of the book is presented.

CHAPTER 2. DESCRIPTION OF THE STUDY AREA AND THE SURVEY DATA

2.1 Introduction

Background information about the natural environment, farming system and economic policy of the Tigray Regional State in Ethiopia is provided in this chapter. A further, the description of the questionnaire survey data collected and used in this study is presented. Describing the regional (and partly the national) economic policy and farming system will help (1) to acquaint readers with Tigray Region and (2) to derive policy implication from the results presented in the proceeding chapters. Since the description of the data in this chapter is not exhaustive, additional descriptions of the data are given in each chapter whenever it is necessary. The rest of the chapter is organised as follows. In the next section, an overview of the region's natural, economic, and social conditions, and the farming systems is provided. In section three, the set-up of the questionnaire survey and the description of the survey data used for this book are presented. The chapter ends with summary and conclusions.

2.2 Overview of the region's economic policy and farming systems

2.2.1 The region's natural and social environment

Tigray Region is located in the Northern part of Ethiopia (Figure 2.1), situated between latitude $12^0 15'N$ and $14^0 57'N$ and longitudes $36^0 27'E$ and $39^0 59'E$ (BPED, 1998b). The region belongs to the African dryland zones often called the *Sudano-Sahelian* Region *(*REST/NORAGRIC, 1995). It has a common boundary with Eritrea in the north, Sudan in the west, the *Amhara* Region in the south, and the *Afar* Region in the east. The total area of the region is 80 thousand square kilometres with a total population of 3.1 million consisting of 598,004 households (in 1994). The region is divided into four zones and 35 *Woredas* (districts). On average, a district may have a population of between 17,286 to 107,332 (3,229 to 27,031 households). The average family size in the region is 4.6 in 1994, which is lower than the national average

(5.15). Each district is subdivided into *Tabia* (peasant associations). One *Tabia* consist of up to 1500 households on average. The *Tabia* is the lowest official administration unit in the region. Each *Tabia* is divided into *Kushets.* One *Tabia* can have up to eight *Kushets*. In most cases *Kushets*, not *Tabias*, own the pasture area, woodland and irrigation schemes. Eight-five percent of the population resides in purely rural areas and the other 15 % lives in towns: either in the capital city of the region, or district centres, or rural centres. There are 74 rural centres registered as rural towns: 35 of them are *Woreda* centres.

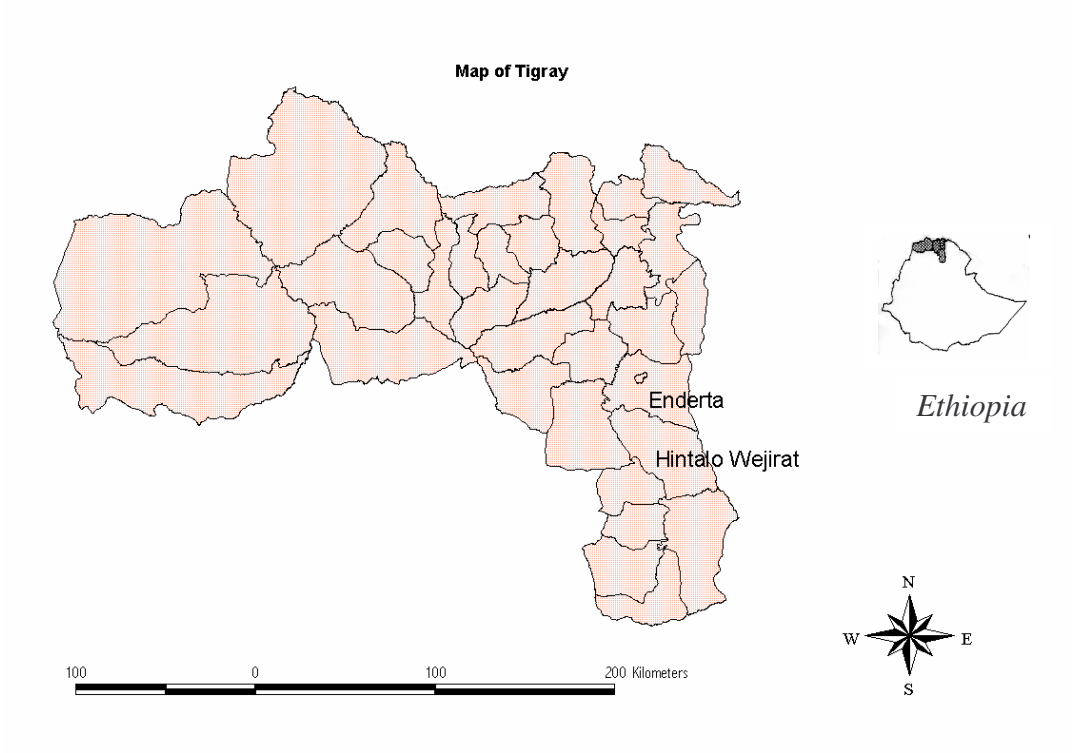


Figure 2.1 Map of Tigray Regional State, Ethiopia

The topography of the region is characterised by highly variable landforms and different altitudes (BPED, 1998b). It ranges from flat lowland to ragged and mountain plateau. The altitude of the region ranges from 500 meters in the eastern part of the region (*Erob*) to 3900 meters in the southern zone near *Kisad Kudo*. *Kiremt* (summer) is the main rainy season of the region. The rain usually starts in late June or early July. It ends in late August or early September.

The natural resources of Tigray are under extreme stress to support the over increasing population (REST/NORAGRIC, 1995). Much of the steep slopes have lost

their protective cover. They are highly overused for cultivation and grazing of livestock. Grasslands have been overexploited. Soil run-off from slopes has caused severe erosion. Most of the soil is eroded by water and wind (BPED, 1998b). The natural forest of the region has been destroyed mainly through encroachment of subsistence cultivation. Crop production and animal husbandry potential of the region has declined severely mainly due to the degradation of natural resources. Agricultural productivity has declined due to soil erosion. Aridification has increased due to clearing of natural vegetation such as forest, woodland and bushland.

The region does not have a well-developed infrastructure (BPED, 1998b). Most areas of Tigray are difficult to reach by mechanised transport. There are not enough roads to connect places and the quality of the available roads has deteriorated greatly. The regional average road density is below the national average. In 1992, the regional road density was 10.3 km/1000km^2, while the national average was 25km/1000km^2. In 1995, the regional road density became 15km/1000km^2,which was still lower than the 1992's national average road density. Until 1997, the region did not have 24 hours supply of electricity in the towns. Since May 1998, most towns located on the main highway have 24 hours of electricity supply from hydroelectricity. The supply of telephone lines and postal services is far below the level of demand and of low quality.

Farmers do not have full access to formal financial institutions such as commercial, insurance and construction banks. The financial institutions that are found in the region mostly serve only the town people. The 12 branches of the Commercial Bank of Ethiopia are located in 11 towns; two Development Banks, one Business and Construction Bank, and two private banks are located in Mekelle. These banks require collateral and involve time consuming screening processes before they provide loans to individuals.

The region does not have enough institutions to improve the educational level and technical skills of its population. Most of the schools are basic schools such as elementary, secondary and high schools. These schools lack even the basic equipment. Furthermore, the increasing number of students is not matched by a corresponding increase in the number of teachers and adequate facilities. There are three higher learning institutions that teach agriculture, engineering and business economics and administration. There are technical vocational training centres in *Mekelle*, *Korem*, *Adigrat* and *Axum* town that are run by the Bureau of Labour and

Social Affairs. There are also five technical training centres run by non-governmental organisations. Two of them, administered by TDA (*Tigray Development Association*), are designed for low-level academic background people. The other three are designed to train medium level technicians in building, mechanical fields, business and agriculture. The demand for high, medium and low level technicians in building and other mechanical fields is not yet fully satisfied. However, trainees from the schools designed for low level training have a hard time getting a job or starting their own business. This is because of financial constraints in starting their own business and the lack of information about the labour market.

2.2.2 The performance of the regional economy and farming systems

The magnitude and growth of the regional economy is given in Table 2.1. Tigray region constitutes 22% of the national GDP[1]. Agriculture is the dominant sector, both at the national and regional levels. Based on the 1995/1996 estimate, agriculture, forestry and fishing constitute 64% of the regional GDP and 90% of the employment. Industry, distributive service, and other services constitute 23%, 4%, and 9% respectively. In 1995/96, the overall regional GDP had grown by 7.3%. The distributive service sector is the fastest growing sector in the region. The second fastest growing sector is the industrial sector. The industrial sector includes, among others, the manufacturing sub sector and the large and medium as well as the small-scale industry and the handicraft sub-sub sector.

Agriculture in Tigray consists of crop husbandry, livestock husbandry and mixed farming. Mixed farming is the dominant type of farming system both at the regional and national levels (Table 2.2). The region's agricultural production is mostly for domestic consumption. Products for export include oil crops such as sesame, pulses such as horse bean and field peas, and skin and hides (CSA, 1997a). The region produces *circa* 555,320 skins and hides per year most of which is for the export market. The production of skins and hides has grown by 27% per year over the last three years.

[1] The figure appears a little exaggerated and it is hard to believe. The region's population and total area is roughly 5.6 and 7.1 percent of the national population and total area, respectively.

Table 2.1 Regional (Tigray) gross domestic product by economic activity at constant factor cost in 1994/95 and 1995/96 (in million Birr except for per capita GDP)

	Gross value		Growth rate %	
Economic activity	1994/95	1995/96	Nominal	Real
1. Agriculture, forestry and fishing	1797.6	1917.5	17	7
2. Industry	648.7	693.7	12	7
2.1. Mining and quarrying	155.0	175.7	10	13
2.2. Manufacturing	73.1	92.3	26	26
Large and medium scale	13.2	29.6	123	124
Small scale industry and handcraft	59.9	62.7	4	5
2.3. electricity and water	23.9	25.8	13	8
2.4. construction	396.7	399.8	11	1
3. Distributive service	123.4	143.4	16	16
3.1. Trade, hotel & restaurant	88.0	102.1	15	16
3.2. Transport and communication.	35.4	41.4	16	17
4. Other services	247.9	269.1	13	9
Regional GDP	2817.7	3023.7	16	7
Population (million)	3.1	3.2	2.5	
Regional Per capita GDP (Birr)	904.8	946.9	13	5

Source: Regional Bureau of planning and economic development of Tigray Region.

Table 2.2. National and regional statistics of crops and livestock husbandry (in thousands)

	National	Tigray Region
Total cropped area hectares (%)	8687 (100.0%)	484 (100%)
Temporary crops only	8114 (93.4%)	483 (99.7%)
Permanent crops only	573 (6.6%)	1 (0.3%)
Number of households (%)		
With crops only	1504 (17.3%)	107 (18.5%)
With livestock only	179 (2.1 %)	19 (3.3 %)
With crops and livestock	7030 (80.7%)	454 (78.2%)

Source: Crop utilization, Statistical Bulletin no. 152, CSA, Addis Ababa, September 1997

Farming systems in Tigray are characterised by a traditional technology, completely based on animal traction and rain-fed. Cereals are the dominant crops with pulses being of secondary importance (Table 2.3). A variety of crops such as cereals, pulses and oil crops are grown in the region. The major crops are sorghum, teff, barley and wheat. Arable land is getting scarce, leading to an extremely intensive land use pattern. Farmlands are owned and run by small farms that are divided into minor plots scattered over an extensive area. The production process is family based with little hired labour. Livestock (except for plow-oxen) play an important but secondary role (REST/NORAGRIC, 1995).

Farming activities start right after harvest, usually between September and December. Farmers plow their lands two to four times before planting depending on the type of soil and crop. The first plowing and in some places the second plowing takes place in the dry season right after harvest. The rest of the plowing activities is

done immediately after a rain shower. Planting is done from late June to early July. The plowing intensity is higher for cereals than for pulses and oil crops. The land is plowed not more than twice for legumes and oil crops, while it is plowed up to four times in case of cereals, especially for teff and wheat.

Table 2.3 National and Regional area (000 hectare) and production (000 quintals*) figure in 1995/1996

Crop Type	National			Regional		
	Area	Production	Yield qt/ha	Area	production	yield qt/ha
Cereals	6,652.56	82,697.14	12.43	436.76	4,926.92	11.28
Teff	2,097.40	17,523.75	8.35	87.88	608.27	6.92
Barley	825.54	8725.32	10.57	87.35	817.11	9.35
Wheat	882.06	10,763.04	12.20	84.55	846.53	10.01
Maize	1,280.68	25,392.92	19.83	45.05	679.63	15.09
Sorghum	1,252.41	17,226.52	13.75	96.14	1,729.68	17.99
Millet	269.35	2,413.42	8.96	35.78	245.70	6.87
Oats	45.11	652.17	14.46	*NA*	*NA*	*NA*
Pulses	904.39	8,141.44	9.00	36.91	329.27	8.92
Others	391.58	1,952.61	4.99	7.76	22.03	2.84
All Crops	7,948.53	92,791.19	11.67	481.43	5,278.22	10.96

*Source: CSA (1997a). Statistical Bulletin number 152, volume IV. NA= not available; *one quintal equals 100 kilograms*

Tigray region is relatively less productive in agriculture compared to the southern and central part of the country. Agricultural production in the region is below the national average. For example, in a good year (1996), the average yield per hectare is 1,167 kilogram at the national level and 1,096 kilogram at the regional level. The region gets a lower amount of rainfall with a higher inter-year variability of rainfall compared to the national average. While the regional average rainfall (from 1968 to 1988) is 578 mm with a coefficient of variation (CV) of 28%, the national average rainfall is 921 mm with a CV of 8%[2].

The most basic constraints for crop production are unreliable rainfall, lack of oxen for plowing, low soil fertility, and outbreak of crop pest. In the Central Zone, for example, unreliable rainfall is perceived by farm households to be the most important problem followed by crop pest and lack of oxen (REST/NORAGRIC). Lack of pasture and fodder are the main constraints in animal production. Scarcity of veterinary clinics is also an important constraint in livestock development. The revival

[2] Using CV to compare the national inter-year rainfall variability with those of regions could be misleading because the CV of the national average rainfall could underestimate the national inter-year rainfall variability.

of livestock farming after a drought period is very difficult due to the fact that a great number of cattle die during the drought period.

The growth in population has resulted in a decrease in the farm size. The average farm size in the region is 0.97 hectares. Seventy percent of the farm households in the region own less than one hectare (Table 2.4). Livestock husbandry in Tigray is constrained by a shortage of grazing land. The forage supplies come from unimproved and overgrazed pasture, and crop residue. Animal dung is used as fuel for cooking in the region, not for enriching the soil. Because of the growing population, expansion into marginal areas and areas with steeper slopes is widespread. The result has been wide loss of massive highlands due to erosion. Increasing the area of land under cultivation in the region is difficult due to land scarcity and malaria in the low land areas of the western zone. Labour absorption in agriculture can only be possible through the intensification of agricultural production and use of irrigation. Reducing the farm size would not necessarily result in underemployment if a transition can be made to intensive land use and irrigation. However, agriculture intensification and use of irrigation has been adopted at a very slow pace and it is unlikely to show faster progress in the near future. As a result, it is becoming very difficult to increase employment in agriculture. The non-farm sectors have also not yet developed well enough to absorb the growing population. The majority of non-farm enterprises are small and often one-person enterprises (CSA, 1997d).

Table 2.4 Household number ('000) and family size ('000) by the size of land holding (in hectare)

Size of holding	Number of households	Number of household members	Average household size
Under 0.1	41.8	146.3	3.5
0.1 – 0.50	199.6	841.9	4.2
0.51-1.00	161.3	823.8	5.1
1.01-2.00	127.6	687.7	5.4
2.01-5.00	36.3	221.7	6.1
5.01-10.00	4.3	*NA*	*NA*
> 10.0	*NA*	*NA*	*NA*
Total	571.3	2,754.2	4.8

*National average household size is 5.15. Source: CSA (1997a). Statistical Bulletin number 152, volume IV; * NA = not available.*

2.2.3 National and regional policy

National Policy. The 1974 revolution resulted in a series of policy measures aimed at expanding collective and state owned farm and non-farm enterprises and managing

the economy through central planning. The military government overthrew the Emperor Haileselasie and declared socialism. Consequently the government nationalised all banks, insurance companies, the industrial sector such as commercial farms and non-farm enterprises, and houses. The government implemented major land reforms so that land became state property. The government imposed restrictions so that an individual could have only one type of occupation. Especially farmers were not allowed to engage in off-farm activities. Hiring of labour was restricted. The establishment of private dealers in the labour market was considered illegal. Farmers were forced to become members of producer's and service cooperatives. These cooperatives were given priority for most types of financial assistance and extension services. Industrial products were distributed through the service cooperatives. Private traders in the rural areas were officially non-existent. The products of farmers were sold at lower prices to the marketing board through the service cooperatives.

Public institutions were given the responsibility to promote the non-farm sector. These institutions were the Rural Technology Promotion Department (RTPD) of the Ministry of Agriculture; the Handcraft and Small Industrial Development Agency (HASIDA) of the Ministry of Industry; and the Adult Training Centres (ATC) of the Ministry of Agriculture. HASIDA was in charge of issuing licenses, organising cooperatives and assisting in the marketing of products. However, these activities were limited to urban areas. RTPD was entrusted with the task of developing and promoting improved farm and non-farm tools as well as food processing and preservation of technologies, which was quite far from the needs of the peasant farmers. ATC of the Ministry of Education attempted to introduce various handicrafts, construction, and farming skills into urban and rural areas. Their efforts were, however, constrained by policy and institutional factors from the very beginning. All promotional activities were aimed at cooperatives. Individuals trained in crafts were unable to set themselves up due to lack of credit, tools, raw materials, demand and business advice.

After the collapse of the military government, a market-based economy replaced the centrally planned economy. In 1991 the coalition of rebellion groups called the Ethiopian People's Revolutionary Democratic Front (EPRDF) overthrew the military government and immediately formed the Transitional Government of Ethiopia (TGE). The TGE took new initiatives to limit the role of the government to

specific economic services, encouraging private investment, improving the bureaucracy and pursuing appropriate macro and sectoral policies (TGE, 1991).

After the formulation of the Federal Democratic Republic of Ethiopia (FDRE) in 1995, the government tried to liberalise the economy and promote investment in the agricultural and industrial sector. The FDRE intended to continue the economic policy agenda of the TGE. The present policy of Ethiopia gives emphasis to both the agricultural and industrial sectors, but with a less clear focus on the rural non-farm sector.

The main objective of the agricultural policy of the present FDRE is to ensure adequate food security by increasing agricultural production and employment. A broad based Agricultural Development-led Industrialization (ADLI) strategy (Adelman, 1984)[3] has been formulated that concentrates on three priority areas: (1) acceleration of growth through the supply of fertiliser, improved seeds, and other inputs; (2) expansion of small scale industries to interact with agriculture; (3) expansion of exports to pay for capital goods import. Under the framework of ADLI, a new system of agricultural extension, termed as participatory demonstration and training extension system, was launched in 1994/1995. It provides agricultural inputs in a package form together with extension advice.

However, the reform process, particularly the structural adjustment, has affected the institutions that were in charge of promoting non-farm activities[4]. RTPD, for instance, has been brought under the regional Bureau of Agriculture. Budget and manpower are the major problems currently facing the centres. Most of them (for example in Tigray) are still establishing themselves. HASIDA is offering technical and managerial services to small-scale industry and handicrafts. Its operations are financed through the revenue generated by charging fees for the service rendered. It is still under reform and yet its services cover only selected urban areas, and no rural areas at all. Most of the Adults Training Centres of the Ministry of Education have been inactive since 1991. In some areas (Tigray) they have been transferred to local NGOs (Tigray Development Agency, TDA).

[3] See Adelman and Vogel (1995) and Adelman, Bournieux, and Waelbroeck (1995) for further discussion on ADLI.
[4] The strategy for the small non-farm sector is not clearly mentioned in the national economic policy, it is yet to be elaborated.

Despite the liberalisation process, the ownership of land has not changed. The land is state property and farmers do not have the right to sell or buy land or give land as a gift. However, farmers are given user's rights. They can lease their holdings, hire labour and can transfer land to their children.

Regional policy. Regions (states) in Ethiopia do not have different policies as such, but their priorities can differ from one region to another. Given the national policy, Tigray Regional State focuses more on environmental rehabilitation and food security. Specifically, a conservation-based agricultural development strategy is followed. The land tenure system in Tigray is the same as the national system, that is, public ownership of land. The present land policy was first devised by TPLF (*Tigray People's Liberation Front*) and was applied first in the liberated areas of Tigray during the war against the Mengistu regime. According to the policy, a person whose livelihood is dependent on agriculture and who normally resides in the area for at least six months is entitled to have land. The land was allocated to farm households based on the size of the family (see also Table 2.4). No land distribution has been done since 1990. The regional government has recently (1997) decided to stop land distribution.

2.2.4 The role of non-governmental organisations

Non-governmental organisations in the Tigray Region are directly involved in providing technical assistance to farm and non-farm communities. These NGOs are internationally, nationally, or regionally based. The internationally based NGOs are Farm Africa, Irish Aid, World Vision, and Evangelical Church. They provide farmers with a variety of services mainly focused on agricultural development, afforestation, and soil and water conservation activities, as well as rural water supply on a project basis. They also provide credit for all income generating activities including petty trade and handicraft. However, their focus on rural non-farm activities is minimal. The nationally based NGOs are Catholic and Orthodox churches. They are engaged in a number of programs including rural afforestation and water supply programs, but do not have programs that focus on rural non-farm activities.

The regionally based NGOs are Relief Society of Tigray (REST) and Tigray Development Association (TDA). REST and TDA are more active and are engaged in more diversified activities (especially REST) than those of internationally and

nationally based NGOs. REST is the most active NGO in the region. It participates in a wide array of activities: environmental rehabilitation such as afforestation and development plantation forestry; soil and water conservation activities; rural water supply, agricultural development such as irrigation development; emergency food aid; construction and maintenance of rural roads; and development of rural credit systems.

REST's involvement in the rural non-farm sector is mainly through its rural credit and savings program. Its service is quite well distributed all over the region. They have 12 main branches and 103 sub-branches. REST provides loans for various cottages and small agro-based industry artisans engaged in rural arts, crafts, shoats, horticulture and cash crops. The specific activities for which loans are provided are: (1) crafts such as embroidery, pottery, basket making, spinning, weaving, carpentry, metal work, and especially making of agricultural implements; (2) petty trade such as buying and selling in the open market, shop keeping, barber shops, tailoring, and preparing local food and drugs; (3) agriculture such as livestock rearing, bee keeping, horticulture, and cereal production. The maximum loan amount is 5000 Birr and the minimum is 50 Birr. The duration of the loan is up to one year depending on the repayment capacity of the borrower and the nature of the activities. The loan is provided on a group basis, charging 12.5% interest which is much higher than the inflation rate[5]. The credit program of REST has improved farmers access to the financial market. However, they still can not satisfy the farm households' demand for credit.

TDA is primarily involved in improving basic education and technical training. Initially, it was also involved in the Integrated Rural Development Program. Since 1996, its focus has been on urban and rural education. TDA is financially dependent on membership contribution. They also solicit funds from international governmental and non-governmental organisations.

TDA runs four technical training centres, two in the Central Zone (*Shire* and *Axum*) and two in *Mekelle*. School dropouts, ex-soldiers, farmers, women, and individuals without jobs are allowed to join the training program. The training is given in basic construction (masonry and carpentry), metal work, woodwork, electricity and auto-mechanics. Handicraft skills such as carpet making are provided

[5] Inflation is contained below 10 percent. The average annual inflation over the last six years is 3.6 percent (MEDC, 1999).

to a limited extent. Graduates are provided with the necessary tools and credit to start their own business. However, their capacity is very limited. They have both financial and accommodation problems.

In summary, it is not clearly known either now or in the past which government organisation is responsible for the promotion of non-farm activities in rural areas particularly for those activities carried out by farm households. The Agricultural Research Centre and the Bureau of Agriculture concentrate on farming activities. The Industry and Commerce Bureaus focus on non-farm activities in the urban areas. Their activities are not well organised and do not clearly target the rural non-farm activities carried out by farm households. The Bureau of Agriculture does some activities through the Rural Technology Promotion department (RTPD) but it is not well coordinated to reach the rural areas. The Handcraft and Small Industrial Development Agency of the Bureau of Industry (HASIDA) does not target rural non-farm activities in general or rural non-farm activities carried out by farm households in particular. Substantial promotional work for farm and rural non-farm activities is done by the non-governmental organisations. The non-governmental organisations (especially REST and TDA) are more active and are better targeted at rural poor and rural non-farm activities than the governmental organisations. However, their activities still require more coordination with government organisations in order to ensure efficient assistance programs and avoid duplication of activities.

2.3 Survey setting and description of the survey data

2.3.1 Survey setting and area description

A questionnaire survey was conducted in the *Enderta* and *Adigudom*[6] Districts (see Figure 2.1 in section 2.2.1 for the location) located in the Southern Zone of the Tigray Region, Northern Ethiopia. The survey includes 201 farm households chosen randomly from a stratified sample area. The choice of the districts was not random, nor were they designed to be representative of the region as a whole. To select districts that represent the whole region, a massive survey covering all districts would

[6] *Adigudom* was formerly a district, and is now part of *Hintalo Wejirat* District.

have been required, which is far beyond the available budget and time of the research project. Instead, given the nature of the gaps in our understanding of off-farm employment and its linkage with farm employment, the present survey placed greater emphasis on depth than on coverage. The two districts were selected because of the following reasons. First, there are off-farm activities undertaken in the area. Second, there are substantial variations in the nature and availability of off-farm activities. Third, there are variations between the two districts in their access to information, market, and infrastructure facilities. However, the choice of Tabias, Kushets, and households were done randomly. The distribution of Tabias and Kushets are shown in Table 2.5. To support the survey, additional information has been collected from labourers and major employers in the off-farm labour market at *Adigudom*, *Quiha*, and *Mekelle* towns.

Table 2.5 The distribution of the sample across *district*s, *tabia*s and *kushet*s

District (*Tabia*)	*Kushet*	Sample households
1. ENDERTA		100
(Felegeselam)		35
	Ashegoda	14
	Emba	11
	Maekeladi	10
(Maytsedo)		31
	Egrihariba	11
	Embafekadu	20
(Shebta)		34
	Egrewenber	8
	Gergenbes	8
	Makel Adi	9
	Randa	9
2. ADIGUDOM		101
(Araasegda)		49
	Ara	25
	Hedmo	24
(Fekrealem)		52
	Aderak	18
	Beleat	22
	Mayifo	12
	Total	201

Farm households were selected from each Kushet proportional to the population (4.2%).

Enderta is near the central city (Mekelle) of the regional government. *Adigudom* is 40 kilometres from Mekelle. There are lots of opportunities for households to work for off-farm wage employment in *Enderta* District. This opportunity is very low in *Adigudom* District except for food for work in *Adigudom*. *Enderta* District has an annual rainfall of 625.5mm with 26% CV, and while that of *Adigudom* is 471.5mm with a CV of 49%. During the 1996 cropping calendar, *Adigudom* received an annual rainfall of 596 mm. *Enderta* received a better

distribution of rainfall in 1996[7]. In 1997, both districts received poorly distributed rainfall. In August, the amount of rainfall was 49% less than the average in *Enderta* and 70% percent less than the average in *Adigudom*.

2.3.2 Description of the data set

Information on various activities of farm households including home, farm and off-farm activities was collected using a survey questionnaire (see the outline of the questionnaire in Appendix A2)[8]. The survey data provides detailed information on seasonal labour allocation (for home, farm, off-farm activities and for each crop), income sources (crop, livestock, wage employment, off-farm self employment, non-labour income), purchase of farm outputs and inputs (including hired labour), sales of farm outputs, expenditure on the consumption of home grown and purchased goods and services, credit, household compositions, and anthropometrics. Local units are partly used for the description of the survey data set. Area is measured in *tsimdi,* which is equivalent to 0.25 hectare. Weight is measured in kilograms. Values are measured in the Ethiopian currency called *Birr*. One US dollar is equivalent to *seven Ethiopian Birr* during the survey period[9].

The main data set characterising the households is given in Table 2.6 and Table 2.7. On the average, the family size is 5.6, which is slightly above the regional (4.8) and national average (5.15). The average dependency ratio (number of dependants over family size) is computed to be 58.4%.

Farm households participate in a variety of farm, off-farm, and home activities. The farming activities include crop production, livestock husbandry and mixed farming. Mixed farming is the dominant type of farming system, and includes both crop production and animal husbandry. The proportion of farm households engaged in crop production only, in livestock husbandry only and in mixed farming are 20%, 6% and 69%, respectively. The farming technology is traditional: simple hand tools, oxen driven implements, and labour. The use of purchased capital inputs

[7] The full rainfall record of 1996 for *Enderta* District and for both *Enderta* and *Adigudom* Districts in 1997 were not available.
[8] The whole questionnaire is put at the following web site: www.sls.wau.nl/twoldehanna/. It was found too big to annex the questionnaire. The data set can be obtained from the author upon request.
[9] The official rate for US dollar is 6.98 Birr, while the black market rate for one US dollar is 7.30 Birr.

such as fertiliser, improved seeds, and pesticides is very low. Labour is the dominant type of farm input. Most of the labour input comes from the family (78%). The remaining labour comes from hired labour (15%) and shared labour (7%).

Table 2.6 Description of the data set (n=402 and values are measured in Birr)

Variables	Mean	Std. Dev.	Min	Max
Family size	5.58	2.15	1	11
Number of dependants	3.26	1.91	0	7
Age of the household head	48	11.83	25	76
Area of land cultivated (in *tsimdi*)*	7.06	4.7	0	24
Number of plots cultivated	3.65	2.11	0	14
Area of land owned (in *tsimdi*)	5.88	2.42	1	15
Number of plots owned	3.06	0.95	1	7
Value of owned farm implements	237.62	185.71	0	1,427
Value of non-farm equipment	8.13	56.34	0	700
Total livestock wealth	3,616	5,298	0	63,700
Market wage rate per hour	1.18	1.61	0.10	14.73
Food expenditure	3,003	1,517	809	15,239
Share of high value crop	0.42	0.26	0	0.99
Percent single households (divorced or widows)	13.7	-	-	-
Percent female headed households	11.44	-	-	-
Percent orthodox households	98.5	-	-	-
Percent Muslim households	1.5	-	-	-

**TSIMDI is a local area measurement unit (one hectare = 4 TSIMDIs); One USD equals seven Ethiopian Birr in 1997.*

The four most important crops in order of their importance in production and the number of households growing a crop are barley, wheat, teff and sorghum. Other crops such as lentils, vetch, linseed, and vegetables also have considerable importance. Most households grow low value crops such as oat, sorghum, finger millet, maize, barley and vetch (latyrus). The average share of high value crop is 42%. Wheat, teff, linseed, lentils, chickpea, beans and vegetables are considered high value crops. This is determined on the basis on their long-term market price in the region. While 16.2% of the households grow only low value crops, 2.2% of the households grow only high value crops.

Most farmers produce under rain-fed agriculture. The average area under irrigation is 0.01 hectare. About six percent of the farm households use irrigation to produce vegetables and some food crops. Seventy-eight percent of the vegetable-growing households are located near the centre of the region, Mekelle. Households that live further from *Mekelle* use irrigation to grow maize and pepper rather than vegetables.

Table 2.7 Description of variables – value per year in Birr- (n=402)

Variables	Mean	Std. Dev.	Min	Max
Crop output	1,962.04	1,911.46	0	15,000
Output of livestock products	497.40	681.9	0	5900
Net crop income	1,339.65	1,342.79	-1082.7	10,770
Off-farm labour income	1121	1340	0	9948
Non-labour income	271.62	902.51	0	10,000
Variable farm inputs	446.07	388.65	0	2,517
Hired farm labour input in hours	92.6	199.84	0	1486
On-farm family labour hours	491.54	325.73	0	1,968
On-farm labour hours from labour sharing	47.00	134.38	0	1,420
Total off-farm labour hours	1347	1402	0	9,920
Non-farm self-employment income	262.50	584.02	0	4000
Income from paid community work	437.89	624.34	0	5,400
Non-farm unskilled wage employ income	284.58	786.03	0	8,340
Skilled non-farm wage employ income	136.29	860.01	0	8,730
Food expenditure	3,003.21	1,516.99	808.5	15,239
Non-food expenditure	800.24	615.41	41	5,525
Labour hours supplied for paid community work	811.64	1,047.45	0	8,640
Labour hours supplied for unskilled non-farm work	385.73	1,072.48	0	9,920
Labour hours supplied for skilled non-farm work	51.66	296.43	0	2,916
Labour hours supplied for non-farm self-employ.	97.56	234.38	0	1,475
Credit received (Birr)	224.29	438.13	0	2,240

One USD equals seven Ethiopian Birr in 1997.

Farm households are involved in two types of off-farm activities: wage employment and self-employment (own business activities). Wage employment includes paid community development work (often called food-for-work), farm work, and manual work in construction, masonry, and carpentry. Self-employment includes petty trading, transporting by pack animal, fuel wood selling, charcoal making, selling fruits, making pottery and handicrafts and stone-mining. The majority of farm households participate in off-farm activities (81%). Most of the farm households work in their *Tabia* (48%) and few go outside their *Tabia* (18%) and *Woreda* (1%). Most of the off-farm works are temporary and do not require any professional qualification with the exception of masonry and carpentry. The proportion of households that do not participate in off-farm wage employment is 27.9%, and the proportion of households that do not participate in off-farm self-employment is 72.14% (Table 2.8).

In most farm households, more than one member participates in off-farm activities. For reasons of simplicity family members are categorised into four groups: household head, wife, other male member, other female member. The dominant type of off-farm work is paid development work. The household heads work in paid development work in 55% of the households, in bricks making and carpentry in 4% of the households, and in manual work in 11% of the households. The household wives work only in paid development work (34%) and other manual work (2%). Other male

members work partly for paid development work (12%) and partly for other manual work (8%). Other female members work for paid development work only (6%). The main participants in non-farm own business are household heads (80%) and household wives (12%).

Table 2.8 Farm household participation in off-farm activities

Type of off-farm activities	Participation rate (%)
Off-farm own-business	27.9
Total wage employment	71.5
Non-farm wage employment	21.6
Manual non-farm wage employment	19.2
Masonry and carpentry	3.5
Food for work	57.7
Off-farm work participation excluding food for work	43.0
Over all off-farm work participation	81

Paid development work is the dominant type of off-farm work. Unless a person is unable to work, the provision of food aid (in case of drought) is linked to the participation of households in development activities such as terracing, reforestation, dam and road construction and maintenance, and the rehabilitation of social services like clinics and schools. Regardless of crop failure, terrace construction and maintenance is done every year until the whole area that needs terracing is covered. Every person above 18 years old has an obligation to provide 20 person days per year for community development works. If a person works more than 20 days, three kilogram of wheat grain is given per person day. If the community development work is limited, priority is given to the poorer households. However, in the years 1996 and 1997, there were many micro dam constructions in the two districts. Hence, any farmer who wanted to work was able to work for paid development work.

Farm household income is composed of farm income, off-farm labour income and non-labour income. In the household's total income, farm income accounts for 57% with livestock contributing 16% and crop production 41 %. Off-farm labour income accounts for 35% and non-labour income accounts for 8% of the total income. The amount of non-labour income that households obtain is very small compared to the farm and off-farm income received. Non-labour income includes remittance (47%), food aid (20%), and gifts and inheritance from relatives (19%).

Most of the people are illiterate, and only few can read and write as a result of attendance in regular schools, adult education or church schools. In the sample, 35% of the household heads can read and write. Of these 62 % attended modern school, 9%

attended an adult education program and 29 % did not attend school. The other 65 percent of the household heads are illiterate. The illiteracy is higher for wives than for husbands.

Farm households allocate their labour between farm and off-farm activities as well as homework. The farm activities that farm households perform are plowing by the male members of the household, usually by the head; weeding and harvesting by all members of the household, and cattle keeping by male and female family members who are less than 15 years old. The off-farm activities are public unpaid work, paid community work, farm wage employment, non-farm wage employment and own non-farm business. The main activity of the household heads is farm work (88%). They also engage in off-farm wage employment (7%), working at home (8%)[10], and trading (21%). The main activities of household wives are food preparation, child caring, and water and fuel wood fetching. Most of the other male members of the households are engaged mainly in cattle keeping (52%). In Only a few households, other male members engage in farm (25%) and off-farm (5%) activities. The rest are either students or elderly people who are not able to work. Other female members are engaged in homework activities (preparing food and child caring, 17%); cattle keeping; farm work (2%) and off-farm work (2%).

Farm household heads work up to 11 hours per day for farm work and up to eight hours for off-farm work. Household wives work usually for 4 hours per day on the farm, but for 11 hours during peak agricultural seasons for weeding and harvesting seasons. However, farm households in Tigray do not work every day due to the Ethiopian Coptic-church holidays. On the average, including Saturdays and Sundays, farm households do not work for 15 days a month for farming activities and for 12 days a month for off-farm activities[11]. Violation of Christian holidays is very rare. Fifty-eight percent of the households have never violated any of the holidays. The proportion of households that violated holidays for home work is 39%, for threshing is 3%, and for harvesting and weeding is 1%. Plowing during holidays is considered a great sin, and hence no one responded to having violated holidays for plowing

[10] A household head works at home when the head of the household is female. About 11.4% of the households in the sample are female headed. All female household heads are either unmarried, widows or divorced.

[11] This means that at most a household spends 15 days per month on farm work and 18 days per month on off-farm work. In the Ethiopian calendar, one year is divided into 13 months. Each month has 30 days, except the 13th month which has 5 days (6 days in a leap year).

farmland. Furthermore, the number of holidays does not have any correlation or dependence with either the educational level or age of the household head. Farm households allocate their time partly for other social services such as church service, social ceremonies, going to towns for legal cases, shopping and other marketing activities. Most households allocate their time for social services during the holidays.

The general wealth of the households is very low. A low level of capital is involved on the farm. The types of capital involved in farming activities are small hand tools and oxen driven equipment. The modal value of agricultural equipment per household is 160 Birr. The majority of the households (96%) have their own farm implements. Almost all farm households (98%) live in their own houses. The houses are made of stone wall and mud roofs. Quite a few farm households construct the roof from tin, which is a sign of wealth in most cases[12]. Most households (53%) also have separate grain stores, made of wooden wall. Those farm households that participate in relatively skilled non-farm wage employment have their own non-farm equipment (5%). On the average, these farm households have 182 Birr worth of non-farm equipment. Other assets of farm households include household goods (64% of household) and valuables (11% of the households) such as jewellery, watch, radio etc. Most households also have separate housing for livestock, sheep, goats and donkeys (69%), which is worth on the average 347 Birr.

The level of saving is very low and sometimes negative. Most farm households usually hold their savings in the form of livestock, sheep and goats as well as grain such as teff, barley and wheat. A few farm households also store teff, barley and wheat for future sale (43%).

Almost all farm households have land because of the egalitarian type of land distribution. The land tenure system does not allow farm households to sell their land. Nevertheless, it allows farm households to lease out their land. Consequently, 11% of the households do not cultivate land. The size of land holding is very small and the land is divided into many parcels. On the average land cultivated per household is seven *tsimdis* (1.75 hectare), which is higher than the regional average (see Table 2.4). The proportion of farm households in the sample who rent land is 45%, and those who rent out land is 17%.

[12] Some houses have roofs made of mud, which are more expensive than roofs made of tin.

There are only few opportunities for farm households to borrow money for farm and non-farm activities. The main suppliers of credit are public financial institutions. Credit is given for off-farm activities on a group basis by the Relief Society of Tigray, REST. Most of the farm credit is tied to farm inputs, but the public financial institutions do not provide credit to hire farm labour (Table 2.9). Private supply of credit and credit for consumption is almost absent. The suppliers of credit for consumption purposes are individual moneylenders and relatives. The proportion of farm households who receive credit from the extension program is 37%, from private moneylenders 2% and from relatives 1%. The credit obtained from the extension program is used for the purchase of fertiliser and oxen. Most farmers do not want to take credit from the extension program (52%) because it is closely tied to the purchase of fertiliser. While 14% of the households do not take credit because they fear they can not repay it, 17% of the households want to take credit but they do not have access to credit. The demand for credit is satisfied for only 17% of the households.

Table 2.9. Reasons for farm household to receive credit

Reasons to borrow	Percent of farm households*
To buy farm implements	0.7
To buy seeds, fertiliser, and pesticides	23.1
To by oxen and livestock	12.7
To hire farm labour	0.0
To pay rent, tax and loans	1.0
To start off-farm business	1.5
For consumption	2.5
Not received loan at all	61.0

** They do not add up to 100 because farm households were allowed to respond to more than one reason.*

A farm household tends to be risk averse since the area is drought prone. About fifty-six percent of the farm households fear that there will be crop failure, of which 84% fear that very much and the rest 16% fear that moderately. When households face crop failure the coping mechanisms are looking for off-farm work, selling household goods and cattle, looking for food aid, and migration.

The majority of the farm households participate in the market through the sale and purchase of grains and livestock products. They sell and buy cereals, pulses, oil crops, vegetables and livestock products (Table 2.10). The crops sold by farm households are wheat, barley, and teff. Most of the produced vegetables are sold on the market although only few households grow it. In the grain market, 44% of the

farm households sell part of their output for the market in a good year and 56% of the households do not sell their output even in good years. The average level of commercialisation (defined as the ratio of output sold to output produced) at household level is 14%. The proportion of autarkic farm households is 4% (neither sells nor buys food products), the proportion of net buyers is 61% and net sellers 35%. In livestock husbandry, only 35% of the households sell livestock products to the market. These products include milk, butter, eggs and chicken. The level of commercialisation in the livestock husbandry is 14.5%. Most farm households are net buyers in both the grain (61%) and livestock product markets (69%). Two percent of the farm households are autarkic, 69% are net buyer and 28% are net sellers. In general farm households' participation in the market is higher in the grain market than in the livestock product market. The participation of farm households is lower in the input market than in the output market. The proportion of farm households that hire farm labour and purchase variable capital inputs is 39% and 32%, respectively.

Table 2.10 Distribution of household meeting their consumption through Purchase

	% of FHH purchase	Ratio own-produced consumption to total cons. %	Ratio purchased cons. to total cons. %
Cereals	45	78	13
Pulse	71	51	46
Oil	23	31	69
Animal products	96	61	37
Beverage	48	60	40
Coffee, tea and sugar	96	1	96
Salt, spices and pepper	97	2	96

FHH stands for farm households

The majority of farm households are actively engaged in the labour market as sellers and buyers of labour services (Table 2.11). Seventy-two percent of the households sell labour and 40% hire labour. Only 10% of the farm households are not involved in the selling and hiring of farm labour. Farm households can be categorised into four labour regimes, namely labour selling, labour buying, both labour buying and selling, and autarkic (neither sell nor buy). Most of the farm households are in the labour-selling regime in all seasons. The percentage of farm households in the labour-selling regime is highest during the slack season (plowing period). The percentage of farm households in the labour-selling regime is lowest during harvesting. Most of the hiring of labour is done during the harvesting season. The percentage of labour-hiring households is lowest during the slack season. A considerable proportion of farm

households is engaged in both the labour selling and labour hiring regimes, especially during the harvesting seasons. A small proportion of farm households is also involved in the autarkic labour regime. Farm households that are involved in the skilled non-farm labour market hire more labour than the farm households that are involved in manual work (Table 2.12). Those involved in non-farm self-employment also have a substantial role in the hiring of farm labour.

Table 2.11 Classification of farm households by labour regimes (%)

Type of labour regime	wage employment only	Wage and non-farm self-employment
1. Total		
Selling and hiring	25.6	30.8
Selling only	46.5	50.00
Hiring only	14.2	9.0
Neither sell nor hire (autarkic)	13.7	10.2
2. Seasonal		
2.1. Plowing period		
Selling and hiring	4.7	6.0
Selling only	66.4	74.1
Hiring only	4.5	3.2
Neither sell nor hire (autarkic)	24.4	16.7
2.2. Planting and weeding		
Selling and hiring	12.2	13.4
Selling only	57.7	62.0
Hiring only	11.2	10.0
Neither sell nor hire (autarkic)	18.9	14.7
2.3. Harvesting and threshing		
Selling and hiring	13.7	17.2
Selling only	38.8	42.8
Hiring only	20.4	16.9
Neither sell nor hire (autarkic)	27.1	23.1

The consumption of farm households (total expenditure) includes food crops (such as cereals, oil crops, pulses), beverages (such as alcohol, coffee and tea), salt, paper, spices, sugar, and honey as well as household goods, clothing, ceremonial expenditures, taxes and contributions to governmental and non-governmental organisations (Table 2.13). Most of the consumption expenditure is on food grains. While the expenditure on food accounts for 79% of the total household expenditure, expenditure on food grains accounts for 49% of the total household expenditure. Of the total expenditure on cereals, 13% is purchased from the nearby market, and the rest comes from their own harvest and food aid. Most of the consumption expenditure on pulses and oil crops comes from purchases. Almost all consumption expenditure on beverages (coffee and tea), honey, and salt results from purchases.

Table 2.12 Proportion of farm households who hired farm labour under different off-farm activities

Type of off-farm activities involved	% hiring farm labour
Food for work	31
Unskilled non-farm work	30
Skilled non-farm work	79
Non-farm self employment	46

The distribution of private expenditures within the household appears to be not biased against females. The average private expenditures of women and girls are higher than that of men and boys, respectively. Expenditures on household equipment, tax, religious and other ceremonies are public in nature; and expenditures on food, clothing, cosmetics and entertainment are private in nature. Since household members eat together from one plate, it is very difficult to know the distribution of food expenditures across household members. However, we were able to identify the intra-household distribution of expenditures on clothing, cosmetics, entertainment and other private expenditure (Table 2.13).

Table 2.13 Distribution of expenditure (in Birr)

Type of expenditure	Mean	Std dev	Min	Max
Total expenditure	3803.45	1822.32	1076.5	15484
Food expenditure	3003.21	1516.99	808.5	15239
Cereal	1857.19	1220.74	325	14440
Pulses	191.05	137.64	0	1973
Oil	13.56	31.68	0	260
Animal products	406.34	443.86	0	4305
Vegetables	3.67	7.95	0	60
Coffee, sugar, tea, salt, spices	531.41	311.61	0	1825
Other expenditure (total –food expenditure)	800.24	615.41	41	5525
Public goods (durable)	17.58	35.98	0	308
Other public goods (social expenditure).	196.61	325.09	0	3585
Private expenditure of men	150.17	161.43	0	1456
Private expenditure of women	296.17	184.62	0	1320
Private expenditure of boys	64.79	91.80	0	700
Private expenditure of girls	74.92	109.87	0	600

2.4 Summary and conclusions

The growth in population has reduced farm size. Crop production in the Tigray region is highly constrained by moisture and soil fertility. Livestock husbandry is constrained by the shortage of grazing land. Due to the growing population, expansion into marginal and steeper slopes is widely practised. Increasing the area of cultivated land in the region is not possible due to land scarcity. The reduced farm size need not necessarily result in underemployment since more intensive land use and irrigation

agriculture can ease the pressure on land. However, the adoption of agricultural intensification and use of irrigation is very slow and it is unlikely to show faster progress in the near future. Hence, it is risky to rely only on the agricultural sector for employment opportunities. Also the non-farm sectors have not yet developed sufficiently to absorb the growing population. It is not clearly known now or in the past which government organisation is responsible for the promotion of non-farm activities in rural areas particularly those activities carried out by farm households.

To provide dependable employment opportunities for the rural people, promotion of off-farm activities is a very reasonable option. However, the nature and determinants of off-farm activities and their link to farming activities are not well known. Furthermore, no systematic study has been done so far on off-farm activities in the country in general and in the region in particular (see Chapter 1). Hence it is not clear how the promotion of off-farm employment is related to the national policy of the Agricultural Development-Led Industrialization (ADLI) in general and to the objective of food self-sufficiency in particular.

Farm households participate in three types of farming activities in the region: crop production, livestock husbandry and mixed farming. Mixed farming is the dominant type of farming system, and includes both crop production and animal husbandry. Most farmers produce under rain-fed agriculture with very limited use of irrigation. The majority of the farm households participate in the market through the sale and purchase of grains and livestock products. They are, however, still at a subsistence level. Most of the farm households are net buyers in the product market and net sellers in the labour market. Most of the production is for own consumption. Farm households engage substantially in off-farm activities.

The general wealth of the households is very low. A low level of capital is involved on the farm. Capital involved in farming activities is in the form of small hand tools and oxen driven implements. There are only few opportunities for farm households to borrow money for farm and non-farm activities. The main suppliers of credit are public financial institutions. Credit is given for off-farm activities on a group basis by the Relief Society of Tigray, REST. Most of the farm credit (public) is tied to farm inputs, but is not available for the hiring of farm labour and consumption purposes. Private supplies of credit and credit for consumption purposes are very limited. The suppliers of credit for consumption are individual moneylender and relatives.

Policies designed to increase self-sufficiency in food and alleviate rural poverty and unemployment must take the microeconomic behaviour of farm households into consideration. In order to assess the microeconomic behaviour of farm households, therefore, a farm household model that combines production and consumption decisions needs to be used. Most of the farmers face a liquidity constraint for purchasing farm inputs. Rationing prevails in the labour market, and transaction costs are involved in the labour, input and output markets. So the farm household model to be developed should be able to handle these specific features.

CHAPTER 3. AN AGRICULTURAL HOUSEHOLD MODEL WITH INCOMPLETE MARKETS: THEORY AND IMPLICATIONS

3.1 Introduction

Modelling of the farm household economy requires not only a model that uses both consumption and production theory simultaneously, but also a model that incorporates transaction cost and rationing in the labour market. An agricultural household model incorporates the agricultural producer, consumer and the labour supply decision of an agricultural household into a single unit (Singh et. al., 1986). It is versatile in the sense that it can model a range of units from purely subsistence farm households to commercial family farms Nakajima (1969, 1986). However, the capital, product, input and labour markets in developing countries are usually partial or incomplete (De Janvry et al., 1991). Farm households are typically characterised by differential endowments of labour and assets that influence their family labour supply (farm or off-farm based on differential labour skill) and their demand for farm labour (depending on land, fixed asset and liquidity constraints). As a result farm households could sell labour service, hire farm labour, or opt for labour self-sufficiency. The labour market they deal with may involve large transaction costs so that the effective wage received when selling labour may diverge significantly from the effective wage paid when hiring labour, thus creating a wide idiosyncratic price band around the market wage (De Janvry et al., 1991). Furthermore, farm households could have differential access to off-farm activities if there is rationing and entry barriers in the off-farm labour market. Therefore the farm household model must be amended to handle transaction cost and rationing in the labour market.

The presence of transaction cost and rationing in the labour market has important consequences for the analysis of labour allocation decisions. If farm households are fully integrated in the labour market (for purchase and sale of labour), family labour can be substituted for by hired labour and the opportunity cost of family labour is the effective wage received when they sell labour and pay the wage for labour employed. If there is no market failure, the production decision can be taken independently from the consumption decision. The solution to the household model is

recursive, with production being solved before the consumption problem, and the two are linked through the income level achieved in production (Singh et al., 1986). If, in contrast, the household is self-sufficient in labour or not fully integrated with the labour market due to rationing and liquidity constraints, the production and consumption (include leisure) decisions are linked; and hence the production and consumption decision must be considered simultaneously. The determinants of consumption choices need to be included in the analysis of the production decision mainly in the crop choice decision. Differential labour integration by farm households implies differential response to policy interventions that affect the market wage, transaction costs, liquidity constraint (credit provision), and rationing of labour (employment creation).

Farmers in Ethiopia, particularly in Tigray, can be considered as farm households, which are not fully integrated into the market. As indicated in the previous chapter, households consume most of the crops produced and are net buyers. Only 35% of the farmers are net sellers and eight percent are neither sellers nor buyers (autarkic) in the grain market. Farmers use a traditional type of agricultural technology composed of small hand tools and oxen driven farm implements. The use of purchased capital input such as fertiliser, improved seeds and pesticides is very minimal. The dominant type of farm input is labour. Most of the farm labour comes from the family members and the use of hired labour is very limited. Farm households responded in the survey that their demand for credit is not fully satisfied. Private supply of credit and consumption credit is almost absent. The available credit is supplied by public organisations and is strongly linked to extension activities. Farm households have limited access to off-farm work and are particularly rationed in the non-farm labour market. Their participation in the off-farm labour market is mostly limited to paid development work such as ‘food for work program’.

As seen from the data in chapter two, all household members eat from the same plate. The distribution of private expenditure within the household does not show any discrimination against women and children. In traditional societies, moreover, it may be very hard to believe that bargaining (collective models) drives labour divisions within the household. Rather, the social norms, religion and customs may motivate it (Jones, 1986, p. 105). The most important issue seems rather the integration of farm households with the product, inputs and labour markets. Hence the

focus in this study is on the transaction costs and rationing in the labour and other input markets rather than focusing on the intra-household issues.

Farm household models that have been developed so far (Singh et. al., 1986) cannot handle all the problems facing an area-specific farm household economy. They do not handle transaction costs in the product, input and labour markets, a liquidity constraint, and rationing in the labour market simultaneously. The objective of this chapter is, therefore, to model and derive testable hypotheses about a household's choice to work on and/or off the farm given transaction costs in the product, input and labour market as well as rationing in the labour market. Specifically, the objectives are as follows. First, to derive testable implications for off-farm employment, hiring of farm labour, and product market under transaction costs, liquidity constraint and rationing in the labour market. Second, to analyse how the liquidity constraint creates a link between farm and non-farm income. A model is developed to mimic the observed patterns in the sample of farm households described in the previous chapter. It uses a non-separable agricultural household model with imperfect market for labour, outputs and inputs (De Janvry et al., 1991). The novel element is that the model includes rationing and transaction cost, specifically, in the labour market.

The rest of the chapter is organised as follows. In the next section, the theory of farm households with an imperfect market is presented. In section three, testable implications for the product, input and labour markets are derived. The chapter ends with some concluding comments.

3.2 Farm household modelling: theoretical background and analysis

Basically there are two classes of household models: unitary and collective household models. The collective model includes the non co-operative model (Bourguignon, 1984; Ulph, 1988; Lunderberg and Pollak, 1993), the efficient co-operative model (Chiappori, 1992) and the Nash bargained co-operative model (Manser and Brown, 1980; McElroy and Horney, 1981; McElroy, 1990). The unitary household model includes separable and non-separable agricultural household models (Alderman et al., 1995; Chiappori, 1992). The unitary models in general represent a household as though it is a single individual and as a unit of decision making in the production and consumption decisions. The advantage of following this model is that it fits exactly into the familiar consumer choice framework and fulfils integrability so that it is

possible to recover the preferences from market behaviour (reduced form equations). However, there are some serious difficulties with this type of models (Chiappori, 1992). The first problem is that it violates the basic rule of neo-classical microeconomics analysis which is based on the requirement that individuals have to be characterised by their own preferences (individualism) rather than being aggregated within the decision unit, the household. The second problem is that it considers a household as a black box such that nothing can be said about the internal decision process (Alderman et al., 1995). The collective model relaxes these assumptions and treats individuals as the unit of decision making rather than the household[1]. Empirically, however, this requires a considerable amount of data to be collected for each member of a household and hence is not realistic given the data set available nowadays (Kapteyn and Kooreman, 1992). It is also difficult and costly to collect accurate information from survey on the distribution of resources within the household.

In separable agricultural household models, the production and consumption decision of a farm household can be modelled as being separable (Singh et. al., 1986) under some restrictive assumptions. The assumptions are that there are perfectly competitive markets for labour and other inputs and outputs, the family and hired labour are perfect substitutes in production, and that there is no specific disutility associated with working off the farm. Under the separability assumption, the decision can be made in two stages (Benjamin, 1992; De Janvry et al., 1992). First, a household decides how much total labour to use on its farm so as to maximise profits from production without any consideration of its consumption or leisure preferences. Second, based on its farm profits and the market prices and wages, it decides how much to consume, how much labour to supply, and how much labour to hire. Thus under separability, the market wage provides an exogenous measure of the value of family labour time, irrespective of whether they work on or off the farm. The production decision of the household influences family labour supply only through the income effect of changes in farm profits.

In a non-separable household model, production and consumption decisions are interrelated. The non-separability of production and consumption decisions might

1 See Chiappori, 1992 and Alderman et al., 1995 for an excellent review and exposition of unitary and collective household models; and Hoddinot and Haddad (1994) for implications.

arise for several reasons. Binding constraints in off-farm employment may prevent complete adjustment in the agricultural labour market (Singh et. al., 1986; Ozane, 1992; Benjamin, 1992). Family and hired labour may be imperfect substitutes in agricultural production (Jacoby, 1993, Skoufias, 1994). Farmers may have preference towards working on or off the farm (Lopez, 1986). Farmers may also be rationed in the credit market (Stiglitz and Weiss, 1981) and the interest rate charged to the household may depend on how much they borrow as well as on household characteristics (Singh et al., 1986). Farmers may be risk-averse (Moscardi and De Janvry, 1977; Dillon and Scandizzo, 1978; Binswanger, 1980) so that the expected utility of profit is maximised (Roe and Graham-Tomasi, 1986). Moreover, markets may fail for some particular product, or for certain inputs and households (De Janvry et al., 1991). Under any of the preceding circumstances, the production and the consumption decisions of farm households can be treated as non-separable in the sense that not only production decisions affect consumption decisions, but also consumption decisions (preference) affect the production decisions. Furthermore, labour supply choices cannot be considered independent of the labour used on the family farm and vice-versa (Singh et al., 1986).

In this study, a non-separable agricultural household model is used for the following reasons. In traditional societies, it is very hard to believe that bargaining (collective models) drive divisions of labour within the household. Rather, social norms, religion and customs in traditional society govern division of labour within the household (Jones, 1986, p. 105). It is also very difficult and costly to collect information on the intra-household resource distribution. Field observations and the available data on individual expenditure within the household do not support the existence of bargaining within the household (see chapter two). Therefore a unitary household model in which production and consumption decisions are inter-related is used. It is assumed that the resource distribution within the household is governed by social norms and cultures and is given for the household.

The agricultural household model developed here is mainly aimed at capturing farm households' decisions to allocate labour for farm and off-farm activities under transaction costs and rationing in the labour market. Farm households follow a utility function (U) composed of a vector of consumption goods (C), Leisure (H) and a taste shifter (a), which includes, for example, age, education, and other characteristics:

$$U = U(H, C; a) \quad (3.1)$$

The utility function is assumed to be quasi-concave, continuous and non-decreasing in consumption goods and leisure. The level of utility attainable by the farm household is subject to the constraints imposed by: its resource endowments, cash (liquidity), the production technology, household time, rationing in the labour market, and the equilibrium condition for goods (commodity balance).

The farm production technology is represented by a closed, bounded and convex production possibility set (Q):

$$Q(q, X, L_h, A, K, L_f, Z) \geq 0 \quad (3.2)$$

where, q_i represents the i^{th} output; X represents farm variable capital farm inputs (such as seeds, fertiliser and pesticides), L_h is hired farm labour; L_{fi} is on-farm labour hours supplied by the household to output (crop) i, K is the capital employed on the farm, A_i is the land allocated for crop i, Z indicates farm characteristics such as soil type and location.

Hired labour is paid a wage rate (denoted as w_h) and it involves supervision cost (*sp).* The supervision cost of hired labour is decomposed into supervision time cost (*sph*) and supervising cash cost (*spc*).

Land is assumed to be given and fixed for the household. The sum of land allocated for each crop (A_i (i=1, 2, 3, . . ., . I)) is equal to the total area of land the household cultivates:

$$\sum_{i=1}^{I} A_i = A \quad (3.3)$$

Labour allocated for each crop *(L_{fi})* is equal to the total on-farm family labour supplied: $\sum_{i=1}^{I} L_{fi} = L_f$

The farm household sells labour for off-farm work at the market wage rate *(w_m).* The market wage is determined by the off-farm labour demand or off-farm wage equation (wage offer equation): $w_m = w(ED, SK, LC, FC)$. The market wage rate depends on the marketable human capital (Mincer, 1974; Huffman, 1991) such as education (*ED*), skill and experience (*SK*); local labour market characteristics (*LC*) and family characteristics (*FC*), but is independent of the hours worked.

Off-farm work involves transaction cost *(tc)* such as commuting, search and information cost. The transaction in the off-farm labour market can be decomposed

into transaction time cost *(tch)* and transaction cash cost *(tcc)*. The farm household faces rationing and an entry barrier in the off-farm labour market such that the level of labour allocated for off-farm work is less than or equal to the level of off-farm labour willing to be allocated, L_{mp}:

$$L_m \leq L_{mp} \tag{3.4}$$

The household allocates its endowment of time (T) among farm work, off-farm work, leisure, supervising hired farm labour, and transacting in the off-farm labour market:

$$\sum_{i=1}^{I} L_{fi} + L_m + H + L_h.sph + L_m.tch = T\,. \tag{3.5}$$

The household's endowment of time is dependent on family size (FS) and number of dependants (NDS). It increases with family size and decreases with the number of dependants.

The household incurs marketing cost (d) such as transport and information cost when buying and selling farm outputs (Omamo, 1998).

The cash constraint[2] that the household faces is

$$\sum_{i=1}^{I}[P_i s_i - d_i s_i] + w_m L_m + v - \sum_{j=1}^{J}[P_j b_j + d_j b_j] - P_x X - w_h L_h - tcc.L_m - spc.L_h \geq 0 \tag{3.6}$$

where P_i is the price of the i^{th} farm output; P_j is the price of the j^{th} consumption good; v is non-labour income, d is marketing cost such as transport and information costs in the sale of farm output and purchase of consumption goods, s is the quantity of farm output sold, b is the quantity of consumption goods purchased; and P_x is the price of variable capital farm inputs.

The following equilibrium condition (commodity balance) must hold for all n goods for the combined set of I farm outputs (q_i) and J consumer goods (C_j).

$$C_n = q_n + b_n - s_n \tag{3.7}$$

The non-negativity constraints are given by

$$C_j \geq 0\,;\, b_j \geq 0;\, q_i \geq 0;\, s_i \geq 0;\, A_i \geq 0; L_{fi} \geq 0\,;\, L_m \geq 0\,;\, H \geq 0;\, L_h > 0;\, X \geq 0 \tag{3.8}$$

[2] Later on we shift to the wording 'liquidity constraint', but without focusing on a credit constraint. For the treatment of liquidity constraint including credit, see Eswaran and Kotwal (1985a, 1986) and Dasgupta (1993, pp.257-259) in which they relate a liquidity constraint with land holding. However, the association of liquidity constraint with land holding may not apply in areas where there is an egalitarian type of land distribution among farm households.

Prices (P_i, P_j *and* P_x), w_h, and marketing costs (d_i) are given.

The household, therefore, chooses the level of consumption goods, purchase of consumption goods, farm and off-farm hours or leisure, quantity of inputs and outputs, sale of farm output in order to maximise utility (3.1) given the constraints (3.2)-(3.8). The lagrangian expression associated with the constrained maximisation problem is given by:

$$\begin{aligned} L \;=\; & U(H,C;a) + \psi\left[Q(q,X,L_h,A,K,L_f,Z)\right] \\ & \lambda\left[\sum_{i=1}^{I}[P_i s_i - d_i s_i] + w_m L_m + v - \sum_{j=1}^{J}[P_j b_j + d_j b_j] - P_x X - w_h L_h - tcc L_m - spc L_h\right] \\ & + \delta\left[A - \sum_{i=1}^{I} A_i\right] + \gamma\left[T - \sum_{i=i}^{I} L_{fi} - L_m - H - L_h\, sph - L_m\, tch\right] + \mu\left[L_{mp} - L_m\right] \\ & + \sum_{n=1}^{N} \eta_n\left[q_n + b_n - s_n - C_n\right] \end{aligned} \tag{3.9}$$

where λ and γ are the lagrangian multipliers for the marginal value of household's cash (or the marginal utility of liquidity) and household's time, respectively; μ is the lagrangian multiplier for the rationing of labour i.e. the shadow value of additional off-farm jobs available; η_n is the shadow value of commodity balance for good *n*; ψ is the marginal utility of the technology constraint, and δ is the shadow value of one unit of land. The Kuhn-Tucker conditions for the interior solutions (except for specific outputs, sales, purchases, crop specific land and labour, off-farm work, and hired farm labour) are[3]:

$$\frac{\partial L}{\partial C_j} = \frac{\partial U(.)}{\partial C_j} - \eta_j = 0 \tag{3.10}$$

$$\frac{\partial L}{\partial H} = \frac{\partial U}{\partial H} - \gamma = 0 \tag{3.11}$$

$$\begin{cases} \dfrac{\partial L}{\partial q_i} = \eta_i + \psi Q_i'(.) \le 0 \\ q_i \ge 0 \text{ and } q_i^*(\eta_i + \psi Q_i'(.)) = 0 \end{cases} \tag{3.12}$$

$$\begin{cases} \dfrac{\partial L}{\partial s_i} = \lambda(P_i - d_i) - \eta_i \le 0 \\ s_i \ge 0 \text{ and } s_i^*(\lambda(P_i - d_i) - \eta_i) = 0 \end{cases} \tag{3.13}$$

[3] See Chiang (1984, pp. 726-728) for the interpretation of the Kuhn-Tucker conditions.

$$\begin{cases} \dfrac{\partial L}{\partial b_j} = -\lambda(P_j + d_j) + \eta_i \le 0 \\ b_j \ge 0 \text{ and } b_j^*(-\lambda(P_j + d_j) + \eta_i) = 0 \end{cases} \tag{3.14}$$

$$\begin{cases} \dfrac{\partial L}{\partial A_i} = 0 \Rightarrow \psi \dfrac{\partial Q(.)}{\partial A_i} - \delta \le 0 \\ A_i \ge 0 \text{ and } A_i^* \left(\psi \dfrac{\partial Q(.)}{\partial A_i} - \delta \right) = 0 \end{cases} \tag{3.15}$$

$$\frac{\partial L}{\partial X_1} = \psi \frac{\partial Q(.)}{\partial X} - \lambda P_x = 0 \tag{3.16}$$

$$\begin{cases} \dfrac{\partial L}{\partial L_{fi}} = \psi \dfrac{\partial Q(.)}{\partial L_{fi}} - \gamma \le 0 \\ L_{fi} \ge 0 \text{ and } L_{fi}^* \left(\psi \dfrac{\partial Q(.)}{\partial L_{fi}} - \gamma \right) = 0 \end{cases} \tag{3.17}$$

$$\begin{cases} \dfrac{\partial L}{\partial L_h} = \psi \dfrac{\partial Q(.)}{\partial L_h} - \lambda(w_h + spc) - \gamma\, sph \le 0, \\ L_h \ge 0 \text{ and } L_h^* \left(\psi \dfrac{\partial Q(.)}{\partial L_h} - \lambda(w_h + spc) - \gamma\, sph \right) = 0 \end{cases} \tag{3.18}$$

$$\begin{cases} \dfrac{\partial L}{\partial L_m} = \lambda(w_m - tcc) - \gamma(1 + tch) - \mu \le 0, \\ L_m \ge 0 \text{ and } L_m^* \left(\lambda(w_m - tcc) - \gamma(1 + tch) - \mu \right) = 0 \end{cases} \tag{3.19}$$

$$\frac{\partial L}{\partial \mu} \ge 0 \quad \mu \ge 0 \text{ and } \mu \frac{\partial L}{\partial \mu} = 0 \tag{3.20}$$

$$\frac{\partial L}{\partial \lambda} = \sum_{i=1}^{I} [P_i s_i - d_i s_i] + w_m L_m + v - \sum_{j=1}^{J} [P_j b_j + d_j b_j] - P_x X - w_h L_h - tcc.L_m - spc.L_h = 0 \tag{3.21}$$

$$\frac{\partial L}{\partial \gamma} = T - \sum_{i=i}^{I} L_{fi} - L_m - H - L_h.sph - L_m.tch = 0 \tag{3.22}$$

$$\frac{\partial L}{\partial \psi} = Q(q_i, X, L_h, A, K, L_f, Z) = 0 \tag{3.23}$$

$$\frac{\partial L}{\partial \eta_n} = q_n + b_n - s_n - C_n = 0 \tag{3.24}$$

$$\frac{\partial L}{\partial \delta} = A - \sum_{i=1}^{I} A_i = 0 \tag{3.25}$$

The superscripts * indicate the optimum level.

Given the assumptions of the utility function and production possibility set, and that the other inequality constraints are linear, the Kuhn-Tucker conditions are both necessary and sufficient conditions for the maximisation of the objective function (Chiang, 1984, pp. 738-740).

Equation (3.10) show the optimality condition for consumption goods. It depends on the marginal utility of the commodity balance. Equation (3.11) and (3.17) are conditions that must be met for optimal allocation of the household's time. Equation (3.11) is equality because households are assumed to have positive leisure time. Equation (3.12) and (3.16) show the optimality conditions for farm output and variable capital farm inputs. Equation (3.13) and (3.14) are Kuhn-Tucker conditions that sow the optimality conditions for the sale of farm output and purchase of consumer goods, respectively. Equation (3.15) and (3.17) are Kuhn-Tucker conditions that show the optimality conditions for the optimal allocation of crop specific land and labour, respectively. Equation (3.18) is a Kuhn-Tucker condition that shows the optimality condition for hired farm labour. Equation (3.19) is a Kuhn-Tucker condition that shows the optimality conditions for off-farm work. If it is less than zero, the optimal hours of off-farm work is negative or zero, whereas if equation (3.19) is an equality, the optimal hours of off-farm work is positive. Unlike the standard farm household model (Singh et al., 1986), the first-order condition for off-farm work not only depends on the marginal value of household time and income, but also depends on transaction costs, and the marginal values of the liquidity constraint and rationing. As a result, at positive optimal hours of off-farm work, the virtual off-farm wage rate (internal wage) is not equal to the marginal productivity of family labour on the farm (details will be discussed in the next section). Equation (3.21), (3.22), (3.23) and (3.24) indicate the restrictions on liquidity, household's time, off-farm employment and commodity balance, respectively.

Since the production and consumption decisions are not separable, an optimal set of farm output (q_i^*); sale of farm output (s_i^*); demand for leisure (H^*), consumption goods (C^*), purchase of consumer goods (b_j^*); on-farm labour demand; on farm labour supply, off-farm labour supply (Huffman, 1980), and crop specific area (A_i^*) and labour (L_{fi}^*) should be derived by simultaneously solving the first-order conditions. However, the solution may not be analytically tractable (Sadoulet and De Janvry, 1995) although testable implications can be derived.

3.3 Implication for the labour, product and input markets

In a non-separable farm household model, the solutions for the household optimisation are not analytically tractable. Therefore, structural equations derived from a utility function can not be used. To circumvent this problem, there are two choices. One is to estimate the reduced form equations, and to use the utility maximisation and first-order conditions to select variables for the equations to be estimated and interpreted (Jacoby, 1993; Skoufias, 1994). The second choice is to specify the utility functions (indirect utility function) and solve the optimisation numerically by applying some restrictive assumptions (Sadoulet and De Janvry, 1995; De Janvry et al., 1992). This option is useful in analysing alternative policy options, but functional forms need to be specified while no tested utility function exists. Here the first option is followed and the model formulated is used to derive testable implications and to select variables for econometric model estimation and interpretation. The first option is accessible and gives wider possibilities to test hypotheses, which has wider policy implications.

In this section, part of the model related to the labour allocation is discussed. The effects of transaction costs and rationing in the labour market and the liquidity constraint on the off-farm labour allocation are analysed. Next the effect of off-farm income on market participation, crop choice, and the use of purchased capital inputs are discussed.

3.3.1 Off-farm work, labour market and food security

In the standard farm household model, a household participates in off-farm work when the market wage is equal to the shadow value of its time weighted by the marginal utility of income. However, when households face a liquidity constraint and transaction costs and rationing in the labour market, two opposing forces act on the allocation of labour for off-farm work apart from the marginal value of on-farm labour (γ). On the one hand, the transaction costs of looking for an off-farm job and the rationing in the labour market decrease the level of labour allocated for off-farm work (hereafter called the *transaction-rationing effect*). On the other hand, a household allocates more for off-farm work when farm households face a binding

liquidity constraint (hereafter-called *liquidity constraint effect*). The net effect depends on the relative strength of the *transaction-rationing effect* and the *liquidity constraint effect*.

The first-order condition (19) captures the effects of the liquidity constraint, and transaction costs and rationing on the labour market on the household's willingness to participate in off-farm activities. When condition (19) is less than zero, that is, $\lambda(w_m - tcc) - \gamma(1+tch) - \mu < 0$, the optimal off-farm work is less than or equal to zero (a corner solution). When $\lambda(w_m - tcc) - \gamma(1+tch) - \mu = 0$, the optimal number of hours for off-farm work is potentially positive. From equation (3.19), virtual wage ($w*_m$) can be derived as:

$$w^*_m = \frac{\lambda .tcc + \gamma(1+tch) + \mu}{\lambda}. \qquad (3.26)$$

This shows that the marginal values of time (γ), the liquidity constraint (λ) and rationing (μ), transaction cash cost (*tcc*) and transaction time cost *(tch)* in the labour market influence the virtual wage and hence households' participation in off-farm activities. For households that are not rationed in the off-farm labour market, μ is zero. Hence the μ affects the virtual wage of the rationed farm households only. The virtual wage is not equal to the shadow value of on-farm labour because of the liquidity constraint, and transaction costs in the labour market. It is the difference between the virtual wage and the market wage offered that determines a farm household's participation in off-farm activities. When the market wage (w_m) is greater than or equal to the virtual wage (w^*_m), the household will be willing to participate in off-farm activities. Transaction cash cost (*tcc*) and transaction time cost *(tch)* increase the virtual wage and discourage the farm household from participating in off-farm activities. The effect of a binding liquidity constraint on the virtual wage and off-farm employment is clear. It decreases the virtual wage and increases the households' willingness to participate in off-farm activities.

Increased off-farm income may have a positive effect on the demand for hired farm labour. From the first-order condition (3.18), the virtual benefit of hired farm labour (w^*_h) is derived as

$$w^*_h = \frac{\psi\, \partial Q(.)/\partial L_h - \gamma .sph - \lambda .spc}{\lambda}. \qquad (3.27)$$

This virtual benefit of using hired farm labour is dependent on the marginal value product of hired labour, supervision cost, marginal utility of liquidity, and household time. It is the difference between this virtual benefit from hired farm labour and the wage paid for a unit of hired labour that determines the farm household's decision to hire farm labour. Any policy change, external factors, that increases (reduces) the supervision cost and reduces (increases) liquidity reduces (increases) the virtual benefit of hired labour and hence reduces (increases) the willingness to hire farm labour. Off-farm income, through the liquidity constraint, decreases the marginal value of the liquidity constraint and increases the virtual benefit of hired farm labour. As a result, off-farm employment will increase the household's willingness to hire farm labour.

When farm households decide to hire farm labour and are still restricted by the liquidity constraint, the level of hired farm labour used can also be dependent on the level of off-farm income obtained. This can be shown from the marginal value product of hired labour derived from the first-order condition (3.18) as $\partial Q(.)/\partial L_h = \lambda(w_h + spc) + \gamma\ sph$. It implies that the marginal value product of hired farm labour is higher when there is a binding liquidity constraint and when the supervision cash cost and supervision time needed for hired labour increase. If farmers work off-farm, the liquidity constraint may be lowered, which will result in a decrease in the marginal value product of hired farm labour and an increase in the use of hired farm labour.

Farm households may hire farm labour while at the same time selling their labour outside their farm. Two conditions must be fulfilled simultaneously for farm households to simultaneously hire farm labour and sell labour for off-farm work. First, the market wage received must be greater than or equal to the virtual wage, i.e. $w_m \geq w^*_m$. Second, the wage premium the households receive over and above the virtual wage of hired farm labour (w^*_h) must be greater than or equal to zero, $w_m - w^*_h \geq 0$.

Those farm households who are relatively skilled have a comparative advantage in hiring farm labour and selling labour for off-farm work at the same time (Yang, 1997). Relatively educated farm households can get a sufficient wage premium over and above the wage paid for the hired farm labour. Suppose that a farm

household's supply of labour for off-farm work is positively sloped, and the household faces a negatively sloped demand curve to hire farm labour. Let us assume also that the wage rate for a skilled off-farm work (W_{mk}) is higher than the wage rate paid for a hired farm labour (W_h) and the wage rate for a manual off-farm work (W_{mu}) is the same as the wage rate paid for a hired farm labour. Hence the farm household fetches higher wage when he is involved in skilled off-farm work and fetches lower wage when he is involved in a manual off-farm work. Figure 3.1a and Figure 3.1b compare the effective wage rate received by the household in a skilled off-farm work and the effective wage rate paid by the household for a hired farm labour. Figure 3.2 compares the effective wage rate received by the farm household in a manual off-farm work and the effective wage rate paid by the farm household for a hired farm labour. Skilled workers receive a positive effective wage premium enabling them to hire and sell labour: $[w_{mk} - tcc - tch] - [w_{hu} + spc + sph] > 0$ (Figure 3.1a). *W*hen the transaction costs of looking for off-farm work and the supervision costs of hiring labour increase from (*tcc +tch*) to (*tcc' +tch')* and from (*spc + sph)* to (*spc' + sph'*), respectively, a skilled worker can receive a negative wage premium, which does not enable them to hire and sell labour simultaneously (Figure 3.1b). The manual workers who have relatively low skill and perhaps lower education levels can not hire and sell labour simultaneously because the effective wage premium is negative: $[w_{mu} - tcc - tch)] - [w_{hu} + spc + sph] < 0$ (Figure 3.2). Hence if the transaction costs in the labour market is not excessively high, it is the relatively skilled (educated) worker who can hire farm labour and sell his labour off-farm.

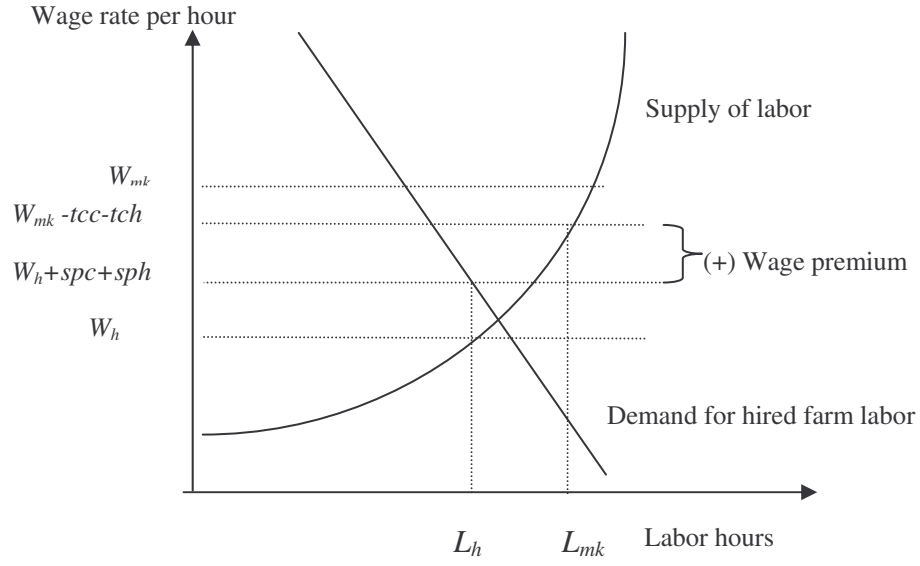


Figure 3.1a Sale of skilled labour and purchase of farm labour under transaction cost

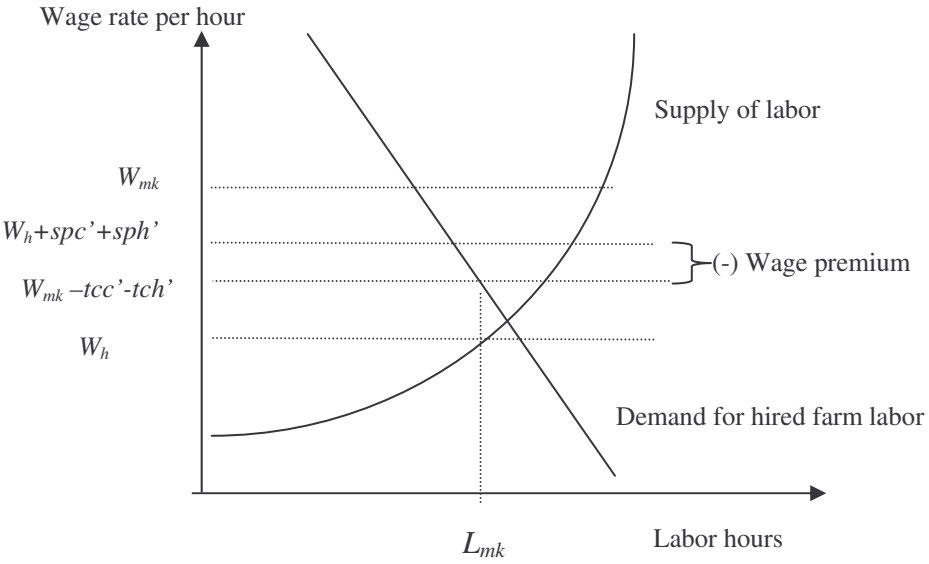


Figure 3.1b Market failure in the sale of skilled labour and purchase of farm labour under higher transaction cost

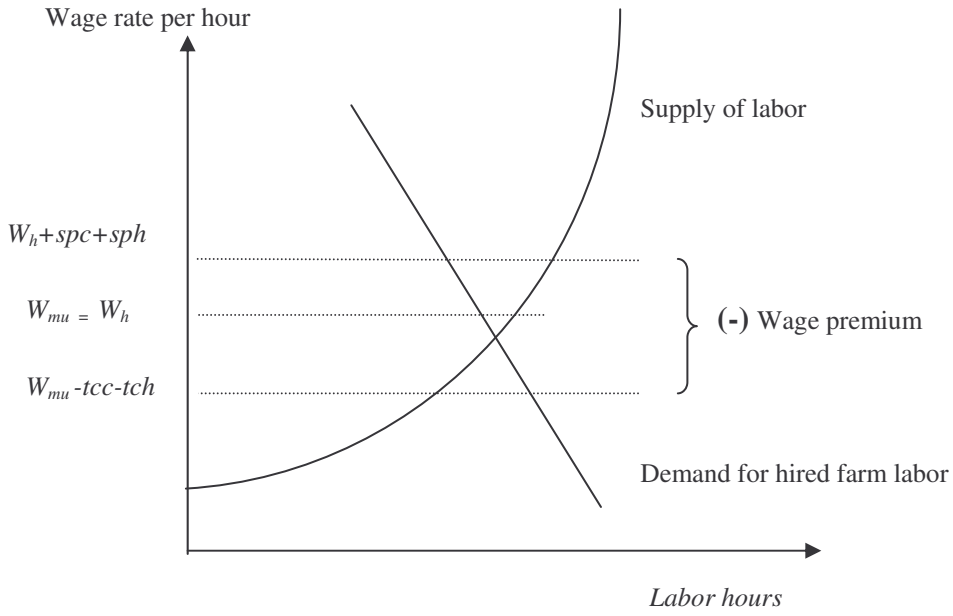


Figure 3.2 Market failure in the sale and purchase of unskilled labour due to transaction cost

This analysis raises the following question. Why a skilled farmer does not leave his farm and engage in non-farm activities if he can earn more than he earns from farming? The reason is that off-farm activities are risky and there is rationing in the off-farm labour market. Moreover, there is no perfect land market that gives farmers the opportunity to sell their land and change their occupation[4]. Therefore, in the absence of a land market and given risky off-farm activities (plus rationing), no one would be willing to take the risk of leaving his farm and be fully engaged in non-farm activities. In this situation, it is rational for a skilled individual to be both a seller and a buyer of labour. Simultaneous purchase and sale of labour helps farmers to exploit the comparative advantage they have in off-farm work without leaving their farm.

The model also shows that efficient marketing systems and off-farm income helps farm households in marginal area to have better food security status. This can be shown using the first-order condition (3.10). The marginal utility of consumption goods is η, which is higher for goods for which the household is a net buyer, implying

[4] Land in Tigray is state property. Farmers have the right to use the land, but they do not have the right to sell their land.

that the level of consumption is lower for these commodities. In other words, the marginal utility of consumption for the purchased commodity is higher than that of the own produced commodity because of marketing costs. When farm households face a binding liquidity constraint, it is not possible for them to purchase consumer goods. Therefore, if the liquidity constraint is released through, among others, off-farm income, the level of consumption could be increased. Therefor, any policy that improves the efficiency of the market systems (decrease the marketing margin) and liquidity (promoting off-farm employment) will improve the food security status of those farm households that are net buyers of food.

The model in general implies that farm households choose to work more for off-farm work than the standard farm household model (Singh et al., 1986) predicts. It also implies that farm and off-farm income will have a positive relationship. Off-farm income will support farm activities through the financing of farming activities and consumption. If there is a binding liquidity constraint, farm households work off-farm in order to buy farm input and hire farm labour. Most importantly, off-farm income helps farm household to attain better food security in marginal areas. Consequently, the following generalisations (hypotheses) can be drawn, which can be tested latter to answer the research questions (objectives) presented in Section 1.3:

1. Rationing and transaction cost in the labour market inhibit farm households from participating in off-farm activities. As a result policy change (any external factors) that increases the availability of off-farm employment and reduces the transaction costs in the labour market increases farmers' participation in off-farm activities;
2. While the liquidity constraint increases the farm household's desire to participate in off-farm activities, the transaction costs in the labour market reduces the desire to hire farm labour;
3. Off-farm employment increases liquidity, and hence increases the willingness to hire farm-labour.
4. Those farm households, which are relatively skilled and capable of getting attractive off-farm activities, can be better off by simultaneously hiring farm labour and selling labour off-farm.
5. Off-farm income helps a liquidity-constrained farm household to have better food security status.

All of these generalisations (hypotheses) are explicitly tested in the coming chapters, except for the direct test on the motivation effect of liquidity constraint on

off-farm work participation, which is found to be difficult. The first hypothesis is tested partly in chapter 7. Chapter 4 tests the second and the fourth hypotheses. Hypothesis three and five are tested in chapter 6 and chapter 8, respectively.

3.3.2 Product and factor market and crop choice decision

A household can be either autarkic (self-sufficient), a net buyer, or a net seller in a product market good *i*. The opportunity cost of production is different in each case. The opportunity cost depends on the potential impact of trading cost (transportation cost, profit margin by merchants, and others) on the equilibrium output (Omamo, 1998; Sadoulet, De Janvry and Benjamin, 1996). This opportunity cost is the shadow value of the commodity balance equation given by η. From (3.14), when the household is a buyer, the purchase price is given by $(\eta_i/\lambda = P_i + d_i)$ and the first-order condition in equation *(3.12)* for a buyer can be rewritten as $\psi Q_i'(q,z) = -\lambda(P_i + d_i)$. From equation (3.13), when the household is a seller of a good in the market, the sales price is $(\eta_i/\lambda = P_i - d_i)$ and the first-order condition in equation *(3.12)* becomes $\psi Q_i'(q,z) = -\lambda(P_i - d_i)$. When the household is not trading, the prices of goods are internal to the household and are endogenous determined by η_i. The implication of these conditions is that due to the trading cost, the optimal response will be greater for the production of goods for which the farm household is a net buyer and smaller for production of items for which the household is a net seller (Omamo, 1998). In general, the household becomes more self-sufficient (autarkic) as the marketing costs increase.

The presence of a liquidity constraint also has important implications for the determination of optimal output. When there is a binding liquidity constraint - that is, $\lambda > 0$ – the decision price for liquidity using and generating factor inputs and products are affected. The first-order conditions (3.12) and (3.13) imply that the presence of a liquidity constraint does affect the relative magnitude of the marginal value product of crops that differ in their need for liquidity. The marginal value product will be higher for crops that require liquidity than for crops that do not require liquidity. Higher marginal value product of liquidity using crops means less production of these crops. Therefore, off-farm employment which releases the liquidity constraint makes farm households shift from lower liquidity using crops to higher liquidity using crops.

The first-order condition in equation (3.16) implies that $\psi \partial Q(.)/\partial X = \lambda P_x$ for the purchased variable capital farm inputs. This means that the marginal value product of purchased variable capital farm inputs is higher and the level of purchased variable capital farm input use is lower when there is a binding liquidity constraint ($\lambda>0$). Therefore, when the liquidity constraint is released through, for instance, off-farm income, the marginal value product of purchased variable farm inputs could be lowered through the use of additional purchased variable capital farm inputs such as fertiliser, improved seeds, insecticide and pesticide.

The land allocation decision for different crops can be derived from the first-order condition (3.15):

$$\psi \frac{\partial Q(.)}{\partial A_i} = \delta \tag{3.28}$$

It implies that the marginal value product of land for each crop is equal to the shadow value of land. Corner solutions could also exist in crop specific land allocation. If equation (3.15) is less than zero for some crops, corner solutions exist, i.e., some crops receive zero amount of land. This means that the marginal value product of land for crops receiving zero amount of land is less than the marginal value product of land for crops receiving positive amount of land. Furthermore, off-farm income may affect land allocation cross crops because the marginal product of land depends on the complementary inputs used on the farm whose use depends on the liquidity constraint. Hence, off-farm income, by affecting the use of inputs, may affect the relative product of land allocated to different crops. Therefore, the decision to allocate land across crops may depend on the total availability of land for cultivation, household taste preferences, crop profitability, off-farm income, farm characteristics, and agronomic conditions and risk considerations.

A farmer allocates labour for a crop *i* if

$$\psi \frac{\partial Q(.)}{\partial L_{fi}} - \gamma = 0 \tag{3.29}$$

This implies that the optimal level of labour allocated for each crop will be determined at a point where the marginal product labour for each crop is equal. Hence the labour use for each crop is dependent on the marginal value product of labour.

It may be interesting to elaborate on the link that exists between crop choice and off-farm income beyond what the model (first-order condition) clearly shows

because the crop specific marginal product of land and labour implicitly reveal the impact of various complementary inputs and liquidity constraints. The influence of off-farm income on crop choice mainly arises when households face an imperfect capital market. Land and labour are allocated among various crops such that the marginal product of labour and land are equal across all crops grown by farmers in a perfect capital market. When households are liquidity constrained, however, more land may be allocated for crops that use less liquidity. Since, in the model employed, off-farm income increases liquidity (or eases the liquidity constraints), land will be reallocated to crops that are liquidity using when a household is more involve in off-farm employment. Off-farm employment can have two contrasting effects on the allocation of labour among crops. When households are more involved in off-farm employment, on the one hand, more labour will be allocated to liquidity using crops in order to take advantage of the purchased inputs used on the crops. On the other hand, more off-farm income results in the reallocation of labour towards crops that use less labour and are less liquidity using because off-farm employment competes with labour on the farm. Therefore, the net effect of off-farm employment on the reallocation of labour among crops is difficult to know *a priori*.

Farmers may not specialise in growing specific crops; rather they may grow a variety of crops. If their decision is not rational, they lose the benefit they would have achieved from specialisation. Farmers' decision to grow a variety of crops at the same time may be rational due to many reasons. If there is constant returns to scale, two or more crops can be grown to make use of the available resources (Burger, 1994). If there is increasing or decreasing returns to scale, the choice that can rationally be made depends on the farm size. Due to transaction costs in the output market, the shadow price of products may be between the selling price and the purchase price, i.e. within the *price band*. Then the shadow price of crops for a household is internally determined by their relative marginal utility of crops grown, not by equation (3.28) and (3.29). When the price band is wide enough, adjustment of crop choices and labour and land allocations are determined by household preference. When more food becomes available, with decreasing marginal returns of food, the increasing use of land and labour for a given crop leads to a decline in the shadow price of that crop. At some point, substituting for that crop by another more attractive crop would become inevitable.

The following generalisations (hypotheses) can be drawn from the analysis of market participation, crop choices and land and labour allocation among crops.

1. The optimal response will be greater for the production of same goods for which the farm household is a net buyer, and smaller for the production of items for which the household is a net seller due to the trading cost.
2. The presence of a liquidity constraint increases the marginal value of a liquidity-using product implying a lower level of output. For products that are not liquidity using, the marginal value of the product is lower implying higher level of output produced. Therefore, off-farm employment can release the liquidity constraint and enable the farm household to shift from the production of lower liquidity using crops to higher liquidity using crops. As a result, off-farm employment can increase the production of crops that require liquidity and decrease the production of crops that do not require liquidity.
3. Off-farm employment releases the liquidity constraint and increases the use of purchased capital inputs such as fertiliser, improved seeds, and pesticides.
4. The direction of the impact of off-farm employment on the allocation of labour among various crops is not known *a priori*. On the one hand, more labour will be allocated to liquidity using crops when households are more involved in off-farm employment in order to take advantage of the purchased inputs used. On the other hand, more off-farm income results the reallocation of labour towards crops that use less labour, and are less liquidity using because off-farm employment competes with labour on the farm.
5. When a farm household is not involved in the market due to high transaction costs, the reallocation of land and labour is determined by a shadow price, which in turn is determined by household preferences.
6. Off-farm employment fosters commercialisation in the rural household economy by promoting the production of liquidity using crops and purchased capital inputs.

Some of these hypotheses are similar to those presented in 3.3.1. Off-farm employment increases the use of purchased inputs such as labour (in 3.3.1) and capital farm inputs (in 3.3.2). Hypothesis three is tested in chapters 5 and 6. Chapter 8 tests hypothesis four and six.

3.4 Conclusions

The farm household model derived considers liquidity constraint, transaction cost and rationing in the labour market simultaneously. It generates testable implications on the farm households' participation in off-farm work. The model predicts that off-farm income may have positive effects on farm income through its effect on the liquidity constraint. The participation of farm households in off-farm activities not only depends on farming and household characteristics, but also on the transaction costs and rationing that exist in the labour market. The liquidity constraint induces farm households to join the off-farm labour market and thereby helps them to buy more capital farm inputs and farm labour. Those farm households which are relatively skilled and capable of working in lucrative off-farm activities hire more farm labour than those which are relatively less skilled and educated. Furthermore, off-farm income helps farm households to attain better food security status in marginal areas.

Farm households can be either buyers or sellers in the product market not only depending on production and consumption preferences, but also depending on the transaction cost involved in buying and selling goods. Trading cost makes the optimal response greater for production of goods for which the farm household is a net buyer, and smaller for production of items for which the household is a net seller. Assuming positive production, if the transaction cost is very high, farm households may be prohibited from being sellers in the output market and they might be better off being self-sufficient.

Off-farm employment, by releasing the liquidity constraint, may affect participation in the factor and product market. A farm household with more off-farm income could finance its farm activities such as hiring labour and purchasing capital input and thus produce more market oriented crops so as to maximise profit. On the other hand, a farm household whose off-farm income is high could simply satisfy his cash requirement from the off-farm income he receives and grow crops for own consumption and sell less of his output (Burger, 1994).

CHAPTER 4. THE WORKING OF LABOR MARKET AND WAGE DETERMINATION

4.1 Introduction

Governments in developing countries interfere in agricultural sectors, among others, through the promotion of public and/or private investment projects, technological innovations and off-farm employment. Particularly, the focus of policy makers in Ethiopia is to increase productivity and attain food self sufficiency and food security on the one hand and to promote investment in the non-farm sector or industrial sector in order to provide alternative income earning opportunities on the other hand. The success of investment in the agricultural and industrial sectors and the extent to which the benefits of technological innovations in agriculture and the investments in the non-farm sector trickle down to the landless and/or poor household depend on the smooth functioning of the labour market, wage determination and the factor bias of technological development. If the labour market is imperfect, the transaction cost of hiring labour will be high, which hinders investment or makes capital relatively cheaper and eventually generates lower employment. If the transaction cost of labour makes capital relatively cheaper than labour, investment will tend to be more capital-intensive, which is not appropriate given the factor endowments (factor proportions) prevailing in developing countries. If there is a smooth functioning of the labour market coupled with labour using technological innovation, the benefit of rural investment will go to the landless and poor households.

Wage rates in rural areas are usually thought to be determined by either subsistence or nutritional requirement or else by the forces of supply and demand. The first class of theories rests on the assumption that, because labour supply is excessive in relation to the complementary factors, wage will be held at a subsistence level. The further assumption that labour supply is perfectly elastic led to a prediction that real wage will be constant over some range regardless of the demand (Sen, 1966). However, this prediction has not been fulfilled. Wages in rural areas may be low, but they are generally observed to vary over both time and space. This observed variation in wage across time, especially over seasons, is attributed to changes in demand and supply (Squire, 1981).

Another variant of the subsistence hypothesis focuses on the relation between nutrition and work efficiency. A positive relation between wage and the efficiency of labour may make it profitable for employers to pay labour more than the subsistence wage (Mazumdar, 1959). This model is known as nutrition-based efficiency wage model in labour economics literature.

The third variant is a model that assumes farm households are partially or wholly integrated in the market and that the labour market operates competitively (Rosenzweig, 1980; 1988). In this model the wage rate depends on supply and demand forces. Wage can also be dependent on marketable human capital (Mincer, 1974) such as experience, education, skill and the physical characteristics of an individual. The evidence that farm households participate extensively in the labour market as both buyers and sellers of labour points to the likelihood of competitive, although not perfect, labour markets.

In a farm labour market where large commercial farms are absent or rare, the main participants as employers as well as employees are farm households. Exchange of labour among farm household can be triggered by the initial differences in absolute and relative factor endowments. Shortage of labour, particularly in peak seasons, can be one of the reasons for farm households to hire farm labour. The other reason could be that allocating their labour for non-farm activities and hiring farm labour simultaneously may be beneficial for farm households. Therefore, the level of farm and non-farm income and other household characteristics may have a substantial influence on household participation in the farm labour market.

The integration of farm households in the market (and the participation of farm households in the labour market as employers) has considerable policy implications regarding the distribution of the benefits that arises from technological innovations in agriculture. If the technological innovations are of the more labour-intensive type, farm households will hire farm labour and the benefits of technological innovations will trickle down to those who do not have land.

Analyses of the labour market in general and the rural labour market in particular and wage determination in Africa are scarce in literature (Reardon, 1997), especially for Ethiopia, and they are absent for Tigray despite their importance for policy makers. Policy makers have little knowledge whether the benefit of the investment is going to the poor who are endowed with labour. Furthermore, the motivations for a farm household to hire farm labour is not well known as well,

especially when a farm household hires farm labour and also sells labour simultaneously.

The objectives of this chapter are the following. First, to describe how the farm and non-farm labour market work, and to analyse the process of wage determination and recruitment of labour. Second, to identify the determinants of farm households' participation in farm labour markets as an employer and the determinants of farm household member's wages in the farm and non-farm labour markets. Descriptive statistics and simple statistical tests are used to explain the workings of the labour market in both the farm and non-farm labour markets. A probit model, consistent with an agricultural household model, is used in order to identify the determinants of a farm household's participation in the farm labour market as an employer. Wage offer equations, correcting for sample selection bias, are estimated to identify the determinants of household members' wage.

The rest of the chapter is organised as follows. In section two, the theoretical framework is outlined. In section three, the data and model specifications are described. In section four, the analysis and estimation results are presented. The chapter ends with conclusions.

4.2 Theoretical framework

There are three basic approaches in the development literature concerning the wage determination and labour market in developing countries (Rosenzweig, 1988). The first approach raised by Chayanov (1925, 1966) and expressed by Sen (1966) is an autarkic model that assumes the non-existence of a labour market. If there is surplus labour in the household, family workers can be removed from the household without a loss in output. In the autarkic model, labour is in surplus only if the removal of a family member leaves the marginal rate of substitution between consumption and leisure unchanged. If family members, by increasing their labour supply, can fully compensate for the lost hours of work associated with a reduction in the number of family workers, labourers can be removed from the household (Agriculture) without any loss in output. Consequently, because labour supply is excessive in relation to the complementary factors, the wage will remain at a subsistence level.

The second model hypothesises that there are agricultural agents willing to or seeking work, but they are unable to find employment. It focuses on the relation

between nutrition and work efficiency. Employers try to capture the benefits of greater work efficiency by improving nutrition through higher wages. A positive relation between wage and the efficiency of labour may make it profitable for employers to pay labour more than the subsistence wage (Leibenstein, 1957, Mazumdar, 1959). This theory led to several testable predictions about the wage payment system: labour-tying (the use of contracts of relatively long duration); an inverse relationship between wage and the earner-dependency ratio, and payment in the form of meals for workers. In labour economics literature, this model is known as nutrition-based efficiency wage model. The other kinds of efficiency wage models are the shirking model (Shapiro and Stiglitz, 1984); the labour turnover model (Salop, 1979); the adverse selection model (Weiss, 1980); and the sociological model (Akerlof, 1982). All of the efficiency wage models have in common that in equilibrium, an individual firm's production costs are reduced if it pays a wage more than market clearing, and thus there is equilibrium involuntary unemployment.

The main idea of the efficiency wage model is that labour productivity depends on the real wage paid by an employer. If wage cuts lower farm productivity, then cutting wages may actually result in higher labour cost. According to the efficiency wage model, a higher wage payment in general has five benefits (Akerlof and Yellen, 1986). Firstly, it improves the nutritional status of workers (from the nutrition based efficiency wage model). Secondly, it reduces shirking of work by employees due to the higher cost of job losses (from the shirking model). Thirdly, it lowers the turnover of workers (from the labour turnover model). Fourthly, it improves the average quality of job applicants (adverse selection model). Fifthly, it improves workers morale (from the sociological models).

Rosenzweig (1988), however, argues that it is only the nutrition-based efficiency wage model (Leibenstein, 1957; Mirrles, 1975; Stiglitz, 1976) which provides an important explanation for the downward rigidity of rural wages, although direct empirical tests of the relationship between nutritional level and effort are extremely rare and perhaps difficult. Binswanger and Rosenzweig (1984) also have reservations about the applicability of all types of efficiency wage models and suggest that it is less likely to be applied to explain rural daily-based wage employment.

The third approach assumes that farm households are partially or fully integrated in the market and that the labour market operates competitively (Rosenzweig, 1980; 1988). Then the wage that an individual or farm household

receives depends on demand and supply forces. This model is called a competitive model in the labour market literature (Collier and Lal, 1986). It has four inherent assumptions: perfect information on the supply and demand side of the labour market, no uncertainty (or perfect future markets), no transaction costs in achieving a competitive market equilibrium, and homogenous labour inputs. Given a convex preference structure of labour-leisure choices of individuals, profit maximisation by the producers and utility maximisation by the consumers, the competitive model leads to a general equilibrium condition in which wage equals the marginal value product of labour, which also equals the labourer's marginal rate of substitution between income and leisure. However, modern neo-classical theorists have tried to relax the assumptions. The introduction of human capital into the neo-classical theory of the labour market helps to take account of some of the factors that leads to the heterogeneity of labour on the supply side of the labour market. Human capital consists of skills acquired through formal and informal education and on-the-job training. This gives rise to differentials in the productivity of different labourers. Since the acquisition of skills involves costs, the skills will be acquired if the skilled wage rate is higher than that the unskilled wage rate. The actual difference is determined by supply and demand considerations and the relative value marginal productivity of different skills.

The neo-classical model has also been extended to include non-separability of production and consumption decisions (Singh, Squire and Strauss, 1986; Caillavet, Guyomard and Lifran, 1994) labour market imperfections (Lopez, 1986; Benjamin, 1992), risk (Roe and Graham-Tomasi, 1986), and imperfection in the input and output markets (De Janvry, Fafchamps, and Sadoulet, 1991) in a farm household economy.

The evidence that farm households participate extensively in the labour market both as buyers and as sellers of labour points to the likelihood of a competitive labour market, although not a perfect labour market. Since there can be unobservable characteristics of a worker which may be an important determinant of workers marginal productivity and hence the demand for labour, exclusive reliance on the neo-classical theory of competitive model would be misleading (Collier and Lal, 1986). Hence, it will be worth to consider other theories such as the efficiency wage theory in explaining the wage structure.

Exchange of labour among farm households arises from initial differences in absolute and relative factor endowments (Collier and Lal, 1986). If the labour market

is smooth, differences in the inequality in factor proportions and marginal productivity will trigger farm households to undertake labour transactions among themselves. In a farm household model setting, a farm household's willingness to hire farm labour depends on the farm characteristics and household composition (such as the availability of family labour). If the household has sufficient family labour, it is obvious that the need for farm labour can be satisfied without hiring labour from outside. If the farm household's benefit from allocating their labour outside the farm is greater than the cost incurred in hiring labour, they will sell labour for off-farm work and hire farm labour simultaneously. This can be easily derived from an agricultural household model (see the theoretical chapter).

4.3 Model specification and the data

Econometric models specification. In this sub-section, econometric models for the probability of hiring farm labour and for the wage offer equations of farm household members are specified. Following chapter three of this book, the decision to hire farm labour (H_i) is modelled as a dichotomous mode (Amemiya, 1981, p. 1486):

$$H_i=1 \text{ if } w_{hi}^{*} \geq w_{hi};\ H_i = 0 \text{ if } w_{hi}^{*} < w_{hi}$$
$$\Pr(H_i=1) = \begin{cases} \Pr(w_{hi}^{*} \geq w_{hi}) \\ \Pr(\gamma' X_i + u_i > 0);\ u_i \sim N(0, \sigma_u^2) \end{cases} \quad (4.1)$$

where w_h is wage paid for hired labour; w_h^* is the virtual benefit the farm household gets from hiring farm labour; *Pr (.)* is probability of an event occurring; X is a column vector of explanatory variables; γ' is a row vector of parameters; u_i is the error term. The vector of explanatory variables includes those factors that affect the virtual wage rate and the market wage rate for hired labour.

In modelling the market wage rate that a household receives from working in off-farm activities (w_m), one needs to consider the truncated nature of household's participation in off-farm activities. Market wage rates are observed only for households who participate in off-farm activities. The participation decision of a household to work off-farm (D_i), can be modelled as

$$D_i=1 \text{ if } w_{ri} \leq w_{mi}\ ;\ D_i = 0 \text{ if } w_{ri} > w_{mi}$$
$$\Pr(D_i=1) = \begin{cases} \Pr\ (w_{ri} \leq w_{mi}) \\ \Pr(\alpha' X_i + u_{1i} > 0);\ u_{1i} \sim N(0, \sigma_{1u}^2) \end{cases} \quad (4.2)$$

where w_r and w_m are the reservation wage rate and the market wage rate, respectively ; *X* is a vector of variables that affects the market and the reservation wage rates; u_{1i} is the error term.

The wage offer equation is given by:

$$w_{mi}=\beta' Z_i + e_i \,,\; e_i \sim N(0,\sigma_e)\,, \quad w_{mi} \text{ is observed if } D_i = 1 \tag{4.3}$$

where *Z* is a column vector of variables that affect the market wage; *β'* is a row vector of parameters; e_i is the error term of the wage offer equation. Furthermore, we assume that the error terms of the participation equation (u_{1i}) and the error terms of the wage offer equation (e_i) have a bivariate normal distribution with zero mean and correlation ρ. Consequently, the expected market wage rate, $E(w_m)$, and the truncated market wage rate, $E(w_m|D_1=1)$, are given by (Amemiya, 1984; pp. 31-33; Maddala, 1983, pp. 174-189, 231-233):

$$E(w_m)=\beta' Z\, F(z) + \rho\sigma_e\, f(z) \tag{4.4}$$

and

$$E(w_m \mid D_i = 1) = \beta' Z + \rho\sigma_e\, f(z)/F(z) \tag{4.5}$$

where $z=\beta' Z/\sigma_{1u}$, σ is the standard error of *u*, $f(z)$ is the density function, $F(z)$ is the cumulative distribution function and $f(z)/F(z)$ is the hazard ratio or inverse mills ratio.

In an agricultural household model (Huffman, 1991) off-farm labour demand or the off-farm wage equation (wage offer equation) facing farm household depends on their marketable human capital (Mincer, 1974), demand influences, earning differential attributes and efficiency wage attributes. Human capital attributes include education, experience, skill health status, and physical strength of individuals. Demand influencing attributes consist of location, year and seasonal dummies. Earning differential attributes include participation in different types of off-farm employment and gender composition of the participants in off-farm activities. Efficiency wage attributes may include the dependency ratio and per capita land cultivated.

The data and estimation. This chapter uses (1) the 201 randomly selected farm household survey done in *Enderta* and *Hintalo Wojerat* districts, (2) the small informal survey done in *Mekelle*, *Quiha* and *Adigudom* towns. The latter includes 24 labourers working in construction works and major employers (big public and private

companies as well as small employers). The labourers and employers were interviewed to get insight into how the labour market works.

The initial differences in factor endowment and the exchange of labour among different farm size classes, the actual process of selection, wage determination and movement of wage over seasons are analysed using descriptive statistics. A probit equation (4.1) is estimated in order to identify the factors that determine the probability of hiring farm labour and the relative importance of these factors.

The determinants of farm household members' wage are identified from wage offer equations using the farm household survey data. Wage rates are defined as off-farm labour income divided by off-farm labour hours supplied. Farm household members are categorised into four categories: the household head, wife, other male members, other female members. Because not all households participate in the labour market, there could be a sample selection bias. To circumvent this problem, Heckman's two-stage method (Maddala, 1983) is used. First the willingness of farm households to participate in off-farm work is estimated from a probit model (2). Then the inverse mills ratios are derived from the probit estimates. Finally the wage offer equations (4.5) for a household in general and for each household member in particular are estimated incorporating their respective inverse mills ratios in the list of the explanatory variables. In all cases, *T*-ratios and significance level are calculated based on White's heteroscedasticity consistent standard errors (Greene, 1997, pp. 547-548).

4.4 Analysis of the labour market

Both the farm and non-farm labour markets adapt themselves to the seasonal nature of agriculture. Agricultural activities in the area are highly seasonal. One cropping calendar takes approximately 12 months. It can be divided roughly into four (or three) seasons: plowing, planting, weeding and harvesting (except that planting and weeding can overlap and be considered as one season). The calendar begins with plowing in December (except for land lying fallow from September of the previous year). Land can be plowed up to four times before planting depending on the type of soil and crop. While teff and wheat fields are plowed four times, a linseed field is plowed once. For the majority of the crops, planting is done at the onset of the rainy season, early June to late July. Chickpeas and latyrus (vetch) are planted in late August. Hand weeding is

done on cereals once or twice during the rainy seasons, mid July to early September. Harvesting is done from October to November. Threshing starts right after harvest and ends before the end of December.

Table 4.1 summarises the seasonal nature of labour use both on and off-farm. Most of the labour use on the farm is during harvesting and threshing. Farm households sell their labour off-farm, in a counter cyclical pattern to the use of farm labour. The participation and extent of off-farm employment is the highest during the slack agricultural season, January to April, and lowest in the peak agricultural season, September to December.

4.4.1 Farm labour market

There are three sources of farm labour, namely, family labour, labour sharing arrangements and hired labour. Hired labour comes mostly from the same village. A labour sharing arrangement is done between neighbours and between farm households. Shared labour can be either reciprocal or non-reciprocal. It is reciprocal in the sense that the household has to repay it in the form of labour or in another implicit form. It can be non-reciprocal in the sense that there is no obligation to pay it immediately in the form of labour. Nevertheless, it is usually expected that the household will help the other at times when the other is short of labour. It is common and polite to offer hired and shared-labourers with food and *sewa* (local brewed drink) during work or after the end of the day. Providing labourers with food and *sewa* during work stimulates them to work hard (boost their morale) according to the sociological model of efficiency wage (Akerlof and Yellen, 1986).

Most farm labour comes from family labour. Family labour accounts for 84.2 % of the farm labour, while the share of hired labour is 10.2 % and shared labour is 5.6%. The highest proportion of farm labour (hired, family and shared labour) is used for harvesting. The second highest use of hired labour and shared labour is for weeding, while the second highest use of family labour is for plowing. About 12% of the hired labour is also used for plowing, during the slack season.

Table 4.1 Seasonal distribution of farm labour, off-farm work participation and wage rates

Type of employment	Total	Seasons		
		January-April (plowing)	May – August (planting and weeding)	Sep.–Dec. (harvest and thresh)
Labour use on the farm	631.13	141.30	191.46	298.37
Off-farm wage employment				
Percent of participation	72.1	71.1	69.9	52.5
Hours supplied	1249.02	573.98	424.25	250.81
Income earned	858.75	367.99	306.04	184.72
Wage received per hour	0.72	0.69	0.75	0.74
Off-farm self-employment				
Percent of participation	27.9	24.6	20.6	14.7
Hours supplied	97.56	55.87	26.72	14.97
Income earned	262.50	148.30	75.59	38.61
Wage received per hour	4.69	3.60	5.03	2.89
Both wage and self employ.				
Percent of participation	80.9	80.1	75.4	60.0
Hours supplied	1346.58	629.83	450.97	265.77
Income earned	1121.24	516.29	381.63	223.32
Wage received per hour	1.18	1.15	1.20	1.10

There are seasonal variations in the use of total farm labour and wage rates. Harvesting takes the highest proportion of total labour and offers the highest wage rate (Table 4.2). Weeding takes the second highest proportion of total labour, but offers the lowest wage rate. The wage rate paid for harvesting is 1.1 Birr/hour, for planting it is 0.93 Birr/hour, for plowing 0.89 Birr/hour and for weeding 0.78 Birr/hour. One would expect that the wage rate during the slack season to be lower than that in the peak season. The reason is that plowing is a difficult job and needs some level of skill, while weeding can be done using relatively lower skill level and is not as intensive as plowing. Besides, rain can interrupt a weeding activity reducing the effective working hours. The reason that the harvesting wage is the highest of all is the urgency of the work and the higher non-farm labour demand during the harvesting season.

Table 4.2 Sources of farm labour and seasonal allocation in 1996 and 1997 (household average)

Type of farm labour	Hours	Plowing	Planting	Weeding	Harvesting
Family labour	491.53	26%	14%	15%	45%
Hired labour	92.60	9%	5%	26%	60%
Shared labour	47.00	11%	8%	35%	46%
Hired wage rate (Birr/hour)	0.96	0.89	0.93	0.78	1.09

Spot contracts dominate the labour market. Only few farm households hire permanent labour for farm work and homework. Two farm households (one percent) were found who hire a permanent farm worker. One household (0.5%) hires a house maidservant, and eight farm households (3.9 %) hire a cattle keeper boy. Permanent

labour contracts are absent in the farm labour market because of the counter-cyclical nature of non-farm employment, the seasonal nature of farm labour demand and the risk associated with agriculture. The participation of labourers in non-farm employment (either wage or self-employment) during the slack season reduces the labourers' exposure to wage uncertainty (Rosenzweig, 1988). If the employers can not fully use permanent labour during the slack season, and the wage uncertainty during the peak season is very low, the employer may prefer casual labour to permanent labour (Bardhan, 1983). For this reason, most of the permanent-labour contracts are on activities that are not seasonal such as homework and cattle keeping.

If permanent labour exists, farm households hire the permanent labour from relatives. Of the households who hire permanent workers, 65 % hire relatives. The search for people to hire for permanent work is done through friends and relatives. There is no agent either formally or informally who mediates in the hiring process[1]. Of the farm households who hire a permanent worker, only one household has responded that he just picked up a worker from the open labour market area without prior information about the person.

Exchange of labour among farm households arises due to initial differences in absolute and relative factor endowments. The difference in absolute and relative factor endowments could be due to demographic, ecological and economic processes (Collier and Lal, 1986). Land was distributed among the farm household in 1990 based on their family size. Given the egalitarian type of land distribution, there should not be initial difference in land ownership. However, the fact is that there is a difference in land endowment among farm households. *Figure 4.1* provides a kernel density estimate of area of land owned and area of land cultivated (on per adult equivalent family size and per working family member bases). The figure shows that distributions of land owned and cultivated are skewed towards the upper tail. The amount of land cultivated is different from the amount of land owned (Table 4.3) because farm household could either rent-in land or rent-out land. Only one household out of the 201 (sampled farm households) did not own land at all. However, after transactions in the land market, about 11% of the farm households did not cultivate

[1] The Ethiopian law does not allow agents to mediate between employees and employers. The law was drafted during the communist regime, and the present government, which is relatively liberal, has not yet reviewed it.

land. Most of the farm households who do not cultivate land also do not own oxen and farm implements.

Table 4.3 gives the distribution of land cultivated per working family member (i.e., initial land labour ratio, see **bolded** row), farm capital per working family member, and transport animal per working family member. These ratios are positively related to farm size indicating that there are differences in the initial endowment of factor proportions among farm households (between small and larger farms). There are also differences in absolute factor endowment among different farm sizes. The total amount of land cultivated and owned as well as the amount of farm capital and number of transport animals owned increases with farm size. The family labour used per unit of land decreases across farm size classes (Table 4.4). Because of the differentiation in both absolute and relative factor endowments, a difference in the marginal productivity of labour and thus inequality among farm households could arise if the labour market performs poorly. Potentially the difference in marginal productivity must create a profitable transaction in a factor market such as labour.

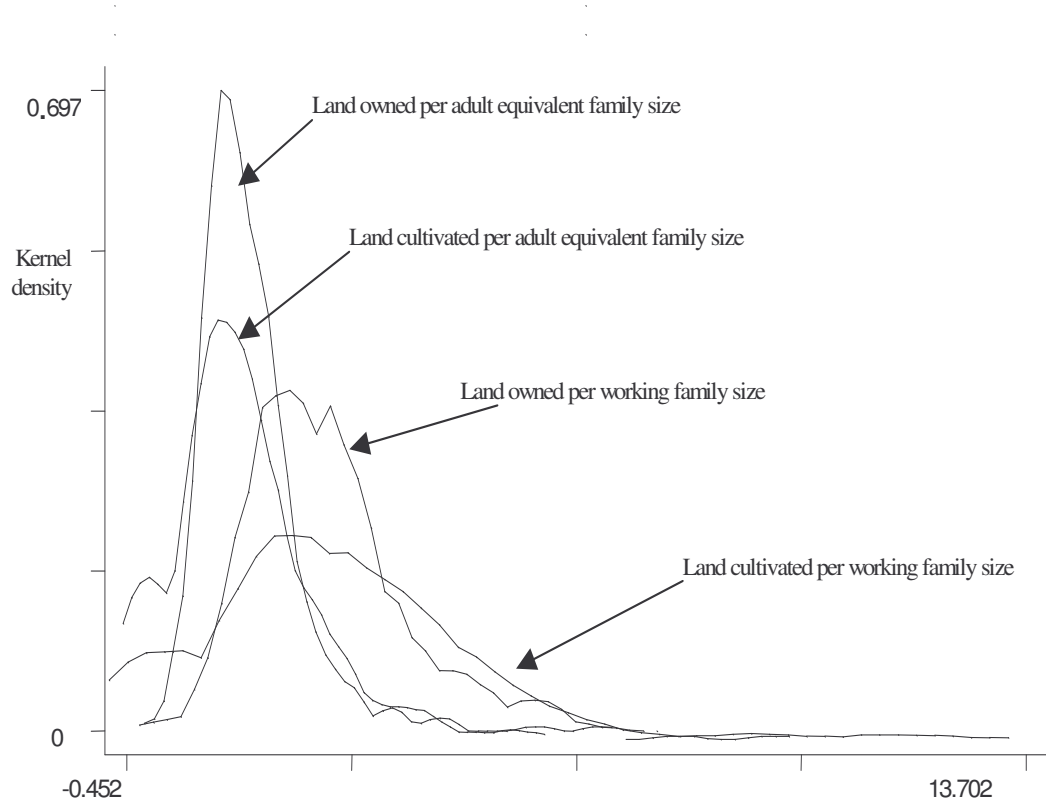


Figure 4.1 Kernel density estimates of area of land owned and cultivated

The differences in factor proportions and marginal productivity have triggered farm households to make labour transactions among themselves. The results show that labour exchange increases with farm size. Hired labour per unit of land cultivated and per working family members increase with farm size (see **bolded** rows in Table 4.4). The proportion of farm households which hire farm labour also increase from 7.14% for smaller farms to 100% in the largest farm. However, the extent of hiring farm labour is very small either because of one or a combination of the following reasons: liquidity constraint, transaction cost (Collier and Lal, 1986) or smaller farm size. The absolute shared labour and the relative shared labour with respect to land cultivated and working family member increases with farm size. This could be an indication of an alternative means of labour exchange when farmers face a liquidity constraint and a high transaction cost in monitoring hired farm labour. Since labour-sharing arrangements are made among neighbours who trust each other, the transaction cost of monitoring shared labour could be lower than that of hired labour. Since a labour-sharing arrangement is not a spot contract, shirking would not be a problem. The renting of land (hiring-in and hiring-out land) among farm households could also be an outcome of the transaction cost in the farm labour market. The level of rent paid for the land leased-in increases and the level of rent received from the land leased-out decreases across farm size classes (Table 4.4).

Nevertheless, the exchange of labour equalises the labour/land ratio (see **bolded** rows in Table 4.4), the returns to land and to labour among different farm size classes. There are no visible differences in the observed mean level of labour/land ratio, return to land and to labour between smaller and larger farm size classes. This implies that the farm labour market operates well enough to make agricultural growth trickle down to the poorer segment of the population.

Farm households also equalise their earnings (marginal productivity of labour) by selling their labour for non-farm (off-farm) activities in response to the differences in the relative factor endowments. The amount of labour sold per working family member and per unit of land cultivated declines as we go from smaller to larger farm sizes. Labour sales, therefore, narrow the differences in the labour input per unit of land and thereby reduces inequality by equalising the payment for family labour. Because there could be an entry barriers (skill and capital requirement) in the non-farm labour market, the unskilled employment labour market contributes substantially towards equalising the differences in factor proportions, inequality and poverty. This

effect is substantial compared to the contribution made by hired labour. Most of the farm households are net sellers of labour. Only farm households who cultivate more than 16 *tsimdi* of land are net buyers of labour on a per unit of land basis.

Furthermore, the majority of the households are net sellers in the labour market. For example, the proportion of farm households who sell labour but do not hire labour at all is 50%. The proportion of farm households who simultaneously sell and buy labour is 31 %. Only 10 % are autarkic (neither sell nor buy labour) in the labour market. Of those who simultaneously hire and sell labour, the majority (78.2 %) are of the middle farm size class (cultivate 4-12 *tsimdi*s). This implies that the middle farm size classes are liquidity constrained and thereby sell labour in order to finance their farming activities (such as hiring of farm labour).

Therefore, it can be concluded that the exchange of labour tends to reduce the absolute and relative gap in labour use per unit of land that exists between smaller and larger farms. However, the extent of hired labour use is small due to the high transaction cost for unmonitored effort, liquidity constraints and smaller farm size. Since most farmers are net sellers of labour, the non-farm labour market, particularly the wage employment contributes greatly to reducing the differences in factor endowments and marginal productivity of labour (as well as poverty and inequality).

Table 4.3 Absolute and relative factor endowments across farm size classes

		Farm size class (area of land cultivated in tsimdi*)						
	Total	[0]	(0-2]	(2-4]	(4-8]	(8-12]	(12-16]	>16
Total land cultivated	7.09	0	1.75	3.61	6.35	10.12	13.90	22. 0
Total land owned	5.88	4.91	3.04	3.59	5.67	7.26	7.86	9.11
Farm implement owned	237.62	39.92	138.64	164.08	218.24	301.72	379.52	732.0
Value of oxen owned	1433.88	62.79	385.71	1034.31	1352.5	1872.87	2419.13	4270.0
Value of transport animals owned	437.51	68.61	121.43	199.61	353.4	606.34	880.44	1745
Family size	5.80	3.3	4.0	4.8	5.9	6.4	6.3	6.9
Working family members	2.30	1.7	1.5	2.1	2.3	2.5	2.6	2.8
Land owned per working family member	2.70	3.2	1.5	1.7	2.6	3.1	3.2	3.3
Oxen owned per unit of land owned	0.22	0.05	0.19	0.26	0.21	0.25	0.29	0.41
Hired-in farm labour hours	92.60	0	0.86	13.75	43.35	141.79	196.83	778.64
Farm labour hours from share labour arrangement	47.00	0	11.07	21.97	36.33	60.05	78.44	291.57
Family labour use on the farm	551.95	0.00	185.85	335.10	495.78	652.63	862.39	1071.36
Total labour use on the farm	676.39	0.00	180.5	325.65	536.24	815.80	1110.96	2243.57
Hired out labour hours (off-farm labour hour)	1346.58	2171.49	1358.46	1099.41	1331.49	1352.72	1081.7	260.43
Farm capital per unit of land cultivated **	251.60	102.71	301.05	336.60	251.40	216.35	199.77	234.29
Farm capital per family size	314.23	48.69	167.28	293.48	292.06	398.28	455.22	761.24
Farm capital per working family member	730.72	88.67	254.57	567.55	715.09	927.89	1131.84	1865.89
Land cultivated per family size	1.32	0	0.53	0.92	1.22	1.84	2.32	3.34
Land cultivated per of working family member	***3.09***	***0***	***0.85***	***1.77***	***2.90***	***4.36***	***5.64***	***8.35***
Land owned per adult equivalent family size	***1.47***	***2.14***	***1.04***	***1.06***	***1.34***	***1.58***	***1.65***	***1.72***
Land owned per family size	*1.21*	*1.92*	*0.92*	*0.90*	*1.08*	*1.27*	*1.30*	*1.37*
Transport animals owned per unit of land cultivated	58.47	68.61	60.71	54.85	56.36	58.61	65.98	79.60
Transport animals owned per family size	75.98	17.93	25.30	46.43	60.56	108.51	128.65	263.31
Transport animals owned per working family member	182.59	26.59	41.07	92.25	159.91	246.16	325.8	691.19

**Land size is measures in tsimdi, a local measure for area. One tsimdi is equivalent to one-fourth of a hectare. ** Farm capital is defined as farm implement plus oxen owned and the average farm capital is put as farm capital per unit of land cultivated for the landless group.*

Table 4.4 Use of labour and return to land and labour across farm size classes

		Farm size class (area of land cultivated in tsimdi*)						
	Total	0	(0-2]	(2-4]	(4-8]	(8-12]	(12-16]	>16
Percent of farm household	100.0	10.7	3.48	12.69	38.81	25.12	5.72	3.48
Percent of farm household who hired farm labour	39.801	0	7.14	19.61	33.33	67.33	65.22	100.00
Percent farm household selling labour	80.85	86.05	85.71	80.39	82.05	83.17	73.91	42.86
Percent of farm household who get share labour	23.88	0	21.43	13.73	22.44	35.64	30.43	57.14
Hired-in farm labour hours per unit of land cultivated	**9.81**	**0**	**0.429**	**3.88**	**6.96**	**13.871**	**14.23**	**36.070**
Hired-in farm labour hours per working family member	39.59	0	0.429	8.37	20.73	59.311	86.21	305.37
Hired-out labour hours per unit of land cultivated	211.9	2171.49**	729.77	311.05	220.40	134.96	77.75	13.44
Hired-out labour hours per working family member	608.09	1212.11	550.09	534.52	575.09	554.36	447.91	97.36
Share labour received per unit of land cultivated	6.17	0	5.54	6.42	5.81	5.93	6.06	11.76
Share labour received per working family member	22.03	0	4.33	13.27	19.58	27.82	33.71	105.52
Family labour use on the farm per unit of land cultivated	75.68	0	104.83	93.43	78.78	64.69	62.75	50.11
Total labour use on the farm per unit of land cultivated	**85.748**	**0**	**107.85**	**90.89**	**84.77**	**80.58**	**81.55**	**101.51**
Value of crop output per unit of land cultivated (Birr)	*265.19*	-	*250.54*	*284.65*	*268.10*	*246.03*	*260.86*	*321.56*
Value of output per labour hour used (Birr)	*3.41*	-	*2.56*	*3.49*	*3.34*	*3.43*	*4.07*	*3.38*
Rent paid for land leased-in (Birr)	203.70	0	0.0	50.539	103.375	255.236	560.760	1750.68
Rent received from land leased-out (Birr)	77.80	549.72	225	24.117	16.570	6.693	0	0

**Land size is measures in tsimdi, a local measure for area. One tsimdi is equivalent to one-fourth of a hectare. ** Since the denominator (land size) is zero, the mean value of hired-out labour is put*

Apart from the differences in factor endowment, household and farming characteristics may affect farm labour transaction. A probit model (4.1) is used to identify the factors affecting the decision of farm households to hire farm labour. The decision to hire farm labour depends on variables (factors) that affect both the virtual wage and the market wage of hired farm labour. These variables include household composition (family size and number of dependants) and characteristics (age, age-squared, and education dummies), farm income, farm size (area of land cultivated) and non-labour income, location and year dummies, and household participation in off-farm activities. All variables, except farm income, are assumed to be exogenous. A Hausman specification test (Greene, 1997, pp. 763-764; Spencer and Berk, 1981; Pindyck and Rubinfeld, 1991, pp. 303-301) was conducted to test if farm income is endogenous to the model. The test rejects the null hypothesis that farm income is exogenous to the model at 1% level. Therefore, fixed farm inputs are used as instrumental variables for farm income.

The estimation result is summarised in (Table 4.5). The predicted probability for a farm household to be an employer in the farm labour market is 37 percent. The probability depends on the level of farm income, household participation in a relatively skilled non-farm wage employment, and family composition, and year dummy. When farm income increases, the probability of hiring farm labour increases. The probability of hiring farm labour increases also with farm size. Farm households who participate in mason and carpentry work have higher probability of hiring farm labour. Therefore, it appears that farm households hire farm labour in order to sell their labour for a better paying non-farm activities. This also confirms the proposition in chapter three (see Figure 3.1) that the skilled workers receives a positive effective wage premium enabling them to hire and sell labour simultaneously. The probability of hiring labour is also dependent on the household endowment of labour. It increases with decreasing family size and with increasing number of dependants. The proportion of households which hires labour is higher in 1996 than in 1997 because 1997 was a relatively dry year. The effects of participation in unskilled non-farm wage employment and non-farm self-employment, education level of the household head and wife, age of the household head on the probability of hiring farm labour are not significantly different from zero. However, the

probability of hiring farm labour increases when a farm household head is able to read and write. It is also decreasing with the age of household head, but at a decreasing rate.

Table 4.5 Farm households' probability of hiring farm labour (n=402)

	Coef.	∂F/∂x*	T-Ratio	P>|T|
Age of the household head	-0.073	-0.028	.051	0.151
Age square	0.001	0.0003	.0005	0.185
Year Dummy (1996=1, 1997=0)	0.446	0.167	.163	0.006
District dummy (Enderta =1, Adigudom=0)	0.319	0.120	.188	0.090
Farm income	0.0003	0.0001	.0002	0.098
Non-labour income	-0.0001	-0.00004	.0001	0.263
Farm size	0.154	0.058	.034	0.000
Participation dummy in non-farm skilled work (yes=1)	1.013	0.384	.467	0.030
Part. Dummy in off-farm unskilled work (yes=1)	-0.018	-0.007	.181	0.920
Participation in non-farm self employment	-0.002	-0.001	.182	0.993
Education dummy of HH head (read and write=1)	0.1403	0.053	.162	0.386
Education dummy of the wife (read and write=1)	-0.391	-0.138	.274	0.154
Family size	-0.336	-0.127	.130	0.010
Number of dependent	0.325	0.123	.138	0.019
Constant	0.239		1.118	0.831
Log likelihood	-192.19			
Pseudo R^2 =	0.29			

* ∂F/∂x - *marginal effect – for dummy variables is a discrete change of 0 to 1; T and P>|T| are the test of the underlying coefficient being zero;* $\chi^2(13)=101.11$*; T-ratios are calculated based on heteroscedasticity consistent standard errors; Prob >* χ^2 *= 0.0000; Predicted probability=0.37 (at mean value); observed probability = 0.39.*

4.4.2 Non-farm labour market

In this section, activities in the non-farm labour market in which farm households are frequently involved are characterised based on the small informal survey done on the nearby rural towns of the farm survey area (see chapter one). The motivations of farm households to participate in non-farm activities, the process of labour recruitment and wage determination, skill acquisition, and movement of wage rates across seasons and employers are described.

The non-farm activities in rural towns (urban areas) in which farmers participate are manual work and skilled work on daily basis. Farmers work in manual and skilled work by commuting to the nearby urban areas. The range of activities includes manual work in building and other construction works, masonry, carpentry, cementing, stone mining etc. Since the end of the long war in Ethiopia (1974 – 1991), people in Mekelle, the central city of Tigray, have been busy in construction work, more so than usual. The

boom in construction work and public work programs has created a demand for non-farm wage employment.

The motivation to participate in non-farm activities is summarised in Table 4.6. Most of the labourers work in non-farm activities because they do not have land or the land they have is insufficient. Some labourers participate in non-farm activities because they find it more profitable than farm work, farm work is insufficient for earning a livelihood, or they are not totally interested in farming activities.

Table 4.6 Motivations to work in non-farm activities

Reasons to work off the farm	Percent of households
I don't have land or enough land	80
Farm work is insufficient for livelihood	33
non-farm work is more profitable than farm work	21
I am not interested to work in farming	4

The response percentage does not add up to 100 because the respondents were allowed to have multiple responses.

The participation of farm households is substantial in urban non-farm work. Forty five percent of those who participate in manual work are farmers. Most of the manual workers are illiterate, only few can write and read. Skilled workers, especially the carpenters, can at least read and write.

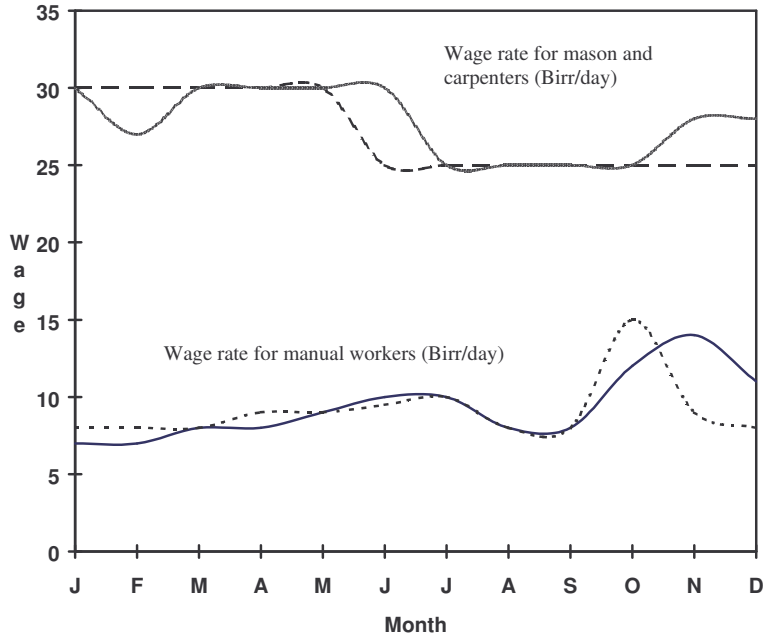
Most of the skilled labour workers acquire the skill without training, only one person in the sample (4%) gets training in building work. This is not a surprising figure as there are no schools that train people in building, carpentry and other technical work except a limited training given by the Tigray Development Agency, TDA. Most acquire the skill gradually during their employment as a manual worker in construction works. It is not only ability that limits the manual worker from becoming a mason or carpenter, but also the lack of equipment required for masonry and carpentry. If they are beginners, they rarely get employment as a mason or carpenter. To be a mason or carpenter in a short period, they have to find someone who is an experienced mason/carpenter under whose supervision they can work as an assistant. Then after a few months, they can get recognition as mason/carpenter. In general, job seekers have to pass through a long search process, usually done via friends and relatives. There is no agent who mediates between an employer and employees. Eighty eight percent of the respondent responded that it is difficult to get a job when you want to.

Labourers have to fulfil few additional criteria before they qualify for the job. For the manual labourers, physical fitness is the most important criterion, and for masons and carpenters, experience supported by a certificate is the most important criterion. Labourers who have their own equipment are the most preferred one. For masons and carpenters, it is impossible to get a job if they do not have their own equipment. The average required investment in equipment for a manual labourer is 40-50 Birr, and for masons and carpenters it is 250-350 Birr. Kinship between the employees and employer and an informal referee are helpful to be employed as labourers and masons. In a private house construction, a referee is needed to verify that he is an experienced mason or carpenter. Sometimes the employers want to see a house built by an applicant worker (or work done by the applicants) before hiring the worker.

It seems that there is an implicit agreement in providing workers with food before, during or after work. Labourers negotiate for the wage during recruitment, but not for the food they receive during work. However, every employer, except government organisations, provides workers local beer once to twice a day while they are working. When workers are supplied local beer, they get stimulated and work relatively quickly and cheerfully. There is a debate in the efficiency wage literature about whether a higher wage can increase effort in the long-run, but not in the short-run (Binswanger and Rosenzweig, 1984). However, the observed reality is that when workers are given food and drink, especially local beer, they just immediately get stimulated and work hard with relatively little supervision. When workers were asked why they work hard when they get food and local beer, they responded that it increases their morale and they work harder and little longer hours than the usual. This supports the proposition made by the sociological model of efficiency wage theory (Akerlof and Yellen, 1986).

The demand for non-farm work is not the same throughout the year. Building work is done during the period when there is no rainfall, particularly during the months of September to June. Hence, masons have a hard time getting a job during the rainy seasons between end of June and beginning of September. For manual labourers, it is difficult to get a job from January to March (the slack season and when the supply of manual labour is relatively higher). In the rainy season, some manual labourers can get a job in farming activities (weeding). The peak period for farm and non-farm work is

October to December where the demand for non-farm work is very high while the supply of labour is relatively low. The wage rates shown in *Figure 4.2* reflect the seasonal pattern of wage rates. The lowest wage rate is seven Birr per day in the slack seasons, whereas the highest wage is 12-15 Birr per day in October, during the harvesting time. This indicates that the wage rates responds to supply and demand conditions. The wage rate paid to labourers also depends on the kind of activity in which they participate. The wage rate for masons and carpenter is three times greater than those for manual workers.



Solid line (____) is for 1996 and dashed line (---------) is for 1997. One day equals 8 hours. One US Dollar equals = 7 Birr (Ethiopian currency).

Figure 4.2* Wage rates (Birr/day) at Mekelle

Wage rates and other fringe benefits vary across employers in the region. *Sur* Construction Company, a major employer in construction work, pays seven Birr per day plus health insurance for workers. It does not provide any food and drink during work. Another big private construction company pays seven Birr plus a piece of bread and a glass of tea during the break. In both cases, the employers set the wage, wage rates do not vary across seasons, and there is no negotiation for the wage, but they recruit labourers

who are physically more fit and masons and carpenters with a certificate of experience. The wages do not vary across seasons and workers do not request an increase in salary during the busy seasons because workers fear that the employer will retaliate against them by not hiring them during the slack season.

For small private employers, the wage rate varies from 8 to 12 Birr depending on the season and the labourer's physical fitness. Small private sector employers decrease the wage they offer during the slack season and employees can increase their wage they demand during the peak season. Usually the wage rate is higher than that paid by the big employers. Small private employers offer workers with local beer once or twice a day, but the duration of the work is not longer than a week. Therefore, labourers have to choose between higher wage and shorter duration on one hand and lower wage and longer duration on the other hand. This choice depends on the capacity of workers to absorb risk and the risk aversion of the labourer. However, the queuing line to get employment with big employers is longer than for small employers, implying that it is risky for labourers to work for small employers.

Wage rates also differ across labourers depending on their loyalty and physical fitness. If a labourer is loyal and found to work well without supervision, his wage could go up to 20% higher than the normal. The employers give these types of labourers an additional assignment of supervising the labourers. Likewise, labourers who are physical more fit get a job easily and receive higher wages than normal. Especially loyal and physically strong workers are relatively in a better position than the rest of the workers when the demand for labour is very low.

Almost all employers responded that shirking is the most important problem when they hire casual labourers. The measure they took when they caught workers shirking is firing. The other way to control shirking may be to pay wages on a piece rate basis, but there are complaints from the employers that the quality of work is not good.

Labourers are also employed as manual workers for community development work. The payment is in kind, in the form of wheat, and no additional food and other fringe benefits are given. This payment is equivalent to six Birr per day (25 % less than the wage rate paid for other type of work). Usually employment in the community development work is given to poorer households on a priority basis when there is

insufficient demand for hired labour. In the years 1996 and 1997, there was a lot community development work with the construction of micro dams, soil and water conservation projects, school and clinic construction, etc. Hence, everyone who was willing to be employed interested could find work. Most of the labourers in the community development work are women implying that women occupy the low paying wage activities. For the other type of wage employment, most of the labourers are men.

4.5 Determinants of wages

In this section, the determinants of the wage rates received by farm households in the survey area and their relative importance are identified. Household members are categorised into four groups: husband (household head), wife (household head if she is unmarried, widowed or divorced), other male members and other female members. Farm households substantially participate in the wage labour market as sellers and buyers (Table 4.7). Nearly 72 % of the household participate in off-farm wage-employment. The previous section shows also that 39 % of the households participate in the labour market as employers. The husbands (the household heads) have the highest participation rates in off-farm wage employment. A considerable proportion of the wives (35%) and other male members (18%) in the sample participated in off-farm wage employment but the participation of the wives is limited to the food for work program. The participation of other female members is very small (6%).

Table 4.7 summarises the distribution of wage rates across household members. It seems that there is a difference in the wage rate received by a household head and other male members on the one hand and that of the wife and other female member on the other hand. The mean separation test shows that the wage rate received by the household head is significantly higher than that received by the wife. Nevertheless, the difference in wage rate received by other male members and other female members is neither significantly different from zero nor greater than zero. The fact that there is a difference in wage rate between husband and wife does not in itself mean that there is discrimination. If there is discrimination between men and women, the effect of other

confounding factors have accounted for and this is dealt with next in the estimates wage offer equations.

Table 4.7 Average off-farm wage and participation rates in off-farm wage-employment

Member type	Wage rate (Birr/hour)	Participation rate (%)
Head	0.73	67
Wife	0.62	35
Other male member	0.72	18
Other female member	0.62	6
Household	0.72	72

Wage offer equation (4.5) for the households in general as well as separately for husbands, wives, other male members and other female members are estimated. The independent variable comes from the following sources: human capital attributes (individual or household characteristics), demand influences, earning differential attributes and efficiency wage attributes. Human capital attributes include education, health status, physical strength of individuals (weight and height dummies) age and age squared. Demand influencing attributes consist of location, year and seasonal dummies. Earning differential attributes include dummies for participation in paid community development work, unskilled and skilled wage employment as well as dummies for participation of male household members in wage employment. Explanatory variables that reflect efficiency wages are the dependency ratio (dependency earners ratio) and per capita land cultivated. Inverse mills ratio, derived from a probit equation (4.2), are also included in all wage offer equations. Variables that indicate individual health, off-farm work participation, and per capita consumption are not included in the estimation of the probit equations. The probit models include household characteristics (age, age-squared, education), household composition (family size, number of dependants), location and year dummies, and variables that affects farm productivity such farm capital, area of land cultivated, variable inputs (fertiliser, seeds and pesticides), etc.

Estimates of the wage offer equation of off-farm work for the household in general are given in Table 4.8. The result does not show a statistically significant wage differential between male and female members of a household. However, controlling for other factors such as human capital attributes, demand influences and type of non-farm employment involved, the dummy for the participation of household heads shows a

positive effect on the wage offer equation of the household. Demand-influencing variables such as seasonal, year and location dummies and a few earning differential variables such as the type of off-farm activities involved are more important in explaining the variation in wage than the human capital attributes (household characteristics) and efficiency wage attributes.

Table 4.8 OLS estimates of wage offer equation of farm households (Dep variable = household wage Birr/hour)

Explanatory Variables	Full model			Restricted model		
	Coef.	T-ratio	P>|T|	Coef.	T-ratio	P>|T|
Age of the household head	-0.006	-0.518	0.605	-0.006	-0.492	0.623
Age squared	0.00003	0.232	0.817	0.00003	0.205	0.838
District dummy (Enderta=1)	0.090	1.790	0.074	0.093	1.863	0.063
Year dummy (1996=1, 1997=0)	0.175	3.366	0.001	0.171	3.456	0.001
Value of off-farm equip. owned	0.0005	1.154	0.249	0.0005	1.170	0.243
Education dummy of HH head	-0.018	-0.410	0.682	-0.012	-0.278	0.781
Education dummy of the wife	0.011	0.213	0.832	0.002	0.044	0.965
Health condition of head (1=ill)	-0.028	-0.668	0.505	-0.032	-0.777	0.438
health condition of wife (1=ill)	-0.030	-0.773	0.440	-0.030	-0.778	0.437
Dummy for Part. in unskilled wage work	0.172	2.095	0.037	0.160	2.044	0.042
Dummy for part. Skilled wage work	1.382	5.277	0.000	1.383	5.298	0.000
head participation in wage work	0.083	0.863	0.388	0.081	0.864	0.388
Other male member part. in wage work	-0.058	-1.040	0.299	-0.057	-1.027	0.305
Dummy for part.in wage work in May-August	0.372	2.682	0.008	0.357	2.727	0.007
Dummy for part. in wage work in Sep-Dec.	0.012	0.157	0.876	0.012	0.160	0.873
Dependency earners ratio	0.035	0.422	0.673			
Land cultivated per capita	0.016	0.733	0.464			
Inverse mills ratio	0.131	1.938	0.053	0.138	2.173	0.03
Constant	0.191	0.765	0.445	0.245	0.914	0.362
Adjusted R^2	0.56			0.57		

T-ratios are calculated based on heteroscedasticity consistent standard errors; P>|T| is the lowest significance level that the underlying coefficient is different from zero.

Estimates of wage offer equations of the heads, wives, other male members and other female members are presented in Table 4.9 and Table 4.10. In all the cases, wage rates are explained more by demand influencing attributes than by individual characteristics and efficiency wage considerations. Wages were higher in 1996 than in *1997* because 1996 was a good harvest year when the farm sector achieved remarkable growth. Consequently, the growth of the farm sector has increased the demand for off-farm work in rural areas through the labour market linkages (Haggblade and Hazell, 1989) resulting in an increase in the wage rate. Except for the other male members, wages are higher in *Enderta* district than in *Adigudom* district indicating the responsiveness of wages to demand. The availability of jobs is usually higher in *Enderta*

district than in *Adigudom* district. The seasonality of demand for off-farm work also has a strong influence on the variation in wages. For example, husbands receive a wage, which is by 0.21 Birr/hour higher in the peak period (September-December) than in the slack season (January-April).

The results show that there is a very high earning differential across off-farm job types. Participation in non-farm activities instead of the food for work program enables household members to get higher wages. Compared to working in the food for work program, household heads get wages 1.62 Birr/hour higher when they work in non-farm skilled jobs and 0.18 Birr/hour higher when they work in non-farm manual jobs. Wives and other male members also get a wage which is 0.10 Birr/hour higher when they participate in non-farm unskilled wage work in contrast to the food for work program. The wage differential across activities reflects the skills required to perform the activities. It is not surprising if the wage paid for labour in the food for work program is low. The food for work program is designed to have a lower wage and to improve the access of the poor to off-farm jobs.

Age, age squared, education, health status, physical strength of individuals, dependency ratio and per capita land cultivated do not show statistically significant effects on the wage rates except for other female members. Other female members who are heavier in weight receive higher wage, while those who are shorter receive a lower wage. Although the ownership of equipment increases the wage rate of all types household members, the coefficients are not statistically significant perhaps because of multicollinearity. However, it is quite common to see (during the informal survey at the Mekelle labour market) farmers who are trained (in a state sponsored training centre) working in low paying non-farm activities because they could not find credit to buy the equipment required to enable them to work in a better paying non-farm jobs. Furthermore, employers in a spot market contract prefer labourers who have equipment, and they are willing to offer slightly higher wages for workers who come with equipment. The employers in the spot contract market do not want to buy their own equipment because they do not have work that lasts for a long period (house construction) or the kind of activity for which they hire labour is seasonal (such as harvesting). Education is affects the wage rate positively, but the effect of education is very small and

statistically insignificant. This may be because most of the off-farm jobs are manual and do not require education at all (Rosenzweig, 1978, 1984, 1988). If some off-farm jobs require education, reading and writing without any other technical skills may not be able to make a substantial change to the wage rate received by the farm households.

The parameter estimates for the dependency ratio and per capital land cultivated (reflecting the efficiency wage theory) are not entirely consistent with the efficiency wage theory. First, they are not statistical significant from zero. Second, the positive effect of per capita land cultivated on the wage rate is quite contrary to the efficiency wage theory. Adjusted R^2 increases when the wage offer equations are estimated without the dependency ratio and per capital land cultivated. Since we are dealing with casual labour, it is not surprising to get results not consistent with the nutrition-based efficiency wage theory. If efficiency wage exists, the nutrition based efficiency wage can only be observed for permanent labour contracts (Binswanger and Rosenzweig, 1984; Bardhan, 1979).

Table 4.9 OLS estimates of wage offer equations of husband and wife (Birr/day)*

Explanatory variables	Dep var. = Husband's wage rate						Dep var. = wife's wage rate					
	Full model			Restricted model			Full model			Restricted model		
	Coef.	T-ratio	P>|T|	Coef.	T-ratio	P>|T|	Coef.	T-ratio	P>|T|	Coef.	T-ratio	P>|T|
Age	-0.013	-0.975	0.330	-0.011	-0.845	0.399	0.001	0.176	0.861	0.001	0.251	0.802
Age squared	0.0001	0.627	0.531	0.0001	0.489	0.625	-0.00003	-0.497	0.619	-0.00004	-0.581	0.562
District dummy (Enderta=1)	0.160	2.827	0.005	0.164	2.841	0.005	-0.046	-1.513	0.131	-0.046	-1.563	0.119
Year dummy (1996=1, 1997=0)	0.160	3.109	0.002	0.159	3.241	0.001	0.151	5.514	0.000	0.151	5.585	0.000
Value of off-farm equip. owned*	0.0001	0.474	0.636	0.0001	0.497	0.619	0.0001	0.561	0.575	0.0001	0.627	0.531
Education dummy (read and write=1)	0.004	0.084	0.933	0.008	0.182	0.856	0.072	0.806	0.421	0.073	0.806	0.421
health condition (ill=1)	0.005	0.122	0.903	0.001	0.028	0.977	-0.025	-1.009	0.314	-0.025	-1.007	0.315
weight dummy (low=1)	-0.053	-1.207	0.228	-0.055	-1.242	0.215	-0.025	-0.907	0.365	-0.024	-0.894	0.372
weight dummy (high=1)	-0.059	-1.041	0.298	-0.062	-1.073	0.284	-0.088	-2.185	0.030	-0.087	-2.127	0.034
height dummy (short=1)	0.012	0.215	0.830	0.010	0.178	0.859	-0.045	-1.488	0.138	-0.046	-1.587	0.113
Height Dummy (long=1)	-0.019	-0.398	0.691	-0.021	-0.448	0.654	0.021	0.588	0.557	0.021	0.591	0.555
Dummy for part. in unskilled wage work	0.182	2.310	0.021	0.174	2.325	0.021	0.100	2.167	0.031	0.101	2.227	0.027
Dummy for Part. skill wage work	1.695	7.319	0.000	1.696	7.329	0.000						
Dummy for part.in wage work May-Aug.	0.195	1.933	0.054	0.191	2.044	0.042	0.323	3.156	0.002	0.324	3.179	0.002
Dummy for part. in wage work Sep-Dec.	0.211	2.345	0.020	0.213	2.371	0.018	0.060	0.867	0.387	0.061	0.880	0.379
Dependency earners ratio	0.056	0.705	0.481				0.010	0.162	0.871			
Land cultivated per capita	0.007	0.296	0.767				-0.002	-0.134	0.893			
Inverse mills ratio	0.193	3.418	0.001	0.194	3.718	0.000	0.172	3.710	0.000	0.171	3.750	0.000
Constant	0.419	1.499	0.135	0.426	1.430	0.154	0.076	0.716	0.474	0.070	0.678	0.498
Adjusted R^2	0.60			0.61			0.577				0.579	

** T-ratios are calculated based on heteroscedasticity consistent standard errors; P>\|T\| is the lowest significance level that the underlying coefficient is different from zero.*

Table 4.10 OLS estimates of wage offer equations of other male and female members (Birr/day)*

Explanatory variables	Dep var. = other male members' wage rate						Dep var. = other female members' wage rate					
	Full model			Restricted model			Full model			Restricted model		
	Coef.	T-ratio	P>|T|	Coef.	T-ratio	P>|T|	Coef.	T-ratio	P>|T|	Coef.	T-ratio	P>|T|
District dummy (Enderta=1)	-0.007	-0.314	0.754	-0.005	-0.245	0.807	0.003	0.370	0.712	0.004	0.552	0.581
Year dummy (1996=1, 1997=0)	0.044	1.632	0.104	0.043	1.597	0.111	0.018	2.016	0.044	0.018	2.021	0.044
Value of off-farm equip. owned	0.001	1.292	0.197	0.001	1.292	0.197	-0.0001	-1.036	0.301	-0.0001	-1.068	0.286
Weight dummy (low=1)	0.081	1.473	0.141	0.081	1.483	0.139	0.046	0.776	0.438	0.045	0.772	0.441
Weight dummy (high=1)	0.008	0.141	0.888	0.011	0.207	0.836	0.133	1.863	0.063	0.131	1.851	0.065
Height dummy (short=1)	-0.019	-0.275	0.784	-0.018	-0.262	0.794	-0.067	-1.723	0.086	-0.068	-1.719	0.086
Height Dummy (long=1)	-0.009	-0.132	0.895	-0.009	-0.130	0.896	0.045	0.966	0.335	0.043	0.910	0.363
Dummy for part. in unskilled wage work	0.104	1.896	0.059	0.098	1.966	0.050	-0.009	-0.474	0.636	-0.011	-0.578	0.563
Dummy for part.in wage work May-Aug.	0.742	6.307	0.000	0.737	6.374	0.000	0.606	6.298	0.000	0.605	6.301	0.000
Dummy for part. in wage work Sep-Dec.	0.042	0.351	0.726	0.041	0.343	0.732	-0.013	-0.105	0.917	-0.013	-0.109	0.914
Dependency earners ratio	0.053	1.181	0.238				-0.003	-0.175	0.861			
Land cultivated per capita	0.003	0.302	0.763				0.003	0.794	0.428			
Inverse mills ratio	-0.054	-0.748	0.455	-0.050	-0.708	0.479	-0.005	-1.137	0.256	-0.005	-1.131	0.259
Constant	-0.089	-2.168	0.031	-0.056	-1.864	0.063	-0.012	-0.863	0.388	-0.009	-1.934	0.054
Adjusted R^2	0.57			0.58			0.72			0.721		

** T-ratios are calculated based on heteroscedasticity consistent standard errors; P>|T| is the lowest significance level that the underlying coefficient is different from zero.*

4.6 Discussion and conclusions

In response to initial differences in factor proportions, farm households integrate themselves into the labour market as employers or as labourers. The exchange of labour tends to reduce the absolute and relative gap in the farm-labour used per unit of land among farm households. However, the extent of use of hired labour is small due to the high transaction cost for monitoring the work effort, liquidity constraints and limited farm size. Nevertheless, the exchange of labour has equalised the returns per labour and land among different farm size classes. This implies that the farm labour market is capable of making agricultural growth trickle down to the poorer segment of the population. Since most farmers are net sellers of labour, the non-farm labour market contributes greatly towards reducing the differences in factor endowments and marginal productivity of labour (thus alleviating poverty and inequality). Although labour exchanges among farm households show seasonal variations, there is also a substantial demand for hired labour in the slack season. This implies that the public work program usually scheduled for the slack seasons is not without an opportunity cost.

Spot contracts dominate the labour market. Permanent labour does not exist in the farm labour market because of the seasonality of farm labour demand, the counter-cyclic nature of off-farm employment, and the risks associated with agriculture. Farm households in the farm labour market and other employers in the non-farm labour market rely on relatives and friends to hire labour. Most workers also rely on relatives and friends to get information about where to find a job. This considerably increase the transaction cost associated with hiring labour and searching for jobs. Hence, there should be assistance from the government to encourage the setting up of dealer who can negotiate between employers and labourers. At least the law that prohibits the establishment of dealers in the labour market should be repealed. Probably, public provision of labour market information might be necessary in the short-run until the market supports the emergence of dealers in the labour market. Such information may include wage rates, the magnitude and type of labour demand (type of skill required) by specific sites and lists of job seekers by skill.

The wage rate in the non-farm labour market varies across agricultural seasons and skill requirements implying that supply and demand forces affect wage rates.

Demand factors are very important in explaining the variations in wages. Individual differences are slightly important for those who find off-farm work in the non-farm sector. There is an efficiency wage in the farm and the non-farm labour market. Most employers provide workers with food during work to stimulate their morale. Most of the people working as masons and carpenters acquire their skill after long time practice, which is very slow and unproductive. This has led to the short supply of well-qualified masons and carpenters for construction and other investment activities. To enable the investment activities and infrastructure works to perform better, there should be some kind of organised on-location training of workers for building and other construction works. The establishment of training programs in addition to those established by the Tigray Development Agency might be necessary. Vocational schools or local master craftsmen can give training programs as well. The most important feature of a successful training program is one linked with the labour market. Unless a training establishment is responsive to changing labour market conditions, their graduates will encounter difficulties in finding employment and the investment in training will be socially unproductive.

Location, type of wage employment and year influence the non-farm wage rate farm households receive. The wage rate varies across location implying that there is lack of mobility of labour, which requires further investigation. Education affects the wage rate positively, but the effect of education is very small and statistically insignificant. This may be because most jobs do not require education (Rosenzweig, 1978, 1984, 1988). Wage rates vary across seasons and activities implying that the wage rates reflect the demand and supply of labour as well as the amount of effort required to perform the job. The efficiency wage in the labour market is not very relevant. Rather, the wage is determined more or less by marginal productivity; farm households are partially engaged in the labour market; and the labour market operates competitively (Rosenzweig, 1988), but is constrained by transaction costs.

CHAPTER 5. INCOME DIVERSIFICATION, OFF-FARM INCOME AND FARM PRODUCTIVITY

5.1 Introduction

Empirical attention has been given more to the effect of agricultural growth on rural non-farm activities (Bagachwa and Stewart, 1992; Hazell and Hojjati, 1995; Haggblade, Hazell and Brown, 1989) than to the effect of off-farm income on farm income. Literature that looks at the effect of off-farm income on farm income deals mainly with a theoretical explanation, postulation of hypotheses and a research agenda (Reardon, 1994, 1997). Few studies that have been made at the household level do not introduce the linkages systematically into a farm household model (Evans and Ngau, 1991). In general empirical evidence on how off-farm income affects farm income at micro level is scarce.

Traditionally, diversification of income sources and crops is thought to reduce farm productivity. However, income and crop diversification can have both positive and negative impact on farm productivity and farm income, and their net impact cannot be determined *a priori*. The lack of specialisation may reduce farm productivity because of inefficiency in management and competition for some complementary inputs such as labour and capital. In case of a credit or capital constraint, farm and off-farm activities can be complementary to each other as sources of cash so that income from off-farm activities can be used to finance purchase of farm inputs (see Chapter 3). Involvement of farm households in various activities may increase their managerial skill and reduce the pressure on land that in turn increases farm productivity. Hence, the net effect of income diversification on production and farm income is *a priori* ambiguous.

Farm households may also diversify their crops because of natural conditions or to reduce the overall income risk. Crop diversification might increase agricultural productivity and farm income if diversification of crop is done in order to keep the crop rotation sequence and match crop with soil type. If diversification of crop is done to reduce the overall income and consumption risk, it will certainly decrease farm income because of the inefficiency introduced from lack of specialisation.

The effect of agricultural growth on the rural non-farm activities is well documented in development economics literature. A rising agricultural income stimulates the growth of rural non-farm activities through production, consumption, and labour market linkages (Haggblade and Hazell, 1989; Reardon, 1997; Reardon et al., 1997). On the other hand, off-farm income also has an important role in the farm household economy. In case of credit constraint and risky environment, off-farm income can increase households' farm productivity by mitigating risk and promoting farm investment (Evans and Ngau, 1991) and financing consumption. Off-farm income provides farm households with insurance against the risk of farming and thereby enables them to adopt new technologies. Off-farm activities help farm household to hire farm labour, purchase farm implements, livestock and other inputs such as fertiliser, pesticides and seeds. Off-farm income reduces the variance of household income, improves food security and smoothes consumption thereby keeping farmers healthy and productive. Off-farm income can also serve as collateral and thus facilitate access to credit (Reardon, Crawford and Kelly, 1994).

The neo-classical farm household model predicted that a farm household chooses to work either on the farm or off-farm depending on the marginal return from farm and off-farm work (Becker, 1965; Singh et al., 1986; Huffman, 1991). When the market wage rate is above the shadow or reservation wage, off-farm income substitutes for farm income, whereas when marginal return to labour is greater than the market wage rate, farm income substitutes for off-farm income. Low and unstable yields, a short growing season, lack of irrigation or drought, credit/capital market failure and land constraint may push farm households into off-farm activities (Reardon, Delgado and Malton 1992). Most importantly, when off-farm and farm returns are less than perfectly correlated, farm households can reduce the overall income risk by diversifying their income sources into various farm and non-farm activities (Reardon et. al. 1994).

In Ethiopia, the policy focus is to increase agricultural productivity and farm income so as attain food self-sufficiency at a national and regional level. While substantial resources have been spent on agricultural research and extension to alleviate food shortage in the nation, no research and extension have been done on the issue of off-farm employment versus farm employment. Despite this fact, farmers are engaged in a variety of off-farm activities to diversify their income and enable them to feed themselves during crop failures. The main question and worry of policy makers

may be whether it is possible to support farmers to enable them to participate in off-farm activities without sacrificing the farm productivity and food self-sufficiency objectives. Hence, looking into the link between farm and off-farm activities and their determinants is necessary before policy measures are taken to promote off-farm activities.

This chapter has the following objectives: (1) to investigate the effect of crop and income diversification on farm productivity; and (2) to identify the determinants and the relative importance of the determinants of off-farm income. The agricultural household model developed in chapter three of this book is used as a conceptual framework to explain and derive variable input demand and the households' choice between farm and off-farm work.

The rest of the chapter is organised as follows. In section two, the theoretical framework is presented. In section three, the econometric models and the methodologies are described. In section four, a description of the survey area and data set are provided. In section five, the results are explained. Finally, some concluding remarks are given.

5.2 Conceptual framework

I follow the agricultural household model developed in Chapter 3. However, the production technology is modified to include diversification indices (Sakurai and Reardon, 1997). The production function is specified as

$$Q = Q(X, L_h, L_f; A, K, CD, IND, z) \tag{5.1}$$

where Q if farm output, *Q(.)* is production function concave in inputs; X variable inputs such as hired labour, seed, fertiliser and pesticides; L_f is on-farm labour hours supplied by the household; *A* is area of land cultivated; *K* is capital (one-year depreciation of farm equipment and livestock); *z* contains farm characteristics; *CD* is *Simpson's* crop diversification index and *IND* is *Simpson's* income diversification index. Crop and income diversification indices (Patil and Taillie, 1982) are defined as:

$$CD = 1 - \sum_{i=1}^{K} \left(\frac{area\ of\ crop\ i\ planted}{total\ area\ cultivated} \right)^2 \tag{5.2}$$

$$IND = 1 - \sum_{i=1}^{K} \left(\frac{income\ from\ activity\ i}{household's\ total\ income} \right)^2 \tag{5.3}$$

where $i = 1, 2, ...K; i=1$ is off-farm income; $2, 3, ...K$ are other sources of income; K is the number of crops grown by a household or the number of income sources of a household. Simpson's index is zero when $K=1$, and one when K is infinity.

Crop diversification and income diversification are included in the production function because diversification can directly affect the efficiency of production. The lack of specialisation may reduce farm productivity because of inefficiency in management and competition for some complementary input such as labour, capital, and cash. However, income diversification may increase agricultural productivity. In case of a credit or liquidity constraint, farm and off-farm activities can be complementary to each other as sources of cash so that income from off-farm activities can be used to finance purchase of farm inputs. The involvement of farm households in various farm activities and non-farm activities will increase their managerial skill because of learning by doing. Involvement in off-farm activities may also reduce the pressure on land and enable farm households to use better farming practices such as fallowing and crop rotation.

If farm households are constrained by the lack of opportunities to work in off-farm activities, crop diversification is another option for reducing the overall income and consumption risks. This will certainly decrease agricultural productivity because of the inefficiency introduced from the lack of specialisation. Farmers may diversify their crops in order to keep the crop rotation sequences and match crops with appropriate soil type. If farm households cultivate plots of land scattered across different soil types, they will have higher crop diversification. This type of diversification most likely increases agricultural productivity and farm income rather than creating inefficiency. The net effect of crop diversification can be, therefore, either negative or positive.

Farm household's decision to choose between working on farm or off-farm activities depends on the first-order conditions *(3.17) and (3.19)* in chapter 3. If the marginal value of leisure or marginal value of on-farm work exceeds the off-farm wage offered, the optimal off-farm work is less than or equal to zero (corner solution). If off-farm wage is greater or equal to the marginal value of leisure time or marginal return from working on the farm, the optimal hours of off-farm work is potentially positive. Hence the participation in and allocation of labour to off-farm activities depends on the factors that affect both the farm and off-farm activities (Huffman, 1991).

In our model, off-farm income affects farm productivity in two ways: through the purchase of farm inputs and through the income diversification index. The income diversification index can be used to determine the differential impact of off-farm income and net farm income on agricultural productivity. The marginal effect of diversifying income sources into off-farm activities on farm productivity is dependent on the marginal contribution of off-farm income to the income diversification index and the effect of diversification on farm production. Given the equation that defines the income diversification index (3), the marginal effect of off-farm income and net farm income on agricultural production is given by:

$$\frac{\partial Q(.)}{\partial Y_o} = \frac{\partial Q(.)}{\partial IND}\frac{\partial IND}{\partial Y_o} = \frac{\partial Q(.)}{\partial IND}.\frac{2Y_o^2 + 2(total\ income - Y_o)^2 - 2Y_o(total\ income)}{(total\ income)^3} \quad (5.4)$$

and

$$\frac{\partial Q(.)}{\partial Y_F} = \frac{\partial Q(.)}{\partial IND}\frac{\partial IND}{\partial Y_F} = \frac{\partial Q(.)}{\partial IND}.\frac{2Y_F^2 + 2(total\ income - Y_F)^2 - 2Y_F(total\ income)}{(total\ income)^3} \quad (5.5)$$

where Y_o is non-farm income and Y_F is net farm income. Hence, whether off-farm income and net farm income have positive or negative impact on farm productivity depends on the sign of the income diversification effect on production and the marginal effect of off-farm and net farm income on the diversification index. The impact of diversifying income sources into off-farm activities compensated for the loss of net farm income can be determined by subtracting (5.5) from (5.4).

The factors that determine input demand and labour supply depend on whether the production decision is separable from the consumption decision. When there is no full participation of households in off-farm work, the household's production and consumption decisions are not separable (Huffman, 1991). Therefore, solving the first-order condition simultaneously, the off-farm labour supply and demand for variable input can be found to be a function of market wages, prices, non-labour income, farm characteristics and household characteristics (Huffman, 1991)[1]. In addition, off-farm labour supply also depends on the total time endowment of a

[1] For the derivation of optimal input, output and farm and off-farm labor supply, see Huffman (1991, pp. 92-98).

household (Singh et al., 1986) and location characteristics (Lass, Findeis and Hallberg, 1991).

Based on the foregoing conceptual model some hypotheses can be drawn. In the production function, both variable and fixed inputs are expected to have a positive sign. The crop diversification and income diversification indexes can have either positive or negative impact on the productivity of agriculture depending on the relative strength of the opposing forces discussed above. Farm output has a positive impact on input demand. If farm households face either a liquidity or credit constraint, off-farm income can have a positive impact on the demand for purchased variable inputs such as hired farm labour fertiliser, seeds, and pesticides. While farm households with higher family size are expected to have a lower level of hired farm labour, those who have a higher number of dependants are expected to hire more farm labour.

Factor inputs that increase farm income are expected to have a negative effect on the off-farm labour supply because of substitution and income effects. When farm income increases, the value of farm labour increases, and household allocate more labour to farm than to off-farm activities. Farm income raises the marginal value of consumption (leisure) and as a result households allocate less labour to off-farm activities. Higher non-labour income is expected to decrease the amount of labour allocated to off-farm work because of income effect resulting an increase in the marginal value of consumption of leisure.

Family characteristics can have diverse effects on the off-farm work decision of farm households. The effect of human capital variable (education) cannot be determined *a priori* as it affects both farm income (which increases the marginal value of farm labour) and off-farm income. Age and age squared can capture the life cycle effect (Sumner, 1982). Households are expected to work more during their younger age and save, and reach a peak at a certain age level. When they reach a certain age level, they start working less and consume what they have saved. Hence, we expect age and age squared to have a positive and a negative effect on off-farm work, respectively. Farm households with a larger family size are expected to allocate more hours for off-farm work because an increase in family size will decrease the marginal value of consumption of leisure. On the supply side, a greater family size increases household's time available for off-farm work. The effect of the number of dependants on the off-farm work decision is ambiguous to determine *a priori*. The number of

dependants in a farm household may reduce the marginal value of consumption and hence increase off-farm work participation, or it may reduce the household's time available for work, especially those of wives, and so reduce the probability and level of participation in off-farm work. The off-farm work decision of a farm household is affected not only by their willingness and their ability to supply labour, but also by the demand for off-farm labour. Location characteristics can capture the impact of access to and availability of employment opportunity. Farm households that are located closer to a bigger town are expected to have higher participation and to allocate more labour for off-farm work.

5.3 Model specification and estimation

In cross section data where prices do not vary, the econometric estimation of the full set of optimal farm input demand and labour supply is problematic. Hence it is necessary to make some simplifications in empirical modelling. An important feature in our data is that there are several observations where farm output, variable farm inputs, and off-farm labour hours supplied are zero. As this feature destroys the linearity assumption, the least square method of estimation is clearly inappropriate (Amemiya, 1984, p. 5). Consequently, the following tobit models are specified, which correspond to the theoretical model developed in chapter 3 (household indicator *i* is suppressed for easy readability).

$$\begin{aligned} &Q^{*}=Q(X,L_f;A,\ K,\ CD,\ IND,\ z,\ e_1)\ ,e_1\sim N(0,\sigma_{e1}^2) \\ &Q\ =Q^{*}if\ Q^{*}>0,\ \ Q=0\ otherwise \end{aligned} \tag{5.6}$$

$$\begin{aligned} &X^{*}=X(Q,Y_o,\ z,\ a,e_2),e_2\sim N(0,\sigma_{e2}^2) \\ &X\ =X^{*}\ if\ \ X^{*}>0;\ \ X\ =0\ \ otherwise \end{aligned} \tag{5.7}$$

$$\begin{aligned} &L_m^{*}=L_m(X,A,K,w_m,z,a,e_3),e\sim\ N(0,,\sigma_{e3}^2) \\ &L_m=L_m^{*}\ if\ L_m^{*}>0;L_m=0otherwise \end{aligned} \tag{5.8}$$

where Q and Q^{*} are observed and latent output, respectively; X and X^{*} are observed and latent variable farm inputs, respectively; Y_o is off-farm income composed of income from off-farm labour and non-labour income, L_m and L_m^{*} are observed and latent off-farm labour hours supplied off-farm, respectively; w_m is the market wage rate received by farm households; e_1, e_2, and e_3 are error terms and σ^2_{e1}, $\sigma^2_{e2,}$ and σ^2_{e3} are their variances, respectively.

This specification is a simultaneous equation (tobit model) which requires a two stage estimation method (Maddala, 1983). Equation (5.6) is a production function in which production is measured in monetary term. It is specified to be dependent on family labour, variable farm inputs (hired labour, seed, fertiliser and pesticides), land, one-year depreciation value of farm implements and livestock, soil depth index, location dummies and a year dummy. Because the dependent variable in the production function is in monetary term, the share of high value crop is added to the production function as an explanatory variable in order to pick up the higher values that might be imposed on the value of farm output[2]. The production function is specified as a Cobb-Douglas production function and final estimation is made per unit of land.

The Cobb-Douglas production function is used because it is linear, homogenous and it yields a reasonable estimate of the marginal productivity of family farm labour. It has an advantage of being easily interpreted in economic term. However, it is more restrictive than a translog production function (Lau, 1986). In our case, the translog production function does not meet the required properties: increasing in inputs, and concave in variable inputs (Christensen, Jorgenson and Lau, 1975). As a result, it yields a negative production elasticity of family farm labour (and the shadow value of family farm labour) for more than half of the households. Despite its apparent complexity for estimation, the constant elasticity of substitution (CES) production function (which is a general case of Cobb-Douglas production function) is only perfectly adequate for two inputs. To use it for more than two inputs, unreasonable restrictions on the substitution possibilities of inputs must be made (McFadden, 1963; Uzawa, 1962)[3].

In the estimation of the production function estimation, family labour hours used at the farm and variable farm inputs are considered as endogenous variables because they may depend on agricultural output. Instrumental variables for family labour used at the farm and variable farm inputs are family size, number of dependants, education dummy, age and age squared of the household head, and soil

[2] Wheat, teff, linseed, lentils, chickpea, beans and vegetables are considered as high value crops, whereas oat, sorghum, finger millet, maize, barley and latyrus (vetch) are considered as low value crops. This is determined based on their long-term market price in the region.

[3] To use more than two inputs in CES production function, factor inputs are divided into classes such that the direct elasticity of substitution between any pair of inputs within a class is one, and between any two inputs drawn from any two different classes is some single value (McFadden, 1963, p.74).

types. Since the crop diversification index, the income diversification index and the share of high value crops may also depend on farm output, they may be correlated with the error term, which can result in biased estimates of the parameters. The number of plots a household cultivates, the soil depth index, the share of different soil types, the dependency ratio, and the value of non-farm equipment owned are used as instrumental variables for the crop diversification index, the income diversification index and the share of high value crops. However, location dummies, year dummies, the one-year depreciation value of farm implements, and the total values of livestock wealth are assumed to be exogenous for the household. The farm implements and livestock wealth is not likely to vary in the short-run. The survey shows that the purchase of farm capital and livestock was not done every year in the study area.

Equation (5.7) and (5.8) refer to the demand for the variable farm inputs, and off-farm hours of labour supply, respectively. The demand for the variable farm inputs is dependent on gross farm income, off-farm income, year and location dummies, the soil index and household characteristics (family size and number of dependants). Since farm and non-farm incomes are assumed to be endogenous, instrumental variable estimation is used. Total labour used on the farm, land, value of farm implements, animal wealth, the share of high value crops, and location dummies are used as instrumental variables for farm income. The instrumental variables used for off-farm income are family size, number of dependants, value of off-farm equipment owned, animal wealth, year dummy and location dummies.

Off-farm hours of labour supply are assumed to be dependent on the wage rate received by a household, farm inputs (such as variable inputs), farm characteristics such as land cultivated, farm implements and livestock wealth owned, non-labour income, human capital variables (education, age, age squared), household composition (family size and number of dependants), location dummies and year dummy. Variable farm inputs and market wage rates are assumed to be endogenous. The area of land cultivated, soil depth, soil type and availability of credit are the instrumental variables used for variable farm inputs. The market wage is defined as off-farm labour income divided by off-farm labour hours supplied. The market wage rate is predicted from a wage offer equation correcting for a sample selectivity bias using Heckman's two-stage method (Maddala, 1983, p. 205, pp. 241-242). Age, age squared, the education dummy, off-farm equipment owned, a district dummy and the inverse mills ratio are used to predict the market wage rate. The inverse mills ratio is

derived from a probit equation of participation in off-farm work. The independent variables in the probit equations are the farm inputs, household assets, age, age squared, family composition, education dummies, year and location dummies.

5.4 Description of the farming system

The data set characterising the households is described in Table 2.6 and 2.7 of chapter 2. A description of important variables is provided in Table 5.1. Farm households in the sample area have two agricultural income sources and three off-farm income sources. The complete list of income sources includes crop husbandry, livestock production, food for work program, unskilled wage employment, skilled wage employment, off-farm self-employment and non-labour income. Farm households participate in two types of farm activities: crop and livestock husbandry. Crop husbandry is the major income source of farm households. In the household's total income, total farm production accounts for 57 % which consists of livestock 16 % and crop production 41 %. Off-farm labour income accounts for 35% and non-labour income accounts for 8 % of the total income. Based on equation (5.3), the average income diversification index is calculated as 0.5.

Table 5.1 Description of important variables

Variable	Median	Mean	Std. Dev.	Min	Max
Income diversification index	0.517	0.500	0.197	0	0.91
Crop diversification index	0.651	0.634	0.208	0	0.99
Soil depth index	0.9	0.669	0.317	0	0.9
Proportion of farmers who receive credit	-	0.393	0.489	0	1.0
Prop. of farmers who use the extension service	-	0.209	0.407	0	1.0
Share of high value crop	0.44	0.418	0.260	0	1.0
Proportion of black soil cultivated	0.25	0.305	0.282	0	1.0
Proportion of sandy soil cultivated	0.286	0.328	0.305	0	1.0
Proportion of loam soil cultivated	0.357	0.364	0.282	0	1.0
Total value of farm output (Birr)	2057.5	2382.0	2129.6	30	20528
Expenditure on total variable farm input	543.5	745.1	845.4	0	5311
Value of farm implements owned	210.5	237.6	185.7	0	1427
Total animal wealth	2770.0	3615.6	5297.5	0	63700
Off-farm labour hours supplied	1045	1346.58	1402.43	0	9920

Land and labour are the most important factors in agricultural production. About 84 % of the total farm labour used come from the family. Of the rest 10 % and 6% come from hired labour and labour sharing arrangements, respectively. Farmers in the sample area classify the soil into three types: black soil (*walka*), loam soil (*bakel*) and sandy soil (*hutsa*). The use of fixed (such as Farm implements) and variable

capital farm inputs is very limited. Farm implements comprise of traditional plow, hoe and sickles. Variable capital input includes fertiliser, pesticides and seeds. The use of credit to finance farming activities and extension services is very restricted. Few of the farm households acknowledged using extension services (21%) and credit to finance their farming activities (39%). Farmers plant a variety of crops, namely cereals such as wheat, barley, teff, sorghum and finger millet; legumes such as vetch, lentils and chick pea; and oil crops such as linseed. Using equation (5.2), the crop diversification index is calculated to be 0.6 on the average.

They also participate in a variety of off-farm activities like non-farm self employment and off-farm wage employment. Off-farm wage employment includes paid work in community development projects (food for work); and non-farm wage employment such as manual work, mason and carpentry. Non-farm self-employment includes petty trade, transportation service using pack animals, wood and charcoal making, selling fruits, making pottery and handcrafts, stone mining etc. In general, about 81% of the farm households participate in off-farm activities.

5.5 Results and discussion

Income diversification and farm productivity. Table 5.2 summarises the results of the production function estimation. The production function fits the data quite well. The result shows that family labour, variable farm inputs and farm implements and livestock used on the farm explain agricultural production to a significant extent. The parameter estimates of all factor inputs have the expected sign and are significantly different from zero at a one-percent level, except for livestock, which is significant at a 10% level. Variable farm input has the highest output elasticity of all factor inputs. When variable inputs increase by 10%, farm output increases by 3.2 %. The elasticity of output with respect to livestock is very low, that is, 0.05. Family labour and farm-equipment have comparable elasticity. When family labour increases by 10%, farm output increases by 2.6% (and in case of farm implements, by 2.7 %). The elasticity of output with respect to total land cultivated is calculated to be 0.12[4] which is greater than the contribution of livestock, but less than that of family labour and farm

[4] Since we use constant return to scale, land elasticity of farm output is given by one minus the sum of elasticities of output with respect to all other inputs (1-0.255-0.316-0.265 = 0.117).

implements and variable inputs. The share of high value crops is not significantly different from zero although the sign is positive. The year dummy shows that agricultural output was higher in 1996 than in 1997, which makes sense as the 1997 was a relatively drought year. Location dummies too are very important and capture the difference in rainfall and other environmental (location) factors.

The crop diversification and income diversification indexes show a remarkable result. Income diversification resulted in higher agricultural output per unit of land. When income diversification increases by 10%, farm productivity increases by 8.6%. Using the formula in equation (5.4), on the average, when off-farm income increases by one Birr, agricultural production increases by 1.7 Birr. Whereas the shift of income from farm income to off-farm income by one Birr increases farm output by 1.5 Birr. This shows that the managerial skill that comes from learning by doing in various activities and the better farming practices effect dominate the effect of competition for input uses and reduction in efficiency that comes from the lack of specialisation. Crop diversification has a positive impact on agricultural output per unit of land. This shows that farm households diversify their crops in order to match the type of crop with the soil type and perhaps to follow crop rotation sequences. Therefore, crop diversification does not result in inefficiency in production.

Table 5.2 Parameters estimation of production function (dependent variable Ln = value of farm output in Birr)

Explanatory variables	Coefficient	Marginal effect (Elasticity for inputs)	∂Y/∂X
Ln (family labour hour)	0.362***	0.255	1.17 Birr/hr
Ln (total variable inputs in Birr)	0.448***	0.316	1.04 Birr
Ln (P2V2ND)	0.375***	0.265	2.65 Birr
Ln (TANIMND)	0.066*	0.047	0.21 Birr
Share of high value crop	1.253	0.883	
Crop diversification index	2.42***	1.710	
Income diversification index	2.454*	1.729	
Soil depth index	0.337	0.238	
Year dummy (1996=1, 1997=0)	0.291**	0.205	
Dummy for Tabia Araasegda	0.905***	0.638	
Dummy for Tabia Fekre alem	1.488***	1.049	
Dummy for Tabia Felegeselam	-0.168	-0.119	
Dummy for Tabia Mytsedo	-0.126	-0.090	

*** *The parameter is significantly different from zero at 1 % ;* ** *the parameter is significantly different from zero at 5 %;* * *the parameter is significant different from zero at 10 %; Ln = natural logarithm; P2V2ND = one-year depreciation value of agricultural equipment Birr per unit of land cultivated; TANIMND = one-year depreciation value of livestock Birr per unit of land cultivated; Elasticity of output with respect to land = 0.12 and the marginal effect is 41.8 Birr per tsimdi of land (one hectare =four tsimdi).*

Off-farm income and the use of variable inputs in agricultural production. The estimation result for demand for variable inputs is summarised in Table 5.3. Soil types, location, farm and non-farm incomes are the most important factors that determine variable input use on the farm. The effect of household composition (dependency ratio) and inter-year environmental factors (year dummy) are not significantly different from zero at any reasonable level of significance. Off-farm income makes the same contribution as farm income to the financing of farming activities. Controlling for other factors, the use of variable farm input is highly influenced by off-farm income. The effect is significantly different from zero at a one-percent level. This implies that farmers are liquidity constrained to finance their farming activities. If farmers were not liquidity constrained, off-farm income would have no effect on the use of variable inputs. When off-farm income increases by 10%, expenditure on farm variable inputs increases by 1.3 percent.

Table 5.3 Tobit estimation of expenditure on variable farm inputs

Explanatory variables	Coefficient	Marginal effect[+]
Dependency ratio	0.28	0.251
District dummy (Enderta=1, Adigudom=0)	0.93***	0.825
Year dummy (1996=1, 1997=0)	-0.16	-0.142
Proportion of black soil	5.89***	5.230
Proportion of sandy soil	5.78***	5.129
Proportion of loam soil	6.04***	5.366
Ln (land cultivated)	0.081	0.072
Ln (off-farm income)	0.15***	0.133
Ln (farm income)	0.16***	0.132
Constant	-2.91***	

*** *The parameter is significantly different from zero at 1 % ;* ** *the parameter is significantly different from zero at 5 %;* * *the parameter is significant different from zero at 10 %; Ln = natural logarithm.*
[+]*See appendix A5.4 for the derivation of marginal effects.*

Off-farm labour supply. Table 5.4 summarises the estimation results of off-farm labour supply of farm households[5]. The probability and level of participation of farm households' in off-farm work is highly dependent on the wage rate they received. The year dummy, variable input used in agricultural production, livestock wealth, land cultivated, non-labour income, wage rate, family composition, and locations explain the variation in the off-farm labour supply. Farm households have an upward-sloping off-farm labour supply curve. The own wage elasticity of off-farm labour supply is inelastic. When the wage rate increases by 10 %, the probability of

[5] Estimates of the probability of participation in off-farm work can be obtained by dividing the parameter estimates of the off-farm labor-supply by the standard error (see Appendix A5.4).

participation in off-farm work and the level of off-farm labour supply increase by 1.9% and 5.3%, respectively[6]. Non-labour income has a negative effect on the supply of off-farm labour signifying the fact that leisure time of the households is a normal good.

Variable input use, farm implements, and land cultivated decrease the supply of off-farm labour. This is due to the income and substitution effects. These variables increase agricultural output and hence the marginal value of farm-labour. When the marginal value of farm labour increases, households substitute farm work for off-farm work (*substitution effect*). When agricultural income increases, due to the increment in factor inputs, the household's demand for leisure time increases (*income effect*) and hence the supply of off-farm labour decreases. However, the effect of livestock wealth on off-farm labour supply is positive and significantly different from zero at a 5% level. This could be due to many reasons. First, since livestock production is less labour intensive and can be done by child labour, it is less likely that livestock husbandry competes with off-farm work for labour. Second, some of the livestock wealth (donkey, mules and horses) can be used to do business in the non-farm sectors such as petty trading, fuel-wood and charcoal selling, stone mining and transport by pack animals.

Household composition and characteristics show some influence on the off-farm work decision. Family size and the number of dependants greatly influence the off-farm work decision. Those with larger family size and greater number of dependants have a higher probability and level of participation in off-farm work. This is because a larger family size increases the availability of labour and reduces the marginal utility of consumption. The education dummy and age of the household head and off-farm equipment owned are modelled to affect off-farm work directly and indirectly through the wage rate. Farm households where the household head can read and write have a lower probability and level of participation in off-farm work. The direct elasticity of off-farm labour supply with respect to education is positive, 0.001. The indirect effect that acts via the wage rate is negative (-0.12). The indirect effect dominates and the net elasticity turns out to be negative (-0.12). The direct effect is not statistically significant at any reasonable level. This is because that substantial

[6] Elasticities are calculated based on the marginal effects on unconditional expected value. These elasticities are always higher than those calculated based on the marginal effect conditional on being uncensored (see Table A5.3 in the appendix).

proportion of the off-farm work (60%) is on food for work program where education is not required at all. The value of off-farm equipment owned shows a positive net effect on off-farm labour supply. While the direct effect is negative, the indirect effect that works via the wage rate is positive. The net elasticity of off-farm work with respect to the value of off-farm equipment owned is calculated as 0.1. The direct effect of the age of the household head on the off-farm labour supply is not significantly different from zero. Nevertheless, the indirect effect that acts via the wage rate is significantly different from zero and has a quadratic pattern. A household head receives highest wage at the age 30.

The probability and level of participation in off-farm activity is also highly influenced by location characteristics and the year dummy, which reflect the demand for off-farm labour. The location dummies show that the probability of off-farm employment is stronger in locations, which are near to construction sites. In general, the participation and the level of off-farm work are higher in 1996 than in 1997.

Table 5.4 Parameter estimates off-farm labour supply (in hours)

Explanatory variables	Coefficient	Marginal effect[+]		
		Unconditional Expected value	Conditional on being uncensored	Probability uncensored
Age of the household head	-32.44	-26.22	-19.20	-0.007
Age squared	0.503	0.41	0.30	0.0001
Year dummy (1996=1, 1997=0)	-346.57**	-280.19	-205.16	-0.077
Education dummy (read and write=1)	4.25	3.43	2.51	0.001
Ln (variable farm input)	-144.32**	-116.68	-85.43	-0.032
Ln (farm implement owned)	-105.20	-85.05	-62.28	-0.023
Ln (livestock wealth)	101.24**	81.85	59.93	0.022
Ln (off-farm equipment owned)	-45.79	-37.01	-27.11	-0.010
Ln (land cultivated)	-602.18***	-486.84	-356.48	-0.133
Ln (non-labour income)	-154.40***	-124.83	-91.40	-0.034
Ln (market wage rate received)	887.39***	717.42	525.32	0.196
Family size	620.65***	501.77	367.42	0.137
Number of dependants	-500.43***	-404.57	-296.24	-0.110
Dummy for Tabia Araasegda	1236.75***	999.86	732.134	0.273
Dummy for Tabia Fekre alem	52.86	42.74	31.29	0.012
Dummy for Tabia Felegeselam	616.8***	498.69	365.16	0.136
Dummy for Tabia Mytsedo	722.39***	584.026	427.65	0.160
Constant	1863.16			

[+]*Marginal effects conditional on being uncensored means the marginal effect on the level of off-farm work being off-farm work is positive. Marginal effects on probability being uncensored means the marginal effect on the probability of participation in off-farm activities.* *** *The parameter is significantly different from zero at 1 % ;* ** *the parameter is significantly different from zero at 5 %;* * *the parameter is significant different from zero at 10 %; Ln stands for natural logarithm.*

5.6 Conclusions

In a risk free and perfect capital market environment, diversification can make farm households loose the gains that they could have achieved from specialisation. However, in an environment where agriculture is risky and the credit market is nearly non-existent, diversification, especially income diversification increases the farm households capacity to undertake risk at farm level and to use more variable inputs in production which will eventually lead to higher return in agriculture. The foregoing analysis has made clear that income diversification increases productivity, that is, increases production per unit of land. It also reveals that off-farm income helps to finance farming activities such as purchase of farm labour and other inputs such as seeds, fertiliser, and pesticides. Since crop diversification is done to match the type of crop with the soil type, it does not result inefficiency in production. Therefore, there is a substantial potential for increasing farm income of farm households by diversifying their income sources in general and by promoting off-farm employment in particular.

The supply of labour for off-farm work (and hence off-farm income) is largely determined by farm characteristics, market wage rate and household compositions. It increases with market wage rate, livestock wealth, and family size, and decreases with non-labour income, farm assets, variable farm inputs, and area of land cultivated.

Farm households have an upward-sloping off-farm labour supply curve. However, an increase in the wage rate does not necessarily lead farmers to leave the farm and work off-farm. Since agricultural production is seasonal, farm households can work off-farm during the slack seasons and work on their farm in peak seasons. If the labour market is smooth and farmers do not have a liquidity constraint, they can hire labour in case of labour shortages. By enabling farm households to engage in both farm and off-farm activities, it might be possible to make farmers more efficient thereby increasing the productivity of agriculture.

Therefore, increasing agricultural output and raising agricultural productivity cannot be seen in isolation. Complementary policies and programs must be developed to strengthen the link between farm and non-farm activities. The current agricultural extension program should encompass both farm and non-farm activities and

encourage the growth of small-scale business and create non-farm employment opportunities in rural areas.

CHAPTER 6. TIME ALLOCATION, LABOR DEMAND AND LABOR SUPPLY OF FARM HOUSEHOLDS

6.1 Introduction

The government in a developing country may intervene in the agricultural sector through pricing policies and investment projects. Such policies can influence production and consumption as well as the livelihood of farm households. These policies may be designed to generate revenue, secure self-sufficiency, improve rural incomes, etc. However, the way in which agricultural households respond to such interventions is a critical factor in determining the relative merits of alternative policies (Singh et al., 1986). To explore the possible responses to government interventions, therefore, it is necessary to understand the microeconomic behaviour of agricultural households.

Two main policy approaches can be identified with a view to increasing employment and reducing poverty. The first one is to improve productivity in agriculture and produce enough food to meet the growing demand, that is, to promote self-sufficiency in food. The second one is to promote investment in the rural non-farm sector in order to provide alternative income earning opportunities. The extent to which the benefit of rural investment strategies, technological innovations in agriculture and the provision of off-farm employment are transmitted through the labour market to the landless and poor households depends substantially on how farm households adjust their labour supply and demand.

Investment in rural non-farm activities will increase the off-farm employment of farm households. However, it can conflict with the objective of increasing food production. If there is surplus labour in the region, providing off-farm employment may have no adverse effect on agricultural production (Sen, 1966). If, however, there is no surplus labour in agriculture, the allocation of labour between farm and off-farm income will depend on the relative return to family labour (Becker, 1965; Gronau, 1977). If farmers find that off-farm employment is more profitable than farming, they will allocate their labour to off-farm activities at the expense of agricultural production. In this case the program of self-sufficiency in food production may not be

achieved. On the other hand, off-farm employment can help to achieve self-sufficiency in food if off-farm income has a positive effect on agricultural production. With the income from the off-farm employment a farmer can buy inputs and thus improve agricultural productivity (Evans and Ngau, 1991).

The objective of this chapter is to identify the determinants of farm labour demand and supply of farm households for farm and non-farm activities and their relative importance; and to assess the role of off-farm income on hired farm labour in Tigray, Northern Ethiopia. The chapter also describes the household's time allocation among its various activities: leisure, home and farming activities and social obligations. The chapter uses an agricultural household model elaborated in Chapter 3, in which production and consumption decisions are interrelated (Singh et al., 1986). Household's labour supply is decomposed into farm and off-farm labour on the one hand, and into male and female members' labour on the other hand. Then a set of structural equations consisting of the production function, labour demand and labour supply equations is specified and estimated using the tobit estimation method (Maddala, 1983).

The rest of the chapter is organised as follows. In the next section, the description of household time allocation among home, farm, non-farm and social activities is presented. The theoretical model is described in section three. In section four, the econometric model and estimation methods are described. The estimation results of labour demand and supply of farm households are presents in section five. The chapter ends with conclusions.

6.2 Description of households' time allocation

The data set includes a sample of farm households from two districts and five Peasant *Tabias* (Peasant associations) as described in Chapter 2. The main occupation of the households is farming activities. Descriptions of additional variables are also given in Table 6.1 (see also Table 2.6 and Table 2.7 in Chapter two). On average, 42% of the family members are working. The household heads and wives sleep eight to ten hours a day. The rest of their time is allocated for various home, farm and off-farm activities as well as for social activities. Home activities include food preparation, childcare, fuel wood gathering and water fetching. Female members mainly do the home activities, but male members sometimes gather fuel wood. In about 51% of the

households, the head participates in fuel wood gathering. Food preparation and childcare are exclusively the female members' duty.

Farm activities include plowing, planting, weeding and harvesting as well as cattle keeping. Male members do all plowing and planting and most harvesting and weeding. Female members participate to a substantial extent in weeding and harvesting activities. In about 80% of the households, male members work for eight to ten hours on the farm, while female members work 4-6 hours during weeding and harvesting time. Child labour is used for cattle keeping. Out of the total labour used in agriculture, 78% comes from family members. The rest of the labour used on the farm comes from hired labour (15%) and labour-sharing arrangement among neighbours (7%). There is a difference in the two districts regarding the source of farm labour. In Enderta, hired and shared labour make a substantial contribution to farming activities. Hired labour constitutes 18% and shared labour accounts for 11% of the farm labour used. In *Adigudom* farm households are close to self-sufficient in labour. The contribution of hired labour (9%) and labour from labour sharing arrangements (1.3%) is very low. In general about 40% of the farm households in the sample hire farm labour. Comparing the district, 50% of the farm households in *Enderta* district hire farm labour, whereas 31% hire farm labour in *Adigudom* District.

Table 6.1 Description of variables related to time allocation

Variables	Mean	St.dev.	Minimum	Maximum
Number of holidays for farm work	15	1.8	11	20
Number of holidays for off-farm work	11.8	1.7	5	15
Hour of sleeping per day for head and wife	8.7	1.18	7	13
Working hours per day on the farm (head)	7.9	2.9	0	11
Working hours per day for farm wife	4.0	3.3	0	10
Total farm labour used in hours	631.1	491.00	0	2909
Family labour used on the farm in hours	491.5	235.73	0	1968
Hired labour used on the farm in hours	92.6	199.84	0	1486
Share labour used on the farm in hours	47.0	134.38	0	1420
Off-farm labour supplied by male members	997.2	1209.6	0 (30)*	9920
Off-farm labour supplied by female members	349.4	604.6	0 (40)*	3840
Market wage rate of male members (n=316)	1.23	1.6	0.20	14.74
Market wage rate of female members (n=167)	0.82	1.03	0.23	9.33

** Figures in parenthesis are the minimum next to zero.*

The male members, particularly the head, are the main participants in off-farm activities. The female participation rate in off-farm activities (42%) is lower than the male participation rate (79%). They all work seven to eight hours per day. The male members' participation rate is higher in *Enderta* District than in *Adigudom* District,

whereas the female members' participation is higher in *Adigudom* than in *Enderta*. Households engaged in two types of off-farm activities: wage employment and self-employment. Wage employment includes paid work on soil and water conservation, manual work, and masonry and carpentry in construction site. Self-employment in non-farm activities includes petty trade, stone mining, manufacturing of handicrafts (weaving, blacksmith work and pottery); and selling prepared foods, drinks, charcoal, and fuel wood. Wage employment is the dominant type of off-farm activity. It accounts for about 92 % of the male members' off-farm working hours and 97% of female members' off-farm working hours.

Apart from home, farm and off-farm activities, households spend substantial time on various social obligations. Every adult member of the household (whose age is greater than 18 years) has to provide 20 person-days per year free labour for public soil and water conservation work. The household head also spends 3.5 hours per week on other social obligations such as church and ceremonial services. Farm households also do not work on farm and off-farm activities during Coptic Church holidays (or Saint days). These holidays have decreased the available time for work by almost 50%. On the average, the Orthodox Christian does not work for 15 days per month on farming activities such as plowing, weeding and harvesting and for 12 days per month on off-farm activities. However, most of the social obligations such as church and ceremonial services and marketing activities are done during the holidays[1].

6.3 Theoretical model

Households maximise utility subject to cash income, time and non-negativity constraints as indicated in chapter two. However, few modifications are made to the household preference and cash and time constraints of chapter two. The farm household derives utility (U) from a combination of consumption goods, on farm labour (L_f) and off-farm labour (L_m) given household characteristic (a) such as education, family size, number of dependants and age. Consumption has a positive, and farm and off-farm labour time have negative impact on utility:

$$U = \mathrm{U}(\ C, -L_f\ , -L_m; a) \qquad (6.1)$$

[1] About 98.5 % of the farm households are Orthodox Christian in the study area and 1.5 % are Muslims.

where C is a vector of consumption goods, L_f and L_m are vectors of on-farm family labour hours and off-farm labour hours, respectively; a is household characteristics. The cash constraint is substituted for by the following income constraint:

$$P_c C \leq \pi(q; L_f, Z) + \sum_{j=1}^{m} w_{mi} L_{mj} + v \equiv Y \qquad (6.2)$$

where P_c is price vector of consumption goods; q is a price vector of net outputs; L_{fj} is a vector on on-farm labour hours supplied by household members; Z is fixed inputs (land, capital and technology) and farm characteristics such as soil type and location; w_{mj} is the market wage rate received by household member j; L_{mj} is off-farm labour hours supplied by the *j-th* household member; v is non labour income; Y is full income; and $\pi(q; L_f, Z)$ is restricted profit function. The profit function is given by

$$\pi(q; L_f, Z) = \max(q^T Q : (Q; L_f, Z \in \bar{T})) \qquad (6.3)$$

where Q is a column vector of net outputs; $\bar{T}$ is a closed, bounded and convex production possibility set.

The condition that the profit is dependent on fixed inputs (such as family labour), and that the preference is allowed to be affected by on-farm and off-farm labour shows that the farm household utility and profit maximisation decisions are not separable (Lopez, 1984). This interdependence arises because the shadow wage rate of farm labour is endogenous, depending on the production and consumption sides of the model.

However the budget constraint is non-linear so that it is not possible to use traditional demand theory. In order to circumvent this problem, the budget constraint is approximated around the optimal level of on-farm labour (Thijssen, 1992) as

$$P_c C \leq Y_O + \sum_{j=1}^{m} w_{fj} L_{fj} + \sum_{j=1}^{m} w_{mj} L_{mj} + v \qquad (6.4)$$

where w_{fj} is the shadow wage rate of on-farm labour of the j^{th} household member given by

$$w_{fj} = \frac{\partial \pi(q; L_{fj})}{\partial L_{fj}}; j = 1, 2, ..., m \qquad (6.5)$$

and

$$Y_O = \pi(q; L_{fj}^*, Z) - \sum_{i=1}^{m} w_{fj} . L_{fj}^* \; ; j = 1,2,...,m . \qquad (6.6)$$

The superscript * indicates the optimum amount. Hence the budget constraint can be rearranged for convenience (Elhorst, 1994) as:

$$P_c C - \sum_{j=1}^{m} w_{fj} L_{fj} - \sum_{j=1}^{m} w_{mj} L_{mj} = Y_o + v \equiv S \qquad (6.7)$$

where S is called unearned income hereafter.

Substituting the linear budget constraint, the household maximises the following Lagrangian function[2]:

$$L = \mathrm{U}(C, -L_{fj}, -L_{mj}; a) + \mu[P_c C - \sum_{j=1}^{m} w_{fj} L_{fj} - \sum_{j=1}^{m} w_{mj} L_{mj} - S] \qquad (6.8)$$

where μ is the marginal value of income. Then solving the Lagrangian function, a reduced form of demand for farm labour (L_d) on the production side, and a system of demand for consumption goods *(C)* and on farm family labour supply (L_{fj}) and off-farm labour supply (L_{mj}) on the consumption side can be obtained:

$$L_d = f(q, z, a) \qquad (6.9)$$

$$L_{fj} = f(w_{fj}, w_{mj}, S, a). \qquad (6.10)$$

$$L_{mj} = f(w_{fj}, w_{mj}, S, a). \qquad (6.11)$$

where L_d is total farm labour hours demanded; L_{fj} is on-farm labour hour supplied by the *j-th* household member; L_{mj} is off-farm labour hour supplied by the *j-th* household member. This means that the farm household operates according to the following two-stage process. In the first stage farm households maximise short-run profit. In the second stage they maximise their utility and make a choice between on-farm profit and on-farm labour time (Elhorst, 1994). This two stage process signifies that the household can only be in equilibrium if the demand for on-farm labour is equal to the supply of on-farm labour, and the marginal value of on-farm labour is equated with the marginal rate of substitution between on-farm labour and consumption.

Theoretically, the marginal productivity of farm labour and the effective off-farm wage rate received must be equal if households are involved in both farm and off-farm activities. Empirically, however, the estimated marginal productivity of farm labour (shadow wage rate) and off-farm wage rate may not be equal for various reasons. First, mis-specification may arise in the production function, which may

[2] Maximizing utility with labor hours as argument instead of leisure hours avoids the problem of assigning arbitrary values for the total households' endowments of time (Elhorst, 1994, p. 262).

result in errors in estimating marginal productivity. Second, if there is rationing and transaction cost in the labour market, the marginal productivity of farm labour and the market wage rate may be different (Skoufias, 1994). Third, due to liquidity constraints and the seasonality of agricultural production, farmers may be involved in off-farm activities in the slack season to finance farming activities during the peak season (Skoufias, 1993). Hence the market wage rate cannot be a substitute for the shadow wage rate in the estimation of labour supply.

6.4 Econometric model specification and estimation

In this section, the production function, labour supply and demand equations are specified. There are two ways to specify the labour supply equations. The first approach is to derive a system of structural demand equations from a particular form of the utility model: for example, the almost ideal demand systems (Deaton and Muellbauer, 1980a, 1980b) or the translog indirect utility model (Christensen, Jorgenson and Lau, 1975). The second approach is to directly specify the reduced form of the labour supply equations, which are often called *ad hoc* models. Structural demand equations have an advantage over the *ad hoc* models in that they can be used to evaluate alternative policy measures through simulation. However, it is not easy to derive the structural equations, especially in non-separable household models. Furthermore, elasticity estimates from a structural model also depend on the choice of functional form of the utility model. Deriving own and cross wage elasticity is much easier with *ad hoc* models. Since the objective here is to derive the elasticity, we follow the second approach.

Since the price vector q is constant across households, the empirical model we employ here is slightly different from the theoretical model mentioned above. In addition to the variables included in the theoretical model (6.9), we include variable capital farm inputs and non-farm income in the list of the explanatory variables for the demand for farm labour and hired labour. Non-farm income is included to account for the liquidity needed to hire farm labour (see Chapter 3 for argument). An we noted earlier, there are several observations in our data where farm output, hired labour hours and family labour supplied on and off-farm are zero. As this feature destroy the linearity assumption, the least square method of estimation is clearly inappropriate (Amemiya, 1984, p. 5). Consequently, the following tobit models for the production

function (Q), reduced form demand for total farm labour hours (which includes hired labour) and for hired labour hours (L_d), the supply of on-farm family labour hours (L_{fj}), and the supply of off-farm labour hours (L_{mj}) are constructed (* denotes latent variable and without * denotes observed variable; household indicator subscript i is dropped to improve readability):

$$\begin{aligned} Q^* &= Q(X, D, \beta, e_1), e_1 \sim N(0, \sigma_{e1}^2) \\ Q &= Q^* \text{ if } Q^* > 0, Q = 0 \text{ otherwise} \end{aligned} \tag{6.12}$$

$$\begin{aligned} L_d^* &= f(X_p, Y_{of}, z, a, e_2), e_2 \sim N(0, \sigma_{e2}^2) \\ L_d &= L_d^* \text{ if } L_d^* > 0 \ , \ L_d = 0 \text{ otherwise} \end{aligned} \tag{6.13}$$

$$\begin{aligned} L_{fj}^* &= f(w_{fj}, w_{mj}, S, a, e_3), e_3 \sim N(0, \sigma_{e3}^2) \\ L_{fj} &= L_{fj}^* \text{ if } L_{fj}^* > 0, L_{fj} = 0 \text{ otherwise} \end{aligned} \tag{6.14}$$

$$\begin{aligned} L_{mj}^* &= f(w_{fj}, w_{mj}, S, a, e_4), e_4 \sim N(0, \sigma_{e4}^2) \\ L_{mj} &= L_{mj}^* \text{ if } L_{mj}^* > 0, L_{mj} = 0 \text{ otherwise} \end{aligned} \tag{6.15}$$

where Q is the total value of crop output; β is a vector of parameters; X is a vector farm input used by the farm household (which includes hours of family labour; hours of hired labour; variable capital inputs such as fertiliser, seed, pesticides; the level of land cultivated; one year depreciation value of farm equipment and of livestock wealth); D in the production function includes location and year dummies as well as the share of high value crops; X_p is expenditure on variable capital inputs; Y_{of} is non-farm income; z is a vector of fixed inputs (such as area of land cultivated, value of farm implements and livestock wealth) and farm characteristics (such as location and year dummies); a denotes household characteristics such as education, family size, number of dependants and age; and e_1, e_2, e_3, and e_4 are error terms summarising the influence of other omitted variables and σ^2_{e1}, σ^2_{e2}, σ^2_{e3} and σ^2_{e4} are the variance of the error terms, respectively. Because the dependent variables in the production function are in monetary terms, the share of high value crop is added to the production function as an explanatory variable in order to pick up the higher values that may be imposed on the value of farm output[3].

The absence of variation in the prices of inputs and outputs can make the identification of the demand for and the supply of labour very problematic. The observed hours of labour use on the farm is the result of an equilibrium between the demand and the supply of labour. Hence to identify the demand for and the supply of

[3] For the definition of the share of high value crops, see chapter five.

labour on the farm, it is necessary to examine variables that shift the demand for and supply of labour. Fortunately we have enough variables that shift the demand for farm labour (such as non-farm income, household compositions, year and location dummies) and the supply of labour (household composition, household characteristics such as age, age squared, education, year and location dummies). Furthermore, the dependent variables in the demand for and supply of farm labour are different in our specification. On the demand side, we estimate total labour demand and hired labour demand, which are influenced more by demand factors than by supply factors. The most important factors for farm labour demand are not only the availability of family labour, but also expected output (which is dependent on the use of farm inputs) and liquidity (such as off-farm income). If there is a need for farm labour, farm households can hire labour and allocate their labour off the farm. On the supply side, we estimate the supply of family farm labour, which is influenced largely by supply factors. As long as farmers have the opportunity to join the off-farm labour market, the most important factors for farmers to supply farm labour are the relative return to family labour on and off the farm, and household preferences and opportunities to work off-farm. Hence family labour used on the farm is influenced more by supply factors than by demand factors. In our estimation, therefore, it is possible to identify the demand for farm labour and the supply of family farm labour.

The log linear model of the production function (6.12)[4] and farm labour demand (6.13), as well as the linear model of the labour supply equation (6.14) and (6.15) are estimated using the instrumental variable approach, often called the two stage tobit estimation method (Maddala, 1983, p. 245). Here in our case we have one on-farm labour supply equation and two off-farm labour supply equations for the male and female members. It was difficult to decompose on-farm family labour into those for male and female members. For off-farm labour supply (L_{mj}) $j=1$ refers to off-farm labour supply for the male members and $j=2$ refers to off-farm labour supply for the female members.

[4] The Cobb-Douglas production function is used because it linear, homogenous and it produces a reasonable estimate of marginal productivity of family farm labor. It has an advantage of being easily interpreted economically. However, it is more restrictive than a translog production function (Lau, 1986). If the coefficients of the translog function on the interaction terms are jointly significant, use of Cobb-Douglas function may represent mis-specification. In our case, in addition to the problem of multicollinearity, the estimated elasticity of family labor on the farm (and the shadow value of family farm labor) turned out to be negative for more than half of the households (53%) when the translog production function is used.

The shadow wage rate for household i (w_{fi}) is derived based on the Cobb-Douglas production function using the expression:

$$w_{fi} = \frac{\hat{Q}_i(.)}{L_{fi}} \beta_f \qquad (6.16)$$

where $\hat{Q}_i(.)$ is the fitted value of output by farm household i, L_{fi} is family labour supplied for farm work by household i, and β_f is estimated coefficient of family labour in the production function. Market wage rates are defined as off-farm labour income divided by off-farm labour hour supplied.

In the production function, family farm labour, hired farm labour, variable capital inputs are considered as endogenous variables. In the equation of demand for farm family labour and hired labour, non-farm income and expenditure on purchased farm inputs are considered as endogenous variables. In the labour supply equation, the shadow wage rate of on-farm family labour (w_f) and unearned income (S) are endogenous to the model. The shadow wage rate of on-farm family labour time is a function of the shadow value of household time and income. Hence any change in the exogenous variables in the system will lead to a new optimal value for the shadow value of households time and thus in turn leads to a new optimal value for the shadow wage rate. This implies that both the shadow wage rate and unearned income are correlated with the unobserved variables summarised by the error term in an econometric estimation of labour supply. One possible way to control for the endogeneity of unearned income and the shadow wage rate is to estimate the labour supply equations (6.14) and (6.15) using the instrumental variables estimation method (Greene, 1993).

With cross section data, getting appropriate instruments, correlated with the endogenous variable but uncorrelated with the error term, is very difficult. However, we have managed to get instruments for the endogenous variables in the production function, labour demand and labour supply equations. The following instruments are used for the endogenous variables in the production function. Instruments used for family farm labour are age, age squared, an education dummy, location dummies, family size, number of dependants; and market wage rate. For hired labour, the instrumental variables used are family size, number of depends, non-farm income, and soil types. For other variable inputs, the level of credit obtained, soil types, a district dummy, and non-farm income are used as instruments.

The instrumental variables used in the labour demand equation are age, age squared, education, location and year dummies, off-farm equipment and transport animals owned for the endogenous variable non-farm income; and the amount of credit obtained, soil type, the share of high value crops, a dummy for participation in extension, and a district dummy for the endogenous variable expenditure on purchased farm inputs.

In the labour supply equations, the instruments used for shadow wage and unearned income (*S*) are all of the farm inputs (except family labour), a district dummy, share of high value crops and soil types. Wage rates of off-farm work are predicted from wage offer equations. Market wage rates are predicted from wage offer equations, which are estimated using Heckman's two-stage estimation method (Maddala, 1983, pp. 231-234) in order to correct for any sample selection bias that might be created. Independent variables in the wage offer equations are age, age squared, ownership off-farm equipment and transport animals, education dummies, year and location (village) dummies, and the inverse mills ratio. Inverse mills ratios are derived from the probit equations for participation in off-farm work. The independent variables in the probit equations are all farm inputs, household assets, age, age squared, family composition, education dummies, year and location (district) dummies.

6.5 Estimation results and discussion

The production function (6.12) is first estimated using the instrumental variable estimation method. The labour demand equation (6.13) for total farm labour and hired farm labour is similarly estimated using instrumental variables. Then the shadow value of farm labour is calculated using the estimated parameters of the production function. The shadow value of farm labour is tested to see if it is equal to the off-farm wage rate received by the farm households following the method used by Jacoby (1993) and Skoufias (1994, pp. 225-226). Instrumental variable estimation is used to test the equality of the wages. There is a strong positive relationship between the market wage rate and the marginal product of farm labour. The test rejects the null hypothesis that they are equal at a one- percent level of significance. Farm labour and off-farm labour supply of farm households are estimated using off-farm wage rates

and shadow wage of farm labour, among others, as explanatory variables. The detailed estimation results for all equations are presented in the appendix.

Farm labour demand. The most important variables that affect total farm labour demand are the area of land cultivated, value of farm equipment, expenditure on purchased capital inputs, non-farm income, year and location dummies (Table 6.2; see also Table A6.3 and Table A6.4 in the appendix). The demand for total farm labour responds positively to the area of land cultivated, the value of variable farm inputs used and off-farm income, and negatively to farm implement and animal wealth. When land area increases by 10%, the demand for total farm labour increases by 4%. Variable inputs appear to be a gross complement to the total farm labour demand with an elasticity of 0.8. The elasticity of farm labour demand with respect to off-farm income is 0.15. Farm implement shows a negative impact signifying the fact that it is a gross substitute with total farm labour. Although the coefficient of livestock wealth is not significantly different from zero at any reasonable level, the negative sign could be due to competition for family labour between livestock husbandry and crop production.

The demand for hired farm labour responds positively to the area of land cultivated, off-farm income, variable farm inputs used and livestock wealth, and negatively to the value of farm implement. The most significant response is to the area of land cultivated and off-farm income. The demand for hired labour is unitary elastic with respect to the areas of land cultivated and non-farm income. One normally expects off-farm income to show no impact on the demand for total and hired farm labour if there is a perfect capital markets (i.e. no borrowing constraint). If, however, farmers face a borrowing constraint, they may depend on off-farm income to finance the hiring of farm labour during peak agricultural seasons. The positive impact of off-farm income on the total and hired farm labour demands supports the latter view that farm households face a borrowing constraint in financing their farming activities. The impact of livestock wealth on the demand for hired labour is positive and significant unlike that of the demand for total farm labour demand. The possible interpretations for this are that (1) livestock production may help farmers generate income that can be used for the purchase of farm labour and (2) hired labour is used exclusively for crop husbandry such that there is no competition for hired labour between livestock husbandry and crop production. Although the sign of the variable farm inputs on the

demand for hired farm labour is positive, the magnitude of the impact is very low and is not significantly different from zero at any reasonable level.

Table 6.2 Marginal effects on the demand for total farm labour and hired farm labour

Explanatory variables	Dependent variables	
	Ln (total farm labour)	Ln (hired farm labour)
Family size	-0.061	-0.757***
Number of dependants	0.04	0.527***
Ln (land cultivated)	0.396***	1.1***
Ln (off-farm income)	0.152*	1.012***
Ln (value of farm implements)	-0.087***	-0.05
Ln (animal wealth)	-0.004	0.349***
Ln (expen on variable farm inputs)	0.766***	0.091
Year dummy (1996=1)	0.103**	0.718***
Dummy for Tabia Araasegda	0.104	-0.472*
Dummy for Tabia Fekre alem	0.265*	1.081**
Dummy for Tabia Felegeselam	-0.368**	-1.545***
Dummy for Tabia Mytsedo	-0.191*	-0.53*

**** is significant at 1%; ** is significant at 5%; and * is significant at 10%.; ln = natural logarithm.*

Family size, number of dependants and livestock wealth do not affect total farm labour demand. Quite a different estimation result is obtained for hired labour demand. The demand for hired labour decreases when the family size increases, whereas the demand for hired labour increases when the number of dependants increases. The demands for total labour and for hired labour vary across the two years. The demand is found to be higher in times of expected good harvest, that is, 1996. The demand for total labour and for hired labour are also highly dependent on natural and environmental conditions as indicated by the location dummies.

Marginal product of farm labour. The production function, from which the shadow wage is derived, fits the data very well (see Table A6.2 in the appendix). All coefficients, except for the depreciation value of oxen and donkey, are significant. The production elasticity of family labour is 0.45, which is quite high. From the production function, the shadow wage rate is computed. In general, the off-farm wage rate received by an average farm household in the sample is 13 % less than the computed shadow value of farm labour. The median average marginal value of farm labour is 1.38 Birr/hour, while the average off-farm wage rate received by the farm household is 0.95 Birr/hour. Looking at the distribution of the marginal value of farm labour, about 26% of the farm households have less than one Birr/hour. The proportion of farm households that have a marginal product of labour between one and two Birr/hour is 58 %. The remaining 16% have above two Birr/hour. The off-farm wage rate ranges from 0.20 Birr/hour to 14.7 Birr/hour. About 83 % of the farm

households receive less than one Birr/hour. Among those farm households who engage in off-farm work, about 31% of them have male members' market wage rate greater than the marginal product of farm labour. The majority (69 %) has a marginal product of farm labour higher than the market wage rate received by male members. In general, there is a difference in the magnitude of the marginal product of farm labour between those farm households engage in off-farm work and those who do not (Table 6.3). The marginal product of labour is 28% higher for the non-participants than for the participants in off-farm activity.

Table 6.3 The marginal product of farm labour for participant and non-participant in off-farm work

	Birr* /hour
Non-participant in off-farm work	1.77
Participant in off-farm work	1.28
Total	1.38

* *One US Dollar was equivalent to seven Ethiopian Birr.*

Labour supply. The estimation results for farm and off-farm labour supply are summarised in Table 6.4 (see also Table A6.5 - Table A6.7 in the appendix). The shadow wage of farm labour, male household members' market wage rate, the household head's education and wife's education, year dummy and some location dummies significantly influence the farm labour supply of family members. The own wage elasticity for on-farm family labour supply is found to be slightly greater than unity (1.24). The influence of the male members' market (off-farm) wage rate is negative signifying the fact that farm labour and off-farm labour are substitutes, but it is small (-0.03). Education has two contrasting effects on the supply of farm labour. On the one hand, households when the head can read and write supply more labour on the farm than those when the head cannot read and write. On the other hand, households when the wife cannot read and write supply less labour on the farm than those when the wife cannot read and write. The fact that less labour was supplied in 1996 than in 1997 and that the labour supply differs across location show that natural conditions such as soil type and the amount of rainfall influence the labour supplied on the farm. The income effect is positive, but not significant. The result is inconsistent with the estimates of off-farm labour supply of male and female members' (see below), which might be due to mis-specification. Although the parameter estimates of family composition (size and the number of dependants) are

not significantly different from zero, the supply of labour on the farm increases with both family size the numbers of dependants. The age of the household shows a quadratic pattern, but the parameter estimates are not significantly different from zero. Family labour supply increases with age, reaches its maximum at the age of 43 years and decreases thereafter.

Table 6.4 Elasticity of on-farm and off-farm labour supply of male and female members

Explanatory variables	On-farm labour	Male off-farm labour	Female off-farm labour
Shadow wage of on-farm family labour	1.238***	-1.264**	-0.680**
Male Off-farm wage rate	-0.026*	0.701***	-0.038
Female off-farm wage rate	-0.0001	-0.049*	0.813***
non-labour income plus Y_o † (S)	0.007	-0.048	-0.143**
Education dummy of head	0.051**	-0.030	0.045
Education dummy of house wife	-0.025**	0.054**	-0.043
Age of the household head	-0.078	0.285	0.858
Family size	0.198	2.396***	0.167
Number of dependants	-0.098	-1.079***	0.439

*Elasticities are calculated based on the unconditional expected marginal effects. For the derivation see Appendix A6.2. *** is significant at 1%; ** is significant at 5%; and * is significant at 10%.. † Y_o is the constant term (intercept) of the linearised budget constraint.*

Wage rate and family composition are the main determining factors in the off-farm labour supply of male members, whereas female members' off-farm labour supply is influenced by the wage rate and non-labour income. The own wage elasticities of male and female members are positive and significant suggesting an upward sloping labour supply. The off-farm labour supply of both male and female members is decreasing with the non-labour income (exogenous income) indicating that leisure time is a normal good. But the parameter estimate of the income effect on the male labour supply is not significantly different from zero. The own wage elasticity of male members' off-farm labour supply is less elastic (0.7) than that of female members' (0.8). The estimated own wage elasticity of both male and female members in this study is higher than those estimated for Indian (Skoufias, 1994) and Peruvian (Jacoby, 1993) households. They are also slightly higher than that estimated for the Northern Ghana (Abdulai and Delgado, 1999). The cross wage elasticity between male and female off-farm labour supply is small[5] and negative indicating that they are substitutes. The off-farm labour supply of male and female members increases with family size and the numbers of dependants. This indicates that family

[5] But they are not symmetric. The effect of the female wage rate on the male wage rate is higher than that of male on female.

size reduces the marginal value of households' leisure time and hence increases the marginal value of households' home time. However, the parameter estimates of family composition on the female members' off-farm labour supply are not significantly different from zero.

When household heads are able to read and write, male members supply less labour for off-farm work and female members (wife) supply more labour for off-farm work. Similarly, when household wives are able to read and write male members supply more labour for off-farm work and female members (wife) supply less labour for off-farm work. The supply of off-farm labour was higher in 1996 than in 1997 although the parameter estimates are not significantly different from zero. Location dummies also have a significant influence on both the male and female labour supplies. However, the age and age squared variables do not show a significant effect on off-farm labour supply (except for the effect of age squared on the male members' off-farm labour supply). Off-labour labour supply of both male and female members decrease with age, but at a decreasing rate when the household grows older.

6.6 Conclusions

The estimated models provide important findings that can be used to derive policy implications. Increased expenditure on purchased farm inputs increases the demand for farm labour, and non-farm-farm income makes a significant positive contribution to the hired farm labour demand. Off-farm labour supply is reasonably responsive to own wage rate. Farm labour supply is a substitute to off-farm labour supply, but it is low enough for off-farm work to discourage farming activities. On the other hand, the effect of the return to farm labour on off-farm work is high enough to make farmers reduce the amount of labour supplied for off-farm work. The own wage elasticities of off-farm labour supply are found to be higher than those estimated for other countries such as India (Skoufias, 1994) and Peruvian Sierra (Jacoby, 1993). They are also slightly higher than that estimated for the Northern Ghana (Abdulai and Delgado, 1999). Male and female members of a household have different wage elasticity. The own wage elasticity of female members is higher than that of male members. The cross wage elasticity between male and female off-farm labour supply is negative, but very low. The shadow value of farm labour and the wage rate received from off-farm

work are not equal perhaps due to the imperfect labour market that arises due to transaction cost and rationing of labour in off-farm work.

These findings may have some policy implications. First, the effect of policies aimed at shifting the supply of off-farm labour will have a differential impact on household labour income depending on the gender composition of households. Second, creating off-farm employment opportunities for female women will only have a small negative impact on the male members' off-farm labour supply. Third, increasing the return to off-farm work (wage rate) can be used as one of the policy instruments to promote off-farm employment with only a small negative impact on the supply of farm labour. Fourth, increasing off-farm employment can help to release the farmers' liquidity constraints and promote commercialisation of agriculture by increasing the use of hired labour on the farm. Fifth, increased use of fertiliser and improved seeds help to increase on-farm employment and absorb idle family labour.

CHAPTER 7. OFF-FARM EMPLOYMENT, ENTRY BARRIERS AND INCOME INEQUALITY

7.1 Introduction

One of the basic assumptions of diversifying income sources into off-farm activities is to supplement the farm income of the poor and reduce the income inequality that exists in rural areas. The incentive to diversify income sources into off-farm activities is stronger for poor than for rich farm households because the relative return to off-farm work is greater for the poor than for the rich. The risk aversion motives to diversify income into off-farm declines as farm household's wealth increases if risk aversion is negatively related with wealth (Newbery and Stiglitz, 1981). However, if there are entry barriers and rationing in the labour market, diversifying income into off-farm activities will be more difficult for poor farm households than for rich farm households (Reardon, 1997). The presence of a credit (liquidity) constraint may make it difficult for poor farm households to finance investment (such as equipment purchase or rent, skill acquisition, capital for initial investment and a license fee) needed to participate in off-farm activities. Community level barriers can also exist that prevent farm households from participating in off-farm activities. Due to poor infrastructure there is limited labour market integration (Sadoulet and De Janvry, 1995). The lack of labour market integration leads to rationing of off-farm jobs in some communities. The lack of infrastructural facilities may restrict the movement of labour between communities or make it costly to move to towns. As a result off-farm employment may worsen income inequality rather than reducing it.

Analysing off-farm work participation without making a distinction between self-employment and wage employment is valid only if the nature of off-farm wage and self-employment are quite similar. But the nature and determinants of off-farm wage employment and off-farm self-employment are different. Off-farm wage employment is a temporary employment contract in which the employer gives a direct order, whereas off-farm self-employment involves ownership of a firm that produces goods and services, and buyers who do not give direct orders (Reardon, 1997). The input requirements of wage and self-employment may also be different. Wage

employment generally does not require as much capital as self-employment. If there is a credit constraint and own capital is limited, then undertaking self-employment may be more difficult than wage employment. Self-employment also requires managerial skill to run the business. On the other hand, wage employment is more available in areas nearer to towns and commercialised agriculture. In areas far from urban centres, farm households can engage in petty trade, as the competition from urban traders is very low. Near urban centres, off-farm self-employment may face serious competition from urban areas. Hence, the determinants of participation in off-farm self-employment and wage employment and their relative importance will be different. As a result, the relative contribution of off-farm wage and self-employment for reducing poverty and income inequality is different within and across communities. Most of the studies have analysed off-farm employment as a whole without making a distinction between wage and self-employment (Abdulai and Delgado, 1999; Jacoby, 1993; Skoufias, 1994). The relative contributions of off-farm wage employment and off-farm self-employment to household total income and poverty alleviation is seldom known (Reardon, 1997). Given the general lack of studies on off-farm activities, analysing the relative importance of wage and self-employment is crucial for a better targeting of programs designed to alleviate poverty.

The objective of this chapter is, therefore, (1) to identify the determinants of farm households' choice between wage and self-employment, and (2) to analyse the relative importance of wage and self-employment in overall household income and income inequality. The total farm household income is decomposed into various categories of farm and non-farm incomes. The income categories used are crop income, livestock income, off-farm self-employment, off-farm wage employment (paid food for work, non-farm manual wage employment and non-farm skilled wage employment) and non-labour income. The relative contributions of these income sources to the overall income inequality are assessed using the G*ini decomposition method* (Lerman and Yitzhaki, 1985). Probit and tobit models as well as a multinomial logit model, consistent with a non-separable agricultural household model, were estimated to identify the factors that determine the labour allocation decisions of farm households.

The rest of the chapter is organised as follows. The nature of off-farm work in the study areas is described in the next section. In section three, a Gini-decomposition technique and an econometric model specification are described. A brief theoretical

background is provided in section four. The impact of off-farm income on overall income inequality is presented in section five. Estimation results are discussed in section six. The paper ends with some concluding comments.

7.2 The nature of off-farm employment

The types of off-farm activities in which farm households participate can be categorised into wage employment and self-employment. Three types of wage employment can be distinguished, namely paid development work, manual non-farm work, and non-manual (skilled) non-farm work. Paid development work involves jobs in community micro dam construction, community soil and water conservation works such as construction of terraces and afforestation, and other community works done under the food for work program. Manual non-farm work is an activity in which farm households work for private and public construction companies in urban and near urban areas. Non-manual (skilled) non-farm work involves masonry, carpentry and cementing in public and private construction sites. Off-farm self-employment comprises mainly petty trade, transporting by pack animals, stone mining, pottery and handicraft, selling of wood and charcoal, local brewery and selling of fruit such as *beles*.

The participation rates for different off-farm activities are presented in Table 7.1. The dominant type of off-farm work is wage employment. Paid development work (food for work) is the major source of wage employment in both districts. The overall average participation rate in wage employment is 72%. The participation rate in off-farm self-employment is approximately 28% of which more than half comes from the Enderta district. Manual non-farm wage employment is the second most important type of wage employment in Enderta district. Non-manual (skilled) wage work is done by 7 % of the households in Enderta district. Non-farm wage employment (both manual and non-manual) is almost non-existent in Adigudom District. The food for work program is the sole provider of wage employment in Adigudom. There is a remarkable difference in the seasonal distribution of participation in off-farm activities between the two districts. In Enderta, farm households' participation in off-farm work is higher during the slack season, twice that of the peak season. In Adigudom, farm households' participation is uniform in all seasons. This implies that there is more surplus labour in Adigudom than in Enderta.

Table 7.1 Off-farm work Participation rates (%) by type and season in two districts

Activities	Total sample (n=402)	Enderta (n=200)	Adigudom (n=202)
Wage employment	72.1	71.0	73.3
January - April	71.1	69.0	73.3
May - August	69.9	66.5	73.3
September - December	52.5	32.0	72.8
Off-farm self-employment	27.9	42.5	13.4
January - April	24.6	38.0	11.4
May - August	20.4	27.5	13.4
September - December	14.7	17.0	12.4
Total off-farm work	81.0	86.5	75.3
January - April	80.1	85.0	75.3
May - August	75.4	75.5	75.3
September - December	60.0	45.0	74.6
Food for work	57.7	42	73.3
Manual non-farm wage work	19.2	38.0	0.5
Skilled non-farm work	3.5	7	0

Employment in paid development work does not require experience, skill and initial capital investment. Its wage rate is the lowest of all types of wage employment. If there are not enough jobs in paid development work, priority is given to poorer farm households. Manual non-farm work requires up to 40 Birr[1] of initial capital for the purchase of equipment needed for the job. Although experience and skill are not required, farm households may spend a lot of time searching for a job in manual non-farm work. Usually, friendship and kinship play a dominant role in getting employment in this type of work. Skilled non-farm work definitely requires experience, skill and initial investment in equipment. At least 150-300 Birr is required to be involved in skilled non-farm work. The wage rate for this type of activity is three times higher than that for manual work. Those who have their own equipment are preferred in the local labour market. In off-farm self-employment, farm households need to have some level of working capital to get started in self-employment (such as petty trade, handicraft and transport by pack animals).

The average (median) return for family labour in farm and off-farm activities is given in Table 7.2. Off-farm self-employment has the highest return among all the activities carried out by farm households. The average return to family labour on the farm (1.34 Birr/hour) or the marginal product of family labour on the farm (1.36 Birr/hour) is lower than the return to labour in off-farm self-employment (2.96 Birr/hour), but higher than the return to labour in off-farm wage employment

[1] One US Dollar is equivalent to seven Ethiopian Birr.

(0.72Birr/hour). It is also higher than the wage rate paid for hired farm labour (1.08 Birr/hour). The structure of wage rate looks different when off-farm employment is decomposed into specific categories. The return to labour in paid development work (0.45 Birr/hour) is the lowest among all the activities. The return to labour in manual non-farm work (0.89 Birr/hour) is lower than the payment to family labour on the farm and the wage rate paid for hired farm labour. However, skilled non-farm wage employment has a return (2.8 Birr/hour) higher than the return to family labour on the farm and the wage rate paid for hired farm labour. It has a return close to that of off-farm self-employment. The return to labour in general seems to be higher in *Enderta* District than in the *Adigudom* District, although the marginal product of labour is almost equal in both districts. Non-farm wage employment is mainly found in the *Enderta* District. No skilled non-farm activity is observed and only one household was found to be involved in manual non-farm work in the sample drawn from *Adigudom* district.

Table 7.2 Average (median) farm and off-farm return to family labour (Birr‡/hour) by districts

Activity	Enderta	Adigudom‡‡	Total average
Average product of family labour on the farm*	2.76	2.56	2.73
Return to family labour on the farm**	1.50	1.26	1.34
Marginal product of family labour***	1.36	1.37	1.36
Wage rate paid for hired farm work	1.11	1.04	1.08
Wage rate for wage employment	0.89	0.55	0.72
Wage rate for food for work	0.62	0.55	0.45
Wage rate for manual non-farm wage work	0.90	0.85	0.89
Wage rate for skilled non-farm work	2.8	-	2.8
Return from off-farm self-employment	3.66	1.52	2.96
Return to family labour on the farm			
Non-participant in off-farm work	1.76	1.93	1.87
Participant in off-farm work	1.44	1.07	1.22
Percent participants earn less relative to non-participants	-18.2%	-44.6%	-34.8%
Marginal product of family labour			
Non-participant	1.96	1.74	1.77
Participant	1.27	1.30	1.28
Percent participants earn less relative to non-participants	-35.2%	-25.3%	-27.7%

** The average product of family labour is calculated as the total value of farm output divided by the hours of family labour used on the farm;*
*** The average return of farm labour is computed as crop income minus variable inputs and one year depreciation of farm equipment and livestock wealth divided by the family labour hours used on the farm.*
**** The marginal product of family labour is calculated from a Cobb-Douglas production function.*
‡ One US Dollar is equivalent to seven Ethiopian Birr. ‡‡ No one participated in skilled non-farm work in Adigudom District.

There is a differential return for farm work between those households that participate in off-farm activities and those that do not. The median return to family labour on the farm for the participating farm households is 35% lower than the return

for the non-participating farm households. The difference in return to family labour on the farm between the off-farm work participants and the non-participants is higher in *Adigudom* than in *Enderta*. In *Enderta* participants earn 18% less for family labour on the farm than those who do not participate, whereas in *Adigudom* participants earn 44% less than those who do not participate.

Despite the high return to labour on the farm, the amount of labour supplied to farming activities is much lower than the amount supplied to off-farm work (Table 7.3). Given the number of people who can work on the farm and off-farm (Table 7.3), farm households could still allocate more labour to off-farm activities if there were enough jobs. Given that an average household has 2.5 working members who work 16 days per month[2] and assuming they can work for eight hours per day, an average household can have 3893 hours available for farm and off-farm work. However, an average household uses only 2148 labour hours (Table 7.3) for farm and off farm work, which is 55 % of their time. Furthermore, when farmers are asked for the reason why they do not work more in off-farm activities, about 60 % of them responded that they could not get off-farm employment around their district. This shows that agriculture is not able to absorb the available labour and there is potentially rationing in the off-farm labour market. Hence we can conclude that off-farm employment can be expanded without reducing the amount of labour available for agricultural activities.

Table 7.3 Labour allocation and availability of an average household

	Enderta	*Adigudom*	Total
Farm labour hours supplied by family members	544	439	492
Off-farm wage employment labour hours	1455	1045	1249
Off-farm self-employment labour hours	148	47	98
Family size	5.8	5.5	5.6
No. people working on farm	2.5	2.7	2.6
No. people working off-farm	1.4	1.4	1.4
Number of dependants	3.3	3.2	3.3

7.3 Theoretical consideration

[2] Due to Coptic Church holidays, farmers use only 53% of their available time for farm and off-farm work.

In a farm household economy with a perfect market, labour is allocated between farm and off-farm activities in such a way that the marginal value of farm labour equals the wage rate for off-farm activities (Becker, 1965; Gronau, 1973; Huffman and Lange, 1989). This means that individuals are willing to participate in off-farm work as long as their marginal value of farm labour (or reservation wage) is less than the off-farm wage rate they command. This implies that poorer farm households have a stronger incentive to diversify their income sources into off-farm activities because they have a lower marginal value of farm labour. One of the motives to diversify income sources into off-farm activities is to manage the risk associated with agricultural production. The extent of the risk motive to diversify income depends critically on risk aversion. Because risk aversion varies inversely with wealth (Newbery and Stiglitz, 1981), the risk incentive to diversify income sources is stronger for poor than for rich. However, there can be entry barriers in the off-farm labour market because off-farm activities may require investment on equipment purchase or rent, skill acquisition and license fees. If households face binding liquidity and credit constraints, poor households could not afford the investment required in the off-farm labour market. Hence if there are entry barriers in the off-farm labour market, the capacity to diversify income sources into off-farm activities is lower for poorer farm households. Individual assets and wealth can affect the type of non-farm activities a household picks up and can worsen the income distribution (Reardon and Taylor, 1996). As a result less wealthy farmers spend most of their time in low paying off-farm activities for which the entry barrier is very low. If there is rationing in the labour market, we may not observe a farm household participating in an off-farm labour market even if the marginal value of farm labour (or reservation wage rate) is less than the marginal value of off-farm labour (Blundell and Meghir, 1987). Therefore, the actual participation of a farm household in off-farm activities (income diversification of household) depends on the incentive and the capacity to participate (Reardon et al., 1998).

A farm household's choice among different types of off-farm activities (wage and non-farm self-employment) can be seen as a two-stage process. In the first stage, a farm household's choice of whether or not to work off-farm depends on the reservation wage rate (see Chapter three of this book for details). If the reservation wage rate is less than the prevailing market wage rate net of commuting cost, the household will participate in off-farm activities. If there is rationing and transaction cost in the labour market and the household faces a binding credit constraint, the

reservation wage rate of that household will be very high and hence it will choose for less off-farm work participation. In the second stage, if the reservation wage rate is less than the prevailing off-farm market wage rate, a farm household will choose among the available off-farm activities depending on the relative wage rates. Obviously, a farm household chooses to work in the off-farm activity with the highest effective market wage rate. If agriculture is risky (and households are risk averse), the household will choose an occupation that is negatively correlated with agricultural income (Newbery and Stiglitz, 1981). If the farmer faces a liquidity (or credit) constraint, he will prefer the one that requires less initial capital. Most probably, the credit constrained farm household will choose wage employment above off-farm self-employment. A farm household with a better asset position may face relatively less credit constraints and hence may prefer to work in off-farm self-employment.

A farm household can participate in more than one off-farm activity. If there are other family members in the household who can participate in off-farm activities, participation in two kinds of off-farm activities is possible. The wife and husband can choose (ex-ante) different off-farm activities with rewards that are negatively correlated in order to stabilise their income. Farm households can also work in both wage employment and off-farm self-employment at different times of the year depending on the availability of jobs. Hence we can observe two types of off-farm occupation in a given household.

Empirical studies have documented that the reservation wage rate that determines the households' participation in off-farm activities is an endogenous variable (Huffman, 1980; Lass, Findeis and Hallberg, 1991). It depends on farm characteristics, family characteristics, locations, and endogenous and exogenous household incomes. Farm characteristics include the farm size (amount of land cultivated), livestock wealth, and the number of animals used for transportation (donkey and horse). Family characteristics include age and educational level of family members, family size, and the number of dependants. Endogenous household income consists of farm income, which depends on farm and location characteristics (Huffman, 1980; Woldehanna et al., 2000). Exogenous household income consists of non-labour income such as transfer income (remittance, gift, food aid) and income from property rent. Off-farm wage is also an endogenous variable, which depends on individual and location characteristics (Huffman, 1980). Variables that raise the reservation wage reduce the probability and level of participation in off-farm work,

but variables that raise the off-farm wage rate increase the participation. Age, educational status, location, farm and non-farm equipment may affect both the reservation and off-farm wage. Hence the direction of influence on off-farm work participation depends on the relative strength of these forces. Farm income, livestock wealth and other income may also improve farm households' access to off-farm work if there is a credit constraint. Hence their impact on the off-farm work participation can be positive.

7.4 Gini decomposition, econometric model specification and estimation

Gini decomposition. *Gini decomposition* is used to analyse the contribution of alternative income sources to overall income inequality (Lerman and Yotzhaki, 1985; Reardon and Taylor, 1996). The conventional Gini coefficient (G) is given by

$$G = \frac{2\, cov\,[Y, F(Y)]}{\overline{Y}} \tag{7.1}$$

where $cov[Y, F(Y)]$ is the covariance of total income with its cumulative distribution of income ($F(Y)$), Y is total household income, and $\overline{Y}$ is mean household income . Decomposing total household income into K sources (y_k), the overall Gini coefficient can be rewritten as

$$G = 2\frac{\sum_{k=1}^{K} cov\,[y_k, F(Y)]}{\overline{Y}} \tag{7.2}$$

Then dividing and multiplying each component k by $cov(y_k, F_k)$ and the mean income of source k ($\overline{y}_k$) yields Gini decomposition by income source as

$$G = \sum_{k=1}^{K} \frac{\mathrm{cov}\,[y_k, F(Y)]}{\mathrm{cov}\,(y_k, F_k)} \times 2\frac{\mathrm{cov}\,(y_k, F_k)}{\overline{y}_k} \times \frac{\overline{y}_k}{\overline{Y}} = \sum_{k=1}^{K} R_k\, G_k\, S_k \tag{7.3}$$

where F_k is the cumulative distribution of income from source k, R_k is the Gini correlation between income from source k and total household income, G_k is the relative Gini of income from source k, S_k is the income from source k's share of total household income.

To analyse how changes in particular income sources will affect overall income inequality, consider a change in each household's income from source k equal to $e_k y_k$ where e_k is close to one. The partial derivative of the overall Gini (G) with

respect to a percentage change (e) in income source k is given by (Lerman and Yotzhaki, 1985, p. 152):

$$\frac{\partial G}{\partial e_k}=S_k(R_k G_k-G) \tag{7.4}$$

Then dividing (4) by G, the relative effect of a marginal change in source *k's* income on the Gini for total income is given by

$$\frac{\partial G}{\partial e_k}\frac{e}{G}=S_k(R_k G_k-G)\frac{1}{G} = \frac{S_k R_k G_k}{G} - S_k . \tag{7.5}$$

This is equal to the relative contribution of income from source k to the overall income inequality minus the share of income from source k in total income.

Econometric model specification. Two sets of models can be used to analyse off-farm employment: off-farm labour supply of farm households and farm households' choices between off-farm activities. The first model involves specifying the hourly supply of labour for off-farm wage employment and off-farm self-employment in order to identify the factors that determine them and their relative importance. For this purpose, we need to specify equations that determine the labour hours supplied to the off-farm activities at the ruling wage rate, conditional on individual participation.

Let latent variable off-farm labour hour be denoted by L^*_m and observed off-farm labour hour by L_m. In an agricultural household model an individual is willing to participate in off-farm work when his/her reservation wage (w_{ri}) is less than the off-farm wage net of commuting cost (w_{mi}) offered:

$$D_i=1 \text{ if } w_{ri}\leq w_{mi} \; ; D_i = 0 \text{ if } w_{ri}>w_{mi} \tag{7.6}$$

where D_i is the participation decision of a household to work off-farm. Consequently the latent variable off-farm labour hours (L^*_m) and observed off-farm labour hours (L_m) can be specified by a tobit model:

$$\begin{aligned} L_{mi}^{*} &= \beta' X_i + e_i ; e_i \sim N(0,\sigma_e^2) \\ L_{mi} &= \begin{cases} L_i^* & \text{if } D_i=1 \\ 0 & \text{if } D_i=0 \end{cases} \end{aligned} \tag{7.7}$$

where β' is a row vector of parameters; X is a column vector of variables that affect the reservation and market wage; e_i is the error term. Following the lines of Maddala

(1983), Amemiya (1984, p. 9) and Blundell and Meghir (1987, p. 181), the log likelihood function of the tobit model can be written as[3]:

$$\log L=\sum_{0}\log(1-\Phi(\beta' X_i/\sigma_e))+\sum_{1}[-\log\sigma_e+\log\phi((L_{mi}-\beta' X_i)/\sigma_e)] \qquad (7.8)$$

where the subscript *0* indicates summation over observations with zero off-farm labour hours, *1* indicates summation over observation with positive observed off-farm labour hours, and $\phi(.)$ and $\Phi(.)$ refer to the standard normal density and probability functions, respectively. The tobit model assumes, however, that the same stochastic process affects both the participation decision and the off-farm labour income. A zero realisation for a dependent variable represents a corner solution or a negative value for the underlying latent dependent variable (Cragg, 1971; Lin and Schmidt, 1984).

The second model is a farm household's choice between off-farm activities. Basically the off-farm work choices available for farm households in the study area can be categorised into four: not participating in off-farm activities at all, participating in off-farm wage employment only, participating in off-farm self-employment only, and participating in both off-farm wage and self-employment. This can be easily modelled using a multinomial logit model (Cramer, 1991; Maddala, 1983). Let U_{ij} denote the utility that a farm household *i* gets from choosing alternative *j* and

$$U_{ij} = u_{ij} + e_{ij} = X_{ij}\gamma_j + e_{ij} \qquad (7.9)$$

where γ_j varies and X_i remains constant across alternatives; and e_{ij} is a random disturbance reflecting intrinsically random choice behaviour, measurement or specification error and unobserved attributes of the alternatives. Let also P_{ij} *(j = 0,1,2,3)* denote the probability associated with the four choices available for farm household *i* with

j = 0 if the farm household does not participate in off-farm work at all,

j= 1 if the farm household participates in off-farm wage employment only,

j= 2 if the farm household participates in off-farm self-employment only and

j= 3 if the farm household participate in both off-farm wage employment and self-employment.

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[3] The likelihood function of a Tobit model is

$$L=\prod_{0}\Pr(L_{mi}=0)\prod_{1}f(L_{mi}|\,L_{mi}>0)\Pr(L_{mi}>0)$$

$$=\prod_{0}[1-\Phi(\beta'X/\sigma_e)]\prod_{1}\Phi(\beta'X/\sigma_e)\frac{\frac{1}{\sigma_e}\phi(L_{mi}-\beta'X)/\sigma_e)}{\Phi(\beta'X/\sigma_e)}\,.$$

Then the multinomial logit model[4] is given by

$$P_{ij} = \frac{exp(X_i\gamma_j)}{\sum_{j=0}^{3} exp(X_i\gamma_j)}. \qquad (7.10)$$

Setting γ_0=0, the multinomial logit model can be rewritten as

$$P_{ij} = \frac{exp(X_i'\gamma_j)}{1+\sum_{j=1}^{j=3} exp(X_i'\gamma_j)} \quad (j=1, 2, 3) \text{ and } P_{i0} = \frac{1}{1+\sum_{j=1}^{j=3}\exp(X_i'\gamma_j)} \qquad (7.11)$$

which can be estimated using the maximum likelihood estimation method.

Estimation procedure. The tobit (7.7) models for off-farm wage employment and off-farm self-employment are estimated to determine the relative importance of factors that affect the off-farm wage employment and off-farm self employment. The multinomial logit model (7.11) is estimated to identify the factors that determine farm households' choices between off-farm wage employment and off-farm self-employment. Explanatory variables used in the probit, tobit and logit model are age, age squared and dummy for education status of the household head, location (district) dummy, year dummy, family size, number of dependants, livestock wealth, ownership of animals used for transportation (such as donkey and horses), value of owned equipment for off-farm work, amount of cultivated land by the household, farm income, non-labour income, and wage rates received by the households. Two education dummies have been constructed: a dummy for those who have traditional education and a dummy for modern (basic) education. They are compared with those who can not read and write at all.

The predicted wage and farm income (rather than observed wage and farm income) are used in order to remove endogeneity. Estimation of farm income is based on a Cobb-Douglas production function (see Chapter 5). Heckman's two stage method (Maddala, 1983) for correcting the sample selection bias is used to estimate the wage rate received by farm households. The wage rate of off-farm wage employment is defined as income from off-farm wage employment divided by the

[4] Assume that farm household *i* prefers, for example, alternative *1* to alternative *0* and *3:* $P_{i1} = \Pr(U_{i1} > U_{i2} \text{ and } U_{i1} > U_{i3}) = \Pr(e_{i2} < X_i\gamma_1 - X_i\gamma_2 + e_{i1} \text{ and } e_{i3} < X_i\gamma_1 - X_i\gamma_3 + e_{i1})$. Assuming e_{ij} are independently and identically distributed with *Weibull* density function, the cumulative distribution function has the form $\Pr(e_{ij} \le \varepsilon) = \exp(-\exp(-\varepsilon))$. The difference between any two random variables with this type of distribution has a logistic distribution function (Judge et al., 1985, p. 770). The probability arising from this kind of model is given by a multinomial logit model.

number of hours supplied for off-farm wage employment. For off-farm self employment, wage is defined as the net income (profit) from off-farm self employment divided by the number of hours supplied for off-farm self employment. The explanatory variables used for the estimation of wage equations are age, age squared, year and education dummies, value of off-farm equipment and transport animals, location dummies and inverse mills ratio. The inverse mills ratios are derived from the probit equations for participation in off-farm wage employment and off-farm self-employment. The independent variables in the estimation of the probit equations are age, age squared, family size, number of dependants, farm inputs and year, education and location dummies.

All variables measured in monetary terms are used in logarithm form. These variables include farm income, non-labour income, the wage rate for off-farm wage and self-employment and the value of off-farm equipment owned[5]. Elasticities of off-farm work participation are computed at sample means.

7.5 Income inequality and income sources

In this section, Gini coefficients for the total household (7.1) and various farm and non-farm incomes (7.3) are calculated. Total household income is decomposed into livestock income, crop income, income from off-farm wage employment, income from off-farm self-employment and non-labour income. Income from off-farm wage employment is further decomposed into income from paid development work (food for work), income from non-farm manual work, and income from non-manual (skilled) non-farm work. Then the income sources elasticity of the overall Gini index is computed using equation (7.5).

Gini coefficients for total income as well as the share of income from various sources and their marginal contribution to overall Gini coefficients are presented in Table 7.4. There is no change in the Gini coefficients when they are calculated from incomes stated in per capita terms. Crop income has the highest contribution to overall income inequality (as measured by Gini coefficients) followed by wage employment and livestock income. Crop, livestock and off-farm wage incomes reduce income inequality. The results are mixed when wage income is decomposed into

[5] Since the logarithm of zero does not exist, zero observations are replaced with a value of one.

various categories. Paid food for work program is the only type of off-farm wage income that reduces income inequality. It is unequally distributed by itself, but favours the poor. The elasticity of total income inequality with respect to food for work income is the highest of all the other income sources' elasticity. Non-farm wage and self-employment incomes have non-equalising effect. Income from unskilled (manual) and skilled (non-manual) non-farm work increases overall income inequality. Non-labour income (such as gifts, remittances, and property rent) is also increases income inequality. The marginal effect on income inequality is higher for non-labour income than for non-farm wage and self-employment income.

There are no consistent findings among previous studies regarding the impact of off-farm income on rural income inequality. Comparison of the results is not easy either, as most empirical studies do not use the same type of income definition and income decomposition and methodology. In Palanpur (India), Lanjouw and Stern (1993) found that off-farm income in general has increased income inequality in 1983/84 and reduced it in 1981/82. Stark, Taylor and Yitzhaki (1986) found that remittance from domestic and international sources has both positive and negative effects on income inequality in two villages of Mexico. In rural Pakistan, Adams (1994) found that non-farm income makes a small contribution to income inequality despite its large share in total income. Non-farm income also has a low Gini coefficient and is poorly correlated with total income. When non-farm income is decomposed into different categories, income from government employment and off-farm self-employment is found to increase income inequality while income from unskilled labour reduces income inequality. In Philippines, Leones and Feldman (1998) found that while income from remittance, trading and skilled labour increases inequality, income from agricultural wage labour and gathering activities such as fishing and logging reduces inequality. All these studies have one common result. Income sources that need skill and capital to enter (such as non-farm self-employment and income from skilled wage labour) increase income inequality. The same goes for the results obtained from this study: off-farm activities that have entry barriers and require capital to start have a negative impact on income inequality. It is only income from food for work programs that have a positive effect on rural income inequality. This is because the food for work jobs do not need skill and capital and are initially targeted to provide employment for the poorer farm households. However, there is a peculiar finding in this study that unskilled non-farm wage work increases income

inequality. Although unskilled non-farm wage work does not require education and skill, it involves very high transaction cost (such as search and commuting cost) unaffordable by poor farmers. Farmers are required to have their own equipment (worth at least 40 Birr) and be able to commute to towns in order to get jobs in the unskilled non-farm labour market.

The possible reason for non-farm income to have a dis-equalising effect from an investment perspective (Reardon, Crawford and Kelly, 1994) is that there is an entry barrier for the poor. Skilled non-farm wage employment and off-farm self-employment require skill and capital to start. In the absence of a perfect credit market, it is only the rich households that can afford to enter into self-employment. Even in the unskilled non-farm labour market, the transaction cost of looking for jobs in the nearby urban areas coupled with rationing in the labour market gives richer farm households an advantage in the non-farm labour market. As a result income from the non-farm labour market increases income inequality. This implies that unless rural non-farm activities are promoted that particularly target the poor, wealthy farm households will dominate the most lucrative form of non-farm activities such as masonry, carpentry and trading.

Table 7.4 Gini Decomposition by income sources

Household Income components	Mean	S_k	R_k	G_k	G_k*R_k	$S_k*R_k*G_k$	$(S_k*R_k*G_k)/G$	$(S_k*R_k*G_k)/G - S_k$
Off-farm self-employ income	262.50	0.068	0.598	0.836	0.500	0.034	0.103	0.035
Off-farm wage income	858.75	0.280	0.489	0.628	0.308	0.086	0.261	-0.019
Income from food for work	437.89	0.174	0.183	0.664	0.122	0.021	0.064	-0.110
Manual non-farm wag income	284.58	0.085	0.406	0.883	0.358	0.030	0.092	0.007
Skilled non-farm wage income	136.28	0.022	0.794	0.978	0.777	0.017	0.053	0.031
Non-labour income	194.31	0.039	0.707	0.951	0.672	0.026	0.080	0.041
Net farm crop income	1339.65	0.448	0.698	0.442	0.308	0.138	0.419	-0.029
Livestock income	497.40	0.164	0.425	0.643	0.273	0.045	0.136	-0.028
Total household income	3152.60					0.330		

S_k is the average share of income from source k in total income;

G_k is Gini index of inequality for income from source k;

R_k is Gini correlation with total income ranking;

G is the Gini index of total income inequality;

$\frac{S_k * R_k * G_k}{G}$ *is the relative contribution of income from source k to the Gini index of total income inequality;*

$\frac{S_k * R_k * G_k}{G} - S_k$ *is elasticity of Gini index of inequality with respect to income source k.*

7.6 Estimation results and discussion

Wage offer equations for off-farm wage employment and off-farm self-employment, off-farm work participation and intensity of participation in wage employment and self-employment and a multinomial model of off-farm works have been estimated. Farm output is found to be the source of heteroscedasticity in the tobit model off-farm labour supply for off-farm wage and self-employment. No heteroscedaticity problem is found in the wage offer equations and multinomial logit model estimations. A Ramsey's RESET test is used to detect heteroscedasticity and a White's test is used to identify the variables causing heteroscedasticity (Maddala, 1992; p. 204). Multiplicative heteroscedasticity model is used to remedy the heteroscedasticity found (Greene, 1997).

Wage offer equations. Estimates of the wage offer equations of off-farm wage employment and off-farm self-employment are given in Table 5. The wage rates households receive are highly influenced by age of the household head, location and year dummies, value of off-farm equipment and number of own animals used for transportation. The age of the household head showed a quadratic pattern consistent with a life cycle hypothesis (Sumner, 1982) for wage employment, and inconsistent with a life cycle hypothesis for off-farm self-employment. The wage rate in off-farm wage employment first increases with the age of the household head, reaches its peak at the age of 30 and then decreases, whereas the wage rate decreases with age for off-farm self-employment. Education seems to favour the wage rate for off-farm self-employment. Those farm households of which the heads have a modern or traditional education receive a lower wage rate in off-farm wage employment and a higher wage rate in off-farm self-employment than those farm households that do not have an education at all. The reason for the negative impact of education on the wage rate for off-farm wage employment could be that most of the off-farm wage work is manual work, which does not require education at all. The effect of traditional education on the wage rate for wage employment and the effect of modern education on the wage rate for off-farm self-employment are statistically insignificant at any reasonable level. Wage rates are higher in *Enderta* district than in *Adigudom* district for both off-farm wage employment and off-farm self-employment. The wage rate for off-farm wage employment was lower in 1996 than in 1997, while the wage rate for off-farm

self-employment was higher in 1996 than in 1997. The return to off-farm self-employment was higher in 1996 than in 1997 because 1996 was a good harvest year and a year when the farm sector achieved remarkable growth. As a result, the growth of the farm sector has favoured off-farm self-employment in rural areas through the consumption linkages (Haggblade and Hazell, 1989; see also Chapter 9). An increase in the number of animals used for transportation increases the wage rate for off-farm self-employment and reduces the wage rate for off-farm wage employment. An increase in the value of owned off-farm equipment reduces the wage rate for self-employment and increases the wage rate for off-farm wage employment. This is consistent with the fact that farmers require transport animals to work in off-farm self employment such as trading, stone mining, wood and charcoal selling. Farmers are also required to have their own equipment in order to get job in the off-farm labour market. Equipment and transport animals may increase the productivity of labour and hence the return to labour. The results reveal also that those farm households who participate in off-farm work receive higher wage rates than those who do not participate in both off-farm wage employment and self-employment.

Table 7.5 Estimates of wage offer equations for off-farm wage employment and self-employment *

Explanatory variables	Ln (wage rate received Birr/hour)		Elasticity of wage	
	Wage employ.	Self-employ.	Wage emp.	Self-emp.
Constant	-4.78 (-4.43)	-2.513 (-2.26)		
Age of the household head	0.189 (4.17)	-0.190 (-4.06)		
Age square	-0.0024 (-5.14)	0.002 (3.57)		
Year dummy(1996=1; 1997=0)	-1.272 (-8.79)	2.096 (14.02)		
Dummy for District (Enderta=1)	0.261 (1.69)	2.435 (15.27)		
Dummy for trad. edu.	-0.009 (-0.042)	0.81 (3.56)		
Dummy for modern edu.	-1.046 (-5.65)	0.043 (0.22)		
No. of owned of transport animals	-0.347 (-5.69)	0.394 (6.26)	-0.43	0.487
Ln (value of off-farm equip. owned)	0.403 (5.34)	-0.263 (-3.37)	0.403	-0.056
Inverse mills ratio	3.50 (32.92)	4.272 (37.409)		
Adjusted R^2	0.76	0.83		

*Figures in parenthesis are T-ratios.

Off-farm wage employment. The elasticities of off-farm labour supply for wage employment at mean values are summarised in Table 7.6. Table 7.7 summarises the elasticities including the indirect effect that arises via the wage rates because the variables entered in the wage offer equations are also used in the off-farm labour supply equations. Table 7.7 also includes the indirect elasticity of land that arises via the farm output. The direct estimation results are presented in Table A7.2 in the appendix.

The wage rate, age of the household head, farm output, livestock wealth, non-labour income, family size and the number of dependants are the main factors which determine off-farm wage employment. The impact of traditional and modern education on the supply of labour for off-farm wage employment is negative, but statistically the effects are not significantly different from zero. The possible interpretation for the negative sign of education may be (1) an increase in education increases the productivity of the individual on the farm or in the household more than it increases the productivity in off-farm employment or (2) off-farm employment in the rural areas of Tigray may not require education at all and hence no special demand in the labour market for relatively educated farm households.

For most of the variables, the results obtained meet our expectations. The impact of farm size (area of land cultivated) on the supply of labour for off-farm wage employment is negative, but statistically not significantly different from zero. The negative impact of farm size (land cultivated) on off-farm wage employment is what the theory and empirical evidence support (Huffman, 1980). Farm households who have a smaller farm depend on off-farm employment to escape from poverty by supplementing farm income, but perhaps due to multicollinearity its coefficient is not significantly different from zero. Own-wage elasticity of the labour supply for off-farm wage employment is positive, but inelastic (0.46). The elasticity of the labour supply with respect to wage rate for off-farm self-employment is small and positive (0.02), but not significantly different from zero. The results confirm that the farm households' participation in off-farm wage employment is driven by the availability of surplus family labour, lower farm size and low farm and non-labour incomes. The supply of labour for wage employment reduces farm income due to the substitution and income effects. The reason for the negative impact of gross farm income is that farm income increases the shadow value of farm labour and the demand for leisure. The hours worked for off-farm wage employment also decrease with an increase in the amount of non-labour income, livestock wealth, horses and donkeys due to the income effects. Even though most of the wage employment is in the food for work program, which does not require labourers to have their own equipment, farm households still need to have their own equipment to work off-farm. Considering the direct and indirect effect that arises via the wage rate, an increase in the value of owned off-farm equipment increases the supply of labour for wage employment. This supports the observation that farm households who have their own equipment are

preferred in the labour market. An increase in the number of owned transport animals reduces the supply of labour for off-farm wage employment because (1) transport animals are not required for most wage work and (2) the ownership of transport animals captures the wealth effect and hence affects the supply of labour negatively (due to the income effect). Farm households' probability and level of participation in off-farm wage employment increases with family size and the number of dependants. These results imply that farm households are involved in off-farm wage employment due to push factors (insufficient farm and non-farm income as well as surplus labour). In other words, off-farm wage employment is considered to be a residual employment that absorbs the surplus family labour, which cannot be fully employed on the farm. Then it would also contribute to reduce income inequality (see Table 7.4).

The age of the household head (including the indirect effect through the wage rate) does not show a quadratic pattern for off-farm labour supply, which is contrary to the predictions of a life cycle hypothesis (Sumner, 1982). The supply of labour for off-farm wage employment is higher for younger households than for older households. The supply of off-farm hours was expected to be directly related to the age of the household head based on the assumption that older individuals have more off-farm work experience and information, and therefore older individuals are able to supply more hours for off-farm employment. The negative impact of age on hours-worked in off-farm wage-employment may be explained by the fact that off-farm work requires more physical effort. And older individuals may not have the strength to work off-farm. Most importantly, due to high population pressure, young farm households can not get enough land to support their livelihood compared to older farm households. Hence the younger households have to rely on off-farm employment to support their livelihood. The off-farm wage employment decision of farm households is also found to be dependent on location and year dummies. There is higher off-farm wage employment in the *Enderta* district than in the *Adigudom* district. The off-farm wage employment was lower in 1996 than in 1997.

Off-farm self-employment. The participation decision in off-farm self-employment is significantly influenced by the level of farm output, wage rates, area of land cultivated, livestock wealth and the value of owned off-farm equipment (Table 7.6 and Table 7.7, see also Table A7.3 in the Appendix). The influence of year and location dummies, educational status, donkey and horses owned are not significantly different from zero statistically at any reasonable significance level. The supply of

labour for off-farm self-employment responds positively to its own wage rate. The own wage elasticity of labour supply for off-farm self-employment is calculated to be inelastic, 0.41, and slightly lower than that of the supply of labour for off-farm wage employment. The elasticity of off-farm self-employment labour supply with respect to the wage rate for wage employment is negative and inelastic, but not significantly different from zero. Family size and the number of dependants do not significantly affect the probability or level of participation, but the signs of the parameter estimates are plausible.

Increases in the level of farm output, livestock wealth, non-labour income and cultivated land are thought to increase the reservation wage rate and reduce off-farm employment. The result partly confirms this hypothesis. An increase in the area of cultivated land reduces the probability and level of off-farm self-employment. When cultivated land increases by one percent, the probability and level of self-employment decreases by 0.34 and 0.89%, respectively. A rise in the level of livestock wealth also increases the reservation wage and affects off-farm self-employment negatively, perhaps through the income effect. However, farm output is found to affect self-employment positively. The elasticity of labour supply for off-farm self-employment with respect to farm output is 0.17. This implies that farm households with more farm output have the capacity to join off-farm self-employment since they can overcome the liquidity and credit constraint. In other words, the liquidity-constraint effect outweighs the reservation wage effect of farm output. The level of non-labour income has a negative, but insignificant effect. The value of owned off-farm equipment and the number of owned transport animals used for transportation increase farmers' access to off-farm self-employment and hence increase the supply of labour, although the effect of transport animals is statistically not significantly different from zero. The fact that family size and number of dependants do not affect the decision to work in off-farm self employment and the strong positive contribution of farm income explain the fact that farmers are motivated to work in off-farm self-employment due to push factors. Farm households with a higher output enter into off-farm self-employment to benefit from (reap) the attractive return.

The results do not provide a clear indication concerning the effect of education and age of the household heads on off-farm self-employment. Farmers with modern education work less and farmers with traditional education work more in off-farm self-employment than those farmers who are not educated at all, but the estimates of

the parameters are not significantly different from zero. This contradicts the previous studies (e.g. Burger, 1994), which state that those who are more educated participate in off-farm activities. An increase in the age of the household head seems to reduce the level and probability of participation in off-farm self-employment, but the estimates of the parameters are not significantly different from zero.

Table 7.6 Elasticity for the probability and level of participation in off-farm wage and self-employment

	Wage employment		Off-farm self-employment	
	Probability (DWP)	Labour hours DWH1)	Probability (OBP)	Labour hour (OBH1)
Farm output in Birr	-0.030***	-0.06***	0.064***	0.171***
Cultivated land	-0.020	-0.04	-0.339***	-0.879***
Livestock wealth in Birr	-0.026**	-0.060**	-0.057***	-0.154***
Number of donkey and horses owned	-0.080**	-0.168**	-0.003	-0.005
Equipment for off-farm work in Birr	-0.065***	-0.138***	0.092***	0.247***
Non-labour income	-0.038***	-0.080***	-0.017	-0.044
Wage rate for wage employment	0.220***	0.464***	-0.013	-0.035
Wage rate for off-farm self-employ.	0.009	0.018	0.152***	0.41***
Family size	1.435***	3.06***	0.279	0.748
Number of dependent	-0.69***	-1.45***	-0.163	-0.501

**** Stands for significant at 1%; ** stands significant at 5%; * stands significant at 10%; + it includes the indirect effect through the farm income (0.12). Elasticities are calculated based on the unconditional expected marginal effects (see Table A5.2 in the appendix for the derivation of marginal effects).*

Table 7.7 Elasticity for the probability and level of participation in off-farm wage and self-employment including both the direct and indirect effects *

	Wage employment		Off-farm self-employment	
	Probability (DWP)	Labour hours DWH1)	Probability (OBP)	Labour hour (OBH1)
Farm output in Birr	-0.030	-0.06	0.064	0.171
Cultivated land	-0.020	-0.04	-0.339	-0.879
Livestock wealth in Birr	-0.026	-0.060	-0.057	-0.154
Number of donk. And horses owned	-0.175	-0.368	0.071	0.195
Equipment for off-farm work in Birr	0.024	0.05	0.083	0.224
Non-labour income	-0.038	-0.080	-0.017	-0.044
Wage rate for wage employment	0.220	0.464	-0.013	-0.035
Wage rate for off-farm self-employ.	0.009	0.018	0.152	0.41
Family size	1.435	3.06	0.279	0.748
Number of dependants	-0.69	-1.45	-0.163	-0.501

** Land includes the indirect effect through the farm income (0.12). Age, year and district dummies, education dummies, No of transport animals and owned off-farm equipment include an indirect effect through the wage rates. Elasticities are calculated based on the unconditional expected marginal effects (see McDonald and Moffit, 1980 for the derivation of marginal effects).*

Off-farm wage employment versus self-employment. The multinomial logit model is used to explain farmers' choices between off-farm wage employment and self-employment. The most important factors that explain farmers' choices between the two types of off-farm employment are farm income, ownership of transport animals, area of land cultivated, family size and location (see Table A7.4-Table A7.7

in the appendix). Farm households prefer working in off-farm self-employment to off-farm wage employment when they have a higher amount of farm income and a greater number of transport animals[1]. On the other hand, they prefer off-farm wage employment to off-farm self-employment when they have a larger family size and more livestock wealth. Off-farm self-employment is also more preferred to wage employment in *Enderta* district than in *Adigudom* district and in a good harvest year (1996) than in a bad harvest year (1997). Off-farm self-employment is preferred to wage employment by farm households who are closer to a big market (such as Mekelle) and at times of stronger consumption linkages (demand for food and non-food products). Farm households who participate in both wage and self-employment tend to leave wage employment and focus on off-farm self-employment when their farm income and number of transport animals owned increase. Farm households who live in *Enderta* district prefer either self-employment or both self and wage employment to wage employment only. On the other hand, farmers who engaged in both wage and self-employment tend to focus only on wage employment when they have a larger family size and more cultivated land. The fact that self-employment is preferred to wage employment when farm output increases and family size decreases confirms that self-employment is undertaken by farm households to reap the attractive return, while wage employment serves as a residual employer and is undertaken due to push factors.

7.7 Conclusions

If there are entry barriers in labour markets, off-farm employment may not reduce income inequality among farm households in rural areas. Our results show that there are entry barriers in the non-farm labour market. Off-farm self-employment increases with increased ownership of off-farm equipment and transport animals, and off-farm wage employment increases with the increased ownership of off-farm equipment. As a result the wealthy farm households are able to dominate the most lucrative form of non-farm activity such as masonry, carpentry and trading. This has resulted in increasing income but also inequality among farm households in the rural areas. The

[1] So farm district dummy is assumed to affect the intercept only. However, when it is allowed to change the slop, farm households in *Adigudom* district prefer wage employment to self-employment when they have higher farm income, but the parameter estimate is not significantly different from zero.

main sources of the inequality are non-farm activities such as non-farm skilled wage work and non-farm self-employment. The present public work program is unequally distributed but it favours the poor and hence reduces the income inequality that exists in the rural areas.

This chapter, by distinguishing between wage and self-employment, enables us to identify (1) the influence of liquidity constraints on labour supply and (2) the motives of farm households to join in various labour markets. While higher farm output discourages farmers from working in off-farm wage employment, it improves the capacity of farm households to participate in the labour market and so increases the level of labour supply for off-farm self-employment. As a result, off-farm wage employment decreases and off-farm self-employment increases with the level of farm output. Off-farm wage employment increases with family size and decreases with the number of dependants. Whereas off-farm self-employment increases when agricultural production increases, it is unaffected by family size and the number of dependants. The fact that self-employment is preferred to wage employment when farm output is larger and family size is smaller reconfirms that self-employment is undertaken by farm households in order to reap the attractive return, and wage employment serves as a residual employment and is undertaken by farm households due to push factors. The supply of labour for off-farm wage employment is slightly more elastic than that for off-farm self-employment. There is no significant cross wage elasticity between off-farm wage and self-employment labour supply. At this stage of economic development in the area, the off-farm activities are not significant enough to create competition for labour in farming activities. Households still have opportunities to work outside their farm without affecting their agricultural production.

The regional rural economy can be expanded to a greater extent through the promotion of off-farm activities. Increasing the availability of off-farm activities and improving the wage rates received by farm households can increase farm households' involvement in off-farm activities. Certain measures can be taken in order to reduce the income inequality effect of non-farm activities. First, rural non-farm investment programs need to focus on non-farm activities in which the poor would participate more than the rich. Second, the underlying factors that hinder farm households' participation in non-farm activities must be addressed and removed. The establishment of training centres to tackle skill barriers, the provision of credit for the

poor together with business-extension advice and the expansion of public employment schemes could be of use. Public provision of information on the labour market could also be helpful to reduce the transaction cost of searching for non-farm jobs. Improving rural infrastructure can also reduce spatial income inequality. Improved infrastructure such as roads can be a double-edged sword for rural inequality. Improving the quantity and quality of infrastructure will reduce income inequality by increasing farmers' income earning opportunities, most probably, through off-farm activities.

CHAPTER 8. CROP CHOICES, MARKET PARTICIPATION AND OFF-FARM EMPLOYMENT

8.1 Introduction

The objective of Ethiopian agricultural policy is to achieve food self-sufficiency and increase the marketing surplus on the one hand and to increase on and off-farm employment on the other hand. The latter two-fold objective is to be achieved by increasing the capacity of agriculture to absorb more labour and by providing alternative employment opportunities. Food security is also one of the prime strategies of Ethiopian agricultural policy in general and marginal states such as the Tigray Regional State in particular.

The possible policy instruments to achieve food self-sufficiency and increased marketing surplus are by guaranteeing a producer floor price and by improving the distribution of inputs. However, Goetz (1992) shows the difficulty of using a producer floor price in Sub-Saharan Africa to encourage farmers to produce more. The reason is that most farmers are net buyers of food (Asfaw et al., 1998) and some fail to participate in a cash market altogether (Goetz, 1992).

The concern of the government to protect producers from the domestic price instability is very high, while the concern to protect the consumers from the price instability is very low. It is assumed that most farmers are sellers of farm output and receive a low farm income when there is a good harvest due to the fall in price. Farmer-consumers who purchase farm output for consumption are thought to be insignificant in number. As a result a price floor is thought to be the only good policy instrument to stabilise farm output prices. However the social usefulness of a price floor is under question. When the majority of the farm households are net buyers, looking at price stability from the point of view of consumers might also be as important as looking at it from the point of view of the producers. If the majority of farm households do not participate in the product market, a price policy to raise prices of agricultural output beyond the market clearing point may not be effective in increasing agricultural output. Pricing policy may also aggravate income inequality among farm households as raising the prices of agricultural output benefits the net

sellers which are assumed to be richer (Jamal, 1995). Improving the access of farm households to markets will be very important if farmers are restricted from market participation. Possible reasons that prevents farm households from participating in the market are the subsistence nature of production and transaction cost (Goetz, 1992). In areas with a thin market, it is time-consuming to discover trading opportunities. Poor market access due to lack of transport, distance, and other barriers such as lack of information may increase a farm household's cost of observing market prices in order to make transaction decisions. Output and price risk may also prevent farmers from participating in the product market.

Off-farm employment may substantially complicate farm management, for it can introduce the possibility of simultaneously having more cash and less labour. Farm households who strive for subsistence using labour-intensive techniques may choose to work off-farm and use the income to finance farming so as to make farm work less onerous or increase the return to farm labour. They may also rearrange their crop choices to suit off-farm work. If there is unemployment or underemployment, off-farm jobs may have practically no effect on farming systems.

The level of off-farm income may increase or reduce the market participation. A farm household with more off-farm income may use it to finance its farm activities such as hiring of farm labour and purchasing of capital input and may engage in farm production on the basis of profit maximisation motive. On the other hand a farmer whose off-farm income is high can meet his cash requirement from the off-farm income he receives and grow crops for own consumption and sell less of his output.

In general, achieving the objectives of food self-sufficiency, increasing marketing surplus and promoting on and off-farm employment may depend greatly on the farmers crop choice decision and market participation and their link to off-farm employment. It is therefore interesting to look at the farmers' crop choice, land and labour allocation decisions, and market participation, and the impact of off-farm employment on the cropping systems and marketing behaviour.

The objectives of this chapter are, therefore, (1) to identify the determinants of land and labour allocations to crops and their relative importance; (2) to analyse the determinants of farm households' participation in the sale and purchase of farm output; and (3) to analyse the relationship between off-farm income and crop choice, land and labour allocations and marketing behaviour.

The rest of the chapter is organised as follows. The description of crop choice and market participation in the study area is described in the next section. In section three, the theoretical background is presented. Formulation of econometric models and methods of estimation are discussed in section four. In section five, the result of econometric estimation are discussed. The chapter ends with conclusions.

8.2 Description of crop choice and market participation

Farmers in the study area grow a variety of cereals, legumes and oil crops. The types of crops grown and their labour and land allocations are given in Table 8.1 and Table 8.2. The most important crop in the study area is barley, covering, on average 36.4% of the total area cultivated despite its lower market price. It is also a crop grown by most of the farmers: about 80% of the farmers grow barley. The share of barley in total expenditure is the highest of all the crops. The possible reason that barley is the dominant crop is that it is relatively drought resistant, the labour requirement is low and it can grow on relatively less fertile land. In general it is a less risky crop. For example, there was no crop failure on barley fields during the 1997 cropping season, whereas about 4% of the teff fields faced crop failure due to drought. Wheat and teff are the second and the third most important crops, respectively. They fetch a higher price than barley. Teff is considered to be a cash crop for farmers in the study area. In terms of the share in total expenditure, teff wins on the third place. However, its labour requirement is very high. The land has to be plowed more than three times and weeded at least twice. The amount of labour required to harvest and thresh teff is also higher than the amount of labour required by other crops. Sorghum and finger millets, which fetch a low price in the market, are also grown by 14% of the household mainly concentrated in Adigudom District.

Table 8.1 Cropping pattern: percent of farm household growing crops

Crop type	Enderta	Adigudom	Total
Teff	63.5	65.4	64.4
Wheat	71.0	64.4	67.7
Barley	78.5	82.7	80.6
Sorghum and finger millet	6.0	22.3	14.2
Legumes	42.5	39.1	40.8
Oil crop	7.5	10.9	9.2
Vegetables	9.5	4.9	7.2

Latyrus (a kind of vetch locally known as *Enguaya*) is the most popular legume crop grown in the area. It constitutes about 74 % of the legume production of the average farm household. In addition to its food value as a source of protein, it has an important place in the crop rotation sequence. It is used to fix nitrogen in the soil. However, it is considered to be an inferior crop. Its price is the lowest of all crops grown in the area. Oil crops such as linseed are also grown by 9.2 % of the farm households. The share of oil crops in the total expenditure is only 0.3%. The production of vegetables is very limited and 70 % of the households growing vegetables are found in villages (in *Enderta District*) nearer to Mekelle where there is sufficient demand for vegetables. Almost all of the vegetable production is for sale. Its share in total expenditure is negligible. The fact that farm households are risk-averse and the income elasticity of oil and vegetable crops is high (see Chapter eight) imply a higher expected utility of farm households from the price variability (Fafchamps, 1992). On the other hand the expected utility gain from price variability of cereals is very low, as the income elasticity is very low. As a result, the probability that farm households grow oil and vegetable crops is lower, while the probability that they grow cereals is higher.

Table 8.2 Cropping pattern on average farm household (one tsimdi = one-fourth hectare)

Crop type	Share of land	Labour hour/ tsimdi	Var. input Birr/tsimdi	Yield KG/ Tsimdi	Yield Birr/tsimdi	Share in total expen
Teff	0.197	167.94	34.70	113.31	241.33	0.15
Wheat	0.250	76.42	87.46	146.73	298.05	0.16
Barley	0.364	71.05	77.13	199.72	279.34	0.18
SFM*.	0.049	83.26	11.49	179.77	275.70	0.01
Legumes	0.110	70.64	48.24	195.77	104.92	0.05
Oil crop	0.018	69.76	29.46	81.54	179.76	0.003
Vegetables	0.010	185.24	61.89	1056.03	1465.37	0.001

**SFM is sorghum and finger millet.*

Households' participation in the product market is described in Table 8.3. The majority of households participate in the product market through the sale and purchase of agricultural products. Only 5% of the households are autarkic in the grain market. With regard to crop outputs and animal products, all farm households participate in the product market. However, farm households participate more actively in the purchase than in the sale of agricultural output. The majority of the households are net buyers in both the crop and animal products market. The net sellers constitute about 35 and 28 % for crop and animal products, respectively.

Table 8.3 Distribution of market regimes in crop and livestock outputs in Enderta (EN) and Adigudom (AD) Districts

Market regime	Crop output			Livestock products			Total output		
	EN	AD	TOT	EN	AD	TOT	EN	AD	TOT
Net buyer	68.0	52.5	60.5	59.0	79.7	69.4	56.0	59.4	57.7
Autarkic	1.0	7.9	4.5	1.5	3	2.2	0	0.5	0.03
Net sellers	31.0	39.6	35.3	39.5	17.3	28.4	44.0	40.1	42.0
Only selling	6.5	5.9	6.2	2.0	1.0	1.5	0.5	0	0.25
Only buying	58	44.6	51.2	49.5	75.2	62.4	33.5	41.1	37.3
Buying and selling	34.5	42.6	38.1	47.0	20.8	33.3	66.0	58.9	62.4
Selling	41	47.5	44.3	49.0	21.8	35.3	66.5	58.9	62.7
Buying	92.5	86.1	89.3	96.5	96.0	96.3	99.5	100.0	99.8

There seems to be a difference in marketing behaviour between those farm households who participate and those who do not participate in off-farm activities (Table 8.4). Most of the farm households who participate in off-farm activities in general are net buyers for crop output and livestock output (64%). On the other hand, most of the farm households who do not participate in off-farm activities are net sellers (61%). When off-farm activities are decomposed, the majority of farmers who participate in off-farm self-employment are found to be net sellers.

Table 8.4 Off-farm activities and marketing surplus (in Birr) of average farmers

	Participation code (number of observations)*				
	0 (n = 77)	1 (n = 213)	2 (n =35)	3 (n =77)	1,2,&3 (n = 325)
% of net buyers in crop and livestock output	38.9	63.9	31.4	71.4	64.1
% of net sellers in crop and livestock output	61.0	35.7	68.6	28.6	36.6
% of net buyers in crop output	37.7	62.9	51.4	79.2	65.5
% of net sellers in crop output	55.8	32.4	45.7	18.2	30.5
% of autarkic in crop output**	6.5	4.7	2.9	2.6	4.0
Marketing surplus in agr. Production	759.0	-107.6	664.6	-230.7	-53.8
Marketing surplus in crop production	547.2	-133.2	294.4	-300.8	-127.0
Marketing surplus in livestock production	211.8	25.3	370.3	70.2	73.0

** 0 = non-participant in off-farm activities, 1= participant in wage employment only, 2 = participant in off-farm self-employment only, 3 = participant in both off-farm wage and self-employment. ** only one observation is found to be autarkic in both livestock and crop output*

There is also a remarkable difference in the level of marketing surplus in both crop and livestock output between those farmers who participate and those who do not participate in off-farm work. The level of marketing surplus is lower for those who participate than those who do not participate in both off-farm wage and self-employment, except in livestock production for off-farm self-employment. The level of marketing surplus in livestock production is higher for participants than non-participants in off-farm self-employment. On the average, participants in off-farm wage employment have a negative surplus (or are net buyer), whereas the participants in off-farm self employment have a positive surplus (or are net sellers).

The average off-farm income (off-farm labour income and non-labour income) of net buyers is higher than those of net sellers (Table 8.5). However, the average income from self-employment is higher for net sellers than for net buyers. This may be due to the fact that those who participate in off-farm self-employment have higher farm output or their production is more oriented towards the market. Since farmers are often borrowing or liquidity constrained, only those who have enough capital (with higher farm income) have the capacity to join off-farm self-employment. This type of income can be one of the sources of income inequality in rural areas (see Chapter 7).

Table 8.5 Off-farm income and participation in the product market of average farmers

	Net sellers	Net buyers
Off-farm self-employment income	345	222
Off-farm wage-employment income	632	974
Non-labour income	172	206

8.3 Theoretical background

Crop choice and allocation of land and labour. In a farm household model setting, a farm household's decision to grow a crop involves a discrete choice on whether to grow a particular crop (see Chapter 3 for a mathematical exposition). This decision depends on the marginal productivity of land across crops. If corner solutions exist, i.e., some crops receive a zero amount of land, the marginal productivity of land for crops receiving a zero amount of land is less than the marginal productivity of land for crops receiving a positive amount of land.

When the production and consumption decisions are separable (Singh et al., 1986) and there are perfect input and output markets, farms should grow the most profitable crops. There is no need to have enough family labour and land to run a farm. In the presence of a perfect insurance market, production choice, particularly crop choice, should not depend on the consumption and risk preferences of the producers (Sandmo, 1971; Fafchamps, 1992). In most developing countries, however, agriculture is highly risky and the insurance and credit markets are far from perfect (Fafchamps, 1992). It is also known that farmers are risk averse (Binswanger, 1980), and their risk aversion depends on the level of wealth. Poor farmers in developing countries attempt to minimise their exposure to risk by growing their own food (Roumasset, 1976, Fafchamps, 1992). Furthermore, the price and production risk

associated with crops might also induce households to grow a particular type of food crop that is not profitable, but dependable (Fafchamps, 1992). Under any of these market imperfections, the production and consumption decisions of farm households are not separable (Benjamin, 1992; Roe and Graham-Tomasi, 1986). As a result, crop choice and land and labour allocation to crops depend on consumption preferences, household composition, and risk considerations.

A risk-averse household reduces the production of food crops for which income elasticities are large. This is because high-income elasticity leads to expected utility gain from price variability (Turnovsky, Shalit and Schmitz, 1980). Consequently a farm household with high-income elasticity for the crop will find it in its interest to be less insured and therefore, grows less of that crop (Fafchamps, 1992, p. 93). Hence the production of crops with high-income elasticity such as vegetables, fruits, meat, dairy, oilseeds and spices will be proportionally lower than other crops whose income elasticity is lower, such as cereals. More risk-averse farmers will seek also to insure themselves against consumption price risk by increasing the production of consumption crops.

The decision on how much labour to apply to each crop grown can be updated regularly depending on the changing current and expected future conditions. This decision to allocate labour for each crop depends on the demand for labour by each crop if the production and consumption decisions of households are separable. However, the production and consumption decisions of farm households in developing countries are far from separable. Hence, the labour allocations for crops not only depend on the demand for labour, but also on factors affecting the supply of labour. In other words, the labour allocation decision of farm households for crops depends on factors that affect both the demand for and supply of labour. These factors include the level of land allocated to each crop, agronomic conditions, expected yield, household composition (which affect the time available for work and leisure), household taste shifters (such as education and age), risk consideration and off-farm employment.

Most farmers do not specialise in growing a specific crop; rather they grow a variety of crops. If their decision is not rational, they lose the gain they would have achieved from specialisation. A farmer's decision to grow a variety of crops at the same time may be rational for many reasons. If there is constant returns to scale, two or more crops can be grown to make use of the available resources (Burger, 1994). If

there is increasing and decreasing returns to scale, the choice that can rationally be made depends on the farm size. Due to transaction costs in the output market, the shadow price of products may lie between the selling price and the purchase price, i.e. within the price band. Then the shadow price of crops for a household is internally determined by the relative marginal utility of crops grown. When the price band is wide enough, crop choices and labour and land allocations are determined by household preference. When an increasing amount of food becomes available, with decreasing marginal utility of food, increasing use of land and labour for a given crop leads to a decline in the shadow price of that crop. At some point, substituting that crop with another more attractive crop would be inevitable.

Off-farm employment may substantially complicate farm management because it can introduce the possibility of simultaneously having more cash and less labour. Farm households who strive for subsistence using labour-intensive techniques may choose to work off-farm and use the income to finance farming so as to make working on the farm less onerous or increase the return to farm labour. They may also rearrange their crop choices to suit off-farm work. As a result they may prefer to grow crops that need less labour, for example cereals rather than vegetables. On the other hand, farm households with adequate capital but excess family labour may not modify their farming practices; rather they may simply boost their level of consumption. If there is disguised unemployment or underemployment, off-farm jobs may have practically no effect on farming systems. When farm households are not able to find permanent off-farm jobs and have to choose among low-paying occasional off-farm jobs, they may suit off-farm work schedule to the labour demand of their farm instead of the other way round. Off-farm income may also lower risk aversion. As a result, off-farm income may induce farm households to grow crops that are risky but remunerative or that require more purchased input.

Marketing of farm output. Farmers face a decision problem of whether or not to participate in the sale and purchase of farm outputs, and if they participate, how much to sell and buy. A farm household can be either autarkic (self-sufficient), buyer, or seller in a product market for agricultural goods. When the production and consumption decisions are made simultaneously, the purchase and sale of agricultural output (Strauss, 1984; Goetz, 1992) are determined by a vector of prices, wage rates, household characteristics affecting taste and availability of time for work and leisure, exogenous income, farm characteristics including fixed inputs, and a vector of

production technology. However, farm households may fail to participate in the market due to transaction cost. In areas with a sparse market, it is time consuming to discover trading opportunities. Poor market access due to lack of transport, distance, and other barriers such as low information may increases a farm household's cost of observing market prices in order to make transaction decisions.

Off-farm work participation and the level of farm income may also affect their participation in the product market. The level of off-farm income may increase or reduce market participation. A farm household with more off-farm income may use it to finance its farm activities such as hiring of farm labour and purchasing of capital input and may engage in farm production on the basis of the profit maximisation motive. On the other hand, a farmer whose off-farm income is high can meet his cash requirement from the off-farm income he receives and grow crops for own consumption and sell less of his output. A farmer with more off-farm income can participate actively in the product market as a buyer. A farmer who works more in off-farm activities may produce less and meet his consumption through the purchase of farm output. Therefore participation of farmers in the product market as seller will be higher for those with higher off-farm income than those with lower off-farm income.

8.4 Model specification and estimation method

Model specification. The following sets of econometric models are constructed to model the crop choice, labour and land allocation decisions of farm households. A household *i's* choice of crop *j* (cr_{ij}) can be modelled using a logit model (for application see Burger, 1994). The assumption underlying the logit model is that the error term of the utility that households attach to each choice has a cumulative distribution of the hyperbolic-secant square ($sech^2$) distribution (Maddala, 1983, p. 9), which implies that the optimal choice is distributed as a logistic statistic:

$$pr(cr_{ij}) = \frac{\exp(\alpha_j x_i)}{\sum_j \exp(\alpha_j x_i)} \tag{8.1}$$

where $pr(cr_{ij})$ is the probability household i chooses crop j, α is a parameter, x_i is a vector of explanatory variables[1]. The share of land (GC) a household i allocates for crop j is given by

$$GC_{ij} = f(\gamma_j x_i, e_{ij}) \; if \; cr_{ij} > 0, \quad GC_{ij} = 0 \; if \; cr_{ij} = 0 \tag{8.2}$$

where γ is a parameter x_i is a vector of explanatory variables and e is the error term.

The allocation of labour hours (LC) by household i for crop j is given by

$$LC_{ij} = f(\beta_j x_i, e_{ij}) \; if \; LC_{ij} > 0, \; LC_{ij} = 0 \; otherwise \tag{8.3}$$

where β is a parameter, x_i as a vector of explanatory variables and e is the error term.

With regard to product market participation, farm households face a two-stage decision problem. The first is a discrete decision whether or not to trade (depending on the cost of market participation) and in which direction (either as buyer or as a seller). The second is (continuous decision) how much to trade conditional on participation as a buyer or seller. Let the utility attained if the household sells output be U^s_i, if he buys output be U^b_i, when he does not sell be U^{NS}_i, does not buy be U^{NB}_i. Let also D_1 be the index of participation in a product market as a seller; D_2 be the index of participation in the product market as a buyer, S^* be the potential level of farm output the household can sell, B^* be the potential level of farm outputs the household can purchase; and S and B are observed sales and purchase levels, respectively. Then the household's probability and level of participation in the product market can be modelled as:

$$D_{1i} = 1 if \; U_i^S > U_i^{NS}; D_{1i} = 0 \; if \; U_i^S \le U_i^{NS}$$
$$\Pr(D_{1i} = 1) = \Pr(U_i^S > U_i^{NS}) = \Pr(\alpha_1' X_1 + u_{1i} > 0) \tag{8.4}$$

$$D_{2i} = 1 if \; U_i^B > U_i^{NB}; D_{2i} = 0 \; if \; U_i^B \le U_i^{NB}$$
$$\Pr(D_{2i} = 1) = \Pr(U_i^S > U_i^{NB}) = \Pr(\alpha_2' X_2 + u_{2i} > 0) \tag{8.5}$$

$$S^* = S(X_{1i}) + e_{1i} = \beta_1' X_{1i} + e_{1i}; e_{1i} \sim N(0, \sigma_{1e}^2)$$
$$S_i = S_i^* \; if \; D_{1i} = 1; S_i = 0 if \; D_{1i} = 0 \tag{8.6}$$

$$B^* = S(X_{2i}) + e_{2i} = \beta_2' X_{2i} + e_{2i}; e_{2i} \sim N(0, \sigma_{2e}^2)$$
$$B_i = B_i^* \; if \; D_{21i} = 1; S_i = 0 if \; D_{2i} = 0 \tag{8.7}$$

where X is a vector of explanatory variables, u's are the error term of the participation decision, e's are the error term of the continuous variable decisions and α and β are

[1] The vector of explanatory variables (x_j) is constant across crops.

parameters to be estimated. When the error terms of the participation decision and continuous decision are correlated (Amemiya 1984, p. 31-32; and Blundell and Meghir, 1987, p. 187), the sales (8.6) and purchase (8.7) equations can be written respectively as:

$$S^{*}=\beta_1^{/} X_{1i}+\rho_1\sigma_{1e}u_{1i}+e^{*}_{1i} \tag{8.8}$$

$$B^{*}=\beta_2^{/} X_{2i}+\rho_2\sigma_{2e}u_{2i}+e^{*}_{2i} \tag{8.9}$$

where ρ_1 and ρ_2 are the correlation coefficients between the error terms of the participation decision and the extent of participation decision in the sales and purchase equations. Equation (8.8) and (8.9) can be estimated using either a two-stage process or using the generalised tobit model (Amemiya, 1984).

Estimation Method. The logit models of crop choice (8.1) and the tobit models of land (8.2) and labour allocation (8.3) are estimated using the maximum likelihood estimation method. The estimations are done for seven categories of crops namely teff, wheat, barley, sorghum and finger millet, legumes, oil crops and horticultural crops.

Variables that reflect profitability, agronomic conditions, consumption preferences and risk consideration are used as explanatory variables in the logit model of crop choice, land and labour allocation equations. Age and age square of the household head, family size, dependency ratio, year dummy, location dummies, dummies for soil types, soil depth index and value of farm implements and number of oxen owned are used as explanatory variables in both the logit model of crop choice and labour allocation equations. Besides, off-farm income, total land cultivated and share of crop in total expenditure are also used as explanatory variables in the crop choice model. In the land allocation equation (8.2), off-farm income, total animal wealth, total land cultivated, value of output expected[2], number of dependants, family size, value of farm and non-farm equipment owned, education and year dummies, the proportion of clay soil and sandy soil cultivated and soil depth indicator are used as explanatory variables. In the labour allocation equation (8.3), off-farm labour hours, level of land allocated and variable inputs used are included in the list of explanatory variables. In all equations, off-farm income, off-farm hours worked, share of crops in total consumption, and expected yield are treated as endogenous variables. The rest of

[2] The value of actual output is used as a proxy for the expected value of farm output.

the explanatory variables are assumed to be exogenous. For all endogenous variables, their predicted values are used in place of their observed values. Off-farm income and off-farm hours worked are predicted from a tobit model. This is equivalent to using a two stage tobit model (Maddala, 1983, pp. 245-246).

The following strategy is followed to estimate the market participation. First the bivariate probit equations of participation as buyer or seller in the product market (equation 8.4 and 8.5) are estimated jointly (which is analogous to Zellner's seemingly unrelated regression, SUR). This estimate is compared with the single probit estimates of equation 8.4 and 8.5. Then the selectivity term or inverse mills ratios are constructed from the best estimates. Second, using the selectivity term derived from the probit equations, the level of sales (8.8) and purchase (8.9) equations are estimated using 3SLS estimation method. Age, age square, education dummies, year dummy, family size, dependency ratio, value of transport animals, value of farm output, off-farm income and variables that reflect transaction cost such as location dummies are used as explanatory variables in both the purchase and sales decision. Off-farm income and farm outputs are considered to be endogenous and the rest are assumed as exogenous variables. Instrumental variables, which are included and excluded in turn in the model, are used to predict the off-farm income and farm output. The instrumental variables used that are excluded from the model are farm labour used, area of land cultivated, variable inputs, off-farm wage rates, livestock wealth and farm and non-farm equipment.

8.5 Estimation results and discussion

Crop choice. The probability of growing a particular crop is influenced by agronomic conditions such as soil type and depth, the level of land cultivated and partly by the availability of equipment and number of oxen owned (Table 8.6, see also Appendix A8.2). As one usually expects, the amount of land cultivated has significantly increased the probability of growing crops for all seven types of crop. The availability of sandy type soil (*hutsa*) has increased the probability of growing wheat and vegetables. The probability of growing teff is higher for households who have black and deep soil. The availability of black soil has also increased the probability of growing vegetables. While the value of farm implements owned increases the probability of growing teff, it decreases the probability of growing barley. The

ownership of oxen has significantly increased the probability of growing barley, but its parameters are insignificant from zero at 10% for the rest of the crops.

The year dummy shows a significant influence on the probability of growing teff and finger millet and sorghum. It may have captured the timing of rainfall. The growing of teff and finger millet and sorghum depends on the timing of rainfall. If there is rainfall in May, farmers grow sorghum, whereas if there is no rain in the month of May, farmers grow teff in place of sorghum. In May 1996 there was sufficient rainfall to grow sorghum, where as in May 1997 the level of rainfall was not sufficient to grow sorghum and finger millet. As a result the probability of growing teff was lower in 1996 than in 1997 while the probability of growing finger millet and sorghum was higher in 1996 than in 1997.

Table 8.6 Elasticity for the probability of growing crops using instrumental variables

Crops/variables	Teff	wheat	Barley	Sorghum	Legume	Oil crops	Veg
Family size	0.118	0.155	0.090	0.061	0.178	0.006	-0.092**
Dependency ratio	-0.090	0.085	-0.008	-0.051	-0.099	0.075	0.046
Soil depth index	0.247***	0.099	0.10***	0.014	0.076	0.044	0.045
Off-farm income	0.096	-0.193	-0.114	-0.014	-0.039	-0.107**	0.040
Value of farm implements	0.162**	-0.025	-0.09**	-0.002	-0.035	-0.042	0.005
Number of oxen owned	-0.012	0.069	0.082**	0.001	-0.074	0.000	-0.011
Land cultivated	0.271***	0.33***	0.20***	0.037**	0.580***	0.032	-0.002
Share in total consumption	0.223	0.025	0.161	-0.093	0.156	0.000	-0.087***

*** stands for significance at 1 %; ** stands for significance at 5 % and * stands for significance at 10 % level.

The results also show that non-farm income, share of crops in total expenditure, age, education, location dummies and household compositions such family size and dependency ratio do not affect the probability of growing crops by farm households in the sample. It is not surprising to see that off-farm income has insignificant influence on crop choice because in areas with a substantial under-employment, farm households are expected to adjust their off-farm activities to their farming conditions. The parameters of the share in total consumption are not significantly different from zero for all crops except vegetables. Besides the parameters for the share in total expenditure are negative for sorghum and vegetables, contrary to our expectation. The impact of family size is positive for all crops except for vegetables and is higher for teff, wheat and legumes. When the dependency ratio increases the probability of growing wheat and oil crops increases while the probabilities for teff, barley, sorghum and legumes decline. However, none of the

parameters for household composition and consumption preference variables are significantly different from zero.

Land allocation. The share of land allocated to crops is greatly dependent on factors affecting profitability (yield), risk bearing ability (livestock, wealth, and value of equipment owned), off-farm income, and availability of land (Table 8.7, see also Appendix A8.3). The share of land allocated to all crop types declines when the area of total land cultivated increases. However, the level of land increases for all crops when total land cultivated increases. The average land shares, the marginal land shares and the elasticity of land allocated for each crop with respect to the total land are summarised in Table 8.8. All crops have positive elasticity, but less than unity[3]. The highest land elasticity for land allocation goes to vegetables and oil crops, which are less productive.

As theory and empirical evidence suggest (Chavas and Holt, 1990), land allocation is significantly influenced by the economic return. The expected yield has increased the share of land allocated to all crop types. The highest response of land allocation to the expected return is in case of teff followed by wheat and barley. These crops are the main food crops and the sources of cash in the area. Off-farm income and wealth also show some influence on the land allocation. While off-farm income decreases the share of land allocated to teff, wheat, barley and finger millet and sorghum, it increases the share of land allocated for legumes and oil crops, which require less labour per unit of land. The influence of off-farm income on land allocated for sorghum and finger millet and oil crops is not significantly different from zero at any reasonable level of significance. The positive impact of off-farm income on the level and share of land allocated to legumes shows that off-farm income helps farmers to exercise land-augmenting practices. Legumes are usually planted after a series of cereals in order to improve the productivity of land (by fixing nitrogen to the soil). The wealth variables show mixed result on land allocation. Livestock wealth increases the share of land allocated for wheat, finger millet and sorghum and legumes but decreases the share of land allocated for teff, barley, oil crops and vegetables. Farm and non-farm implements reduce the share of land allocated for teff, wheat, barley, legumes and vegetables, but increase the share of

[3] If all farm households were growing all crops, marginal budget shares would add up to one and the elasticity of all crops would not be leas than one. Farm households must be shifting to a new crop when area of land under cultivation increases.

land allocated to finger millet and sorghum and oil crops. In general the result of wealth variables is not consistent regarding the response of crop choice to risk. The expectation was that wealth variables would increase the share of land allocated to relatively risky crops (such as teff and wheat) and decrease the share of land allocated to relatively less risky crops (such as barley, finger millet and sorghum).

The results on the influence of consumption preference also do not coincide with our expectation. When farm household's consumption and production decisions are inseparable, one normally expects consumption preferences to influence crop choice decision. However, consumption preference does not affect the land allocation decision of farm household at all. For all crop types, the influence of the share of crops in total consumption on land allocation is not significantly different from zero at any reasonable significance level. Besides, the impact of the shares in total consumption is negative for finger millet and sorghum and vegetables.

Table 8.7 Elasticity of share of land allocated to crops at mean values

	Teff	Wheat	Barley	SFM	Legumes	Oil crops	Veget.
Off-farm income	-0.2263***	-0.1989***	-0.3645***	-0.1151	0.0923	0.0590	-0.0512
Total animal wealth	-0.0052	0.0037	-0.0469***	0.0251	0.0005	-0.0091	-0.0045
Equipment owned (Birr)	-0.0625**	-0.0465**	-0.0736***	0.0008	-0.0001**	0.0240	-0.0559
Total land cultivated	-0.6146***	-0.5891***	-0.3099***	-0.5407***	-0.4344***	-0.277*	-0.0435
Expected yield	0.7749***	0.5685***	0.5339***	0.2701***	0.5783***	0.1856***	0.1751***
Share in total expenditure	-0.0197	0.2773	0.0929	-0.0521	-0.7716	-0.1751	-0.3397
Number of dependants	-0.1386	-0.3116**	-0.1787**	-0.3436	-0.2634	0.2637	-0.0099
Family size	0.4226***	0.7492***	0.4542**	0.6168	0.4590	-0.5554	0.1857
Proportion of clay soil	0.1191***	0.0502***	0.0320**	0.0426	0.1046**	0.0764	0.1893***
Proportion of sandy soil	0.0799***	0.1049***	0.0777**	0.0379	0.0105	0.0062	0.2991***
Soil depth index	0.2821***	0.3867***	0.4446	0.1643	0.3530***	0.2222	0.1152***

**** Stands for significance at 1 %; ** stands for significance at 5 % and * stands for significance at 10 % level. SFM is sorghum and finger millet.*

Land allocation is greatly influenced by family composition. Family size shows a significant and positive influence on the share of land allocated to teff, wheat and barley. This may imply that farm households allocate more land to the main food crops, which require relatively higher amount of labour in production. Teff, wheat and barley are crops that require higher amount of labour and are the main food crops in the area. The influence of the number of dependants is negative and significant for wheat only. The allocation of land is also greatly influenced by natural environmental conditions such as rainfall and soil types. More land is allocated in 1996 than in 1997 for sorghum and finger millet. This is due to the favourable rainfall conditions in 1996. The share of land for barley is higher when the soil is deep and sandy. Legume

crops receive a higher share when the share of black soil cultivated increases. Teff and wheat receive a higher share of land in deep, black and sandy soils.

No meaningful result is obtained regarding the effect of education on land allocation decisions. The education dummy of the household head show positive impact on the land allocation for wheat, finger millet and sorghum, and negative impact for teff, barley and vegetables. However, none of the parameters are significantly different from zero at 10% level, except for teff and vegetables.

Table 8.8 Average land share, marginal land share and total land elasticity of land allocation

Crop type	Average land share	Marginal land share	Elasticity land with respect to total land cultivated
Teff	0.197	0.089	0.45
Wheat	0.250	0.118	0.47
Barley	0.364	0.263	0.72
Sorghum and F. millet	0.049	0.035	0.51
Legumes	0.110	0.067	0.61
Oil crop	0.018	0.013	0.76
Vegetables	0.010	0.010	0.93

Labour allocation. The most important factors that influence the labour allocation decision of farm households are soil type, soil depth, area land allocated, the level of labour supplied off-farm, farm equipment and oxen (Table 8.9, see also Appendix A8.4). Household composition and labour availability also has limited influence on the labour allocation of farm households. Controlling for agronomic and other social and economic factors, off-farm employment show a significant negative impact on the level of labour allocated for teff, wheat, barley and vegetables. The impact for sorghum, finger millet, legumes and oil crops is not significantly different from zero.

The amount of labour allocated to all crops increase with the amount of land allocated except for vegetables. It also increases with increasing soil depth for all crops except for sorghum, oil crops and vegetables. Households with a higher proportion of sandy soil use a higher amount of labour for wheat and barley. Family size (showing the availability of labour) shows a positive and significant impact only on the level of labour allocated to wheat. Its impact for the rest of the crops is insignificant. While the level of farm implements owned increases the use of labour for teff, it reduces the use of labour for wheat. Its impact on the rest of the crops is statistically insignificant. The ownership of oxen shows a significant positive effect on the labour use for wheat only.

The use of variable farm inputs such as fertiliser, insecticide and improved varieties increases the use of labour for wheat, barley, sorghum, finger millet and legumes. Its impact on the use of labour for teff, oil crops and vegetables is not significantly different from zero. The positive impact of farm variable inputs implies that the intensive use of commercial inputs can be used as a means to promote on-farm employment. Purchased capital inputs such as fertiliser and improved seeds can increase on-farm employment not only because they are labour using, but because they are also land augmenting. Hence the intensive use of variable farm inputs can increase the return to family labour on the farm and encourage family members to use more labour on the farm.

Table 8.9 Elasticities of labour allocation across crops

	Teff	Wheat	Barley	SFM	Legum	Oil	Vege
Family size	0.108	0.308**	0.085	0.470	0.133	-0.775	0.414
Dependency ratio	-0.019	-0.020	-0.034	-0.664	0.016	0.521	0.786
Soil depth index	0.255***	0.240***	0.129***	0.532	0.273***	-0.192	0.160
Hours worked off-farm	-0.27***	-0.254**	-0.149**	-0.490	-0.180	-0.311	-2.403**
Value of farm implements	0.133***	-0.112**	0.026	-0.381	0.007	0.244	0.186
Value of oxen owned	-0.004	0.088*	-0.017	0.063	-0.049	-0.168	-0.671
Land cult. with spec. crop	0.525***	0.439***	0.459***	0.24***	0.339***	0.31***	0.309***
Variable farm inputs used	0.012	0.102***	0.137***	0.10***	0.114***	0.027	0.028

*** Stands for significance at 1 %; ** stands for significance at 5 % and * stands for significance at 10 % level.

Product marketing behaviour. Single equation and full information maximum likelihood bivariate probit equations were estimated. But the estimates of the cross equation correlation in the bivariate probit model is not significantly different from zero at any reasonable level. So single equations probit estimates are sufficient to construct the selectivity term (inverse mills ratio). Hence the results of the single probit equations are used for the rest of the discussion.

The probability and level of participating in the product market both as a buyer and as a seller is significantly influenced by transaction cost, level of output and off-farm income (Table 8.10, see also Appendix A8.5). The variables reflecting consumption preferences (such as dependency ratio), family size, education and age do not affect the market behaviour of farm households. Those villages that are far from market areas have a low probability and level of buying and selling agricultural outputs than those villages nearer to market area signifying the importance of transaction cost. The level of output reduces the probability and the level of participation in the market as a buyer and increases the probability and level of

participation in the market as a seller. The magnitudes of the impact are higher for sellers than for buyers. The output elasticity of sales is greater than unity (1.3) while the output elasticity of purchase is inelastic (-0.354).

The off-farm income affects the marketing behaviour of households through its influence on the sale and purchase of farm outputs in the opposite way. While off-farm income increases the probability and level of purchase of agricultural output, it reduces the probability and level of sales of agricultural outputs. However, the impact on the level of sales is very small and not significantly different from zero. This implies that when off-farm income increases, the marketing surplus of farm output decreases, but very small. To elaborate more, for most of the small farmers who do not have another source of income (such as off-farm income), the main source of cash income is the sale of farm output. To buy compulsory food and non-food items, which cannot be produced on their farm (such as salt, spices, clothes and taxes), farm households have to sell farm output. When the farm households obtain off-farm income, they can stop selling farm output and use the cash obtained from off-farm work to purchase the food and non-food items required. However, off-farm employment can help farm households finance their farming activities through the purchase of farm inputs such as hired labour, fertiliser, and improved seeds. In a drought prone area, off-farm income can help to purchase food for consumption and keep farmers productive on their farm. As a result, off-farm employment can increase farm output and its negative impact on the sale of farm output can be very low. Therefore, in a less dynamic agricultural area, the impact of off-farm employment on the marketing surplus of farm outputs could be very minimal.

Table 8.10 Elasticities of market participation and the level of purchase and sales in the product market

Variable	Probability of being Buyer	Probability of being Seller	Purchase	Sales
Family size	-0.080	0.125	0.260	-0.160
Dependency ratio	0.098*	-0.013	0.240	0.113
value of transport animals owned	-0.004	0.049	-0.020	0.016
total value of crop yield	-0.040**	0.253***	-0.354***	1.303***
Off-farm income	0.053**	-0.057**	0.153***	-0.018

*** Stands for significance at 1 %; ** stands for significance at 5 % and * stands for significance at 10 % level.

The selectivity terms (inverse mills ratio) show that buying and selling households sell and buy more than the households selected at random. This result suggests that those who participate in the product market have a comparative

advantage in the market either as buyers or sellers, due to lower transaction cost and unobservable factors such as farmers' skill and access to information and information sources.

8.6 Conclusions

Crop choice and land and labour allocation decisions of farm households and their relation with off-farm employment are modelled in a non-separable agricultural household model setting. Due to the existence of substantial underemployment in the area, the influence of off-farm employment on the crop choices of farm households is not substantial. Instead farm households adjust their off-farm activities to their farming condition in most of the cases. The influence of off-farm employment is rather slightly stronger on the land and labour allocation decisions of farm households. It increases the allocation of land for legumes and oil crops, which are less productive, less labour using and land improving. Off-farm employment also reduces the use of labour for cereals implying that off-farm employment competes with farming activities for labour. The results also show that crop choice, land and labour allocation decisions of farm households are influenced by agronomic conditions (such as soil type and depth), the area of land cultivated, risk considerations and partly by the availability of equipment and number of oxen owned.

Furthermore, off-farm employment influences the marketing behaviour of farm households. While the probability and level of purchase of food increases with increasing off-farm income, the probability of grain sales decreases with increasing off-farm income. The negative impact of off-farm income on the marketing surplus of farm outputs is found to be very minimal. Farmers are restricted from participating in the product market because of lower farm output and off-farm income, higher transaction cost and lack of access to information and information sources. Although the majority of farm households are reasonably linked to a product market, the majority of them are net buyers, which limits the use of pricing policy as a means to raise the income of farm households in the region. Given that the majority of farmers are net buyers, pricing policy in order to protect consumers is as important as pricing policy to protect producers. In general there is little relevance for pricing policy in the area. Rather it will be beneficial to take measures to reduce the transaction costs by improving the infrastructure. Proximity to market and alternative income opportunities such as off-farm activity will improve the link of farmers to the market.

Improving the link of farmers to the market means that the government has alternative policy instruments to achieve its desired objectives.

CHAPTER 9. PRODUCTION AND CONSUMPTION LINKAGES AND THE DEVELOPMENT OF RURAL NON-FARM ENTERPRISES

9.1 Introduction

The foregoing chapters have demonstrated that there is underemployment in the rural areas of Tigray. Farm households are endowed more with labour than with capital and land. They employ a low level of capital and operate small farms. As a result the present farming system is not dynamic enough to absorb the growing population. On the average, farm households use not more than 53% of their available time working on and off-farm (see Chapter 6 and Chapter 7). Due to the seasonality of agricultural production, rural labour cannot be employed fully unless irrigation agriculture or rural non-farm activities are widely adopted. Neither irrigation facilities nor non-farm activities are developed sufficiently to employ the surplus rural labour at the moment. Irrigation development alone cannot be relied upon to reduce under-employment in rural areas because its development is too slow to tackle the problem. Labour under-utilisation can be attacked on either the supply side or the demand side of a labour market. In practice, little can be done to bring about a supply-side adjustment. The labour force is currently growing faster than employment. The only real supply-side alternative is to reduce the growth of labour supply by limiting the population growth, which is quite difficult in developing countries at the moment. Hence policy must concentrate on the demand side of the labour market in order to reduce or ameliorate underemployment of the rural labour force. Among others, the promotion of micro and small-scale enterprises (MSE) in rural areas can reduce the problem of rural underemployment.

Despite their importance, development policies usually neglect the role of rural non-farm activities and their link to agriculture. This might be due to the fact that the role of the rural non-farm sector in the rural economy is poorly understood. The knowledge gap in the role of the rural non-farm sector is reflected in the policies of the developing countries. Particularly in Ethiopia, there is no development policy that identifies and includes the rural non-farm sector as an important component of the economy and a source of employment. The agricultural ministries have focused on

farming and the industry ministries have focused on industries. Rural non-farm activities and their link to farm activities are completely neglected. The neglect of the rural non-farm sector as well as their link to the agricultural sector is socially costly (Lanjouw and Lanjouw, 1997). Without recognising the importance of the rural non-farm sectors, the sector's potential role in absorbing the growing rural labour force, in reducing rural-urban migration, in contributing to the national economy and promoting a more equitable distribution of income cannot be materialised. It is crucial, therefore, to identify the contribution of micro and small- scale enterprises to development (to employment, income generation and poverty alleviation) and to make policy makers aware of the roles played by MSEs.

The contribution of agricultural production to rural non-farm activities is well-documented (Haggblade, Hazell and Brown, 1989; Bagachwa and Stewart, 1992; Reardon, 1997). A rising agricultural income stimulates the growth of rural non-farm activities through production, consumption, and labour market linkages. A growing agricultural sector can increase employment in the non-farm sector through the demand for purchased agricultural inputs (*backward production linkages)* and consumption goods and services *(consumption linkages)* and the supply of raw materials for processing and distribution *(forward production linkages).* An increase in agricultural income raises the opportunity cost of labour in non-farm activities (*labour market linkages*), and thereby induces farm households to shift from very labour-intensive, low return off-farm activities into more skilled, higher-investment, high-return activities. In fragile and marginal areas, non-farm income can reduce the incidence of poverty and the direct dependence on land which affects the environmental quality, crop mix and cropping potentials (Reardon et al., 1998; Reardon and Vosti, 1995). However, the magnitude and relative strength of the production and consumption linkages are not well known in Ethiopia, particularly in Tigray.

The objective of this chapter is (1) to analyse the developments and constraints of rural small-scale enterprises and their link to the agricultural sector; and (2) to examine the production and consumption linkages as well as their relative strength. The contribution of this chapter is, therefore, to fill the gap in understanding about the type and magnitude of the linkages that exist between the farm and non-farm sectors in the region using already well established methodology (Hazell and Roëll, 1983).

We try to explain and quantify the linkages that have not been examined so far in any of the preceding chapters for the sake of completeness.

This chapter brings two different issues together each of which could have been treated separately. However, because of lack of space and time, I choose to do them in one chapter briefly. The first part deals with the problem and development of micro and small-scale enterprises (MSE) as well as the general link that exists between the farm and non-farm sectors in the Tigray Regional State. The analysis of farm and non-farm linkages and constraints and development of MSE are based on secondary data collected by the Central Statistical Authority of Ethiopia and the Tigray Regional Bureau of Trade and Transport. The second issue is enumerating and if possible, quantifying the production and consumption linkages that exist between the farm and non-farm sectors. These linkages are enumerated and quantified using the survey data obtained from a sample of 201 farm households in the two districts of the Tigray Regional State. The development and constraints of rural micro and small-scale enterprises are discussed in section three. In section four, production and consumption linkages are assessed. The paper ends with some concluding comments.

9.2 Theoretical background

To bring economic growth to developing countries, it is advisable to adopt technologies more appropriate to the factor endowment of the area (Gills, et al., 1992; Hayami and Ruttan, 1985). Farm households in developing countries are endowed more with labour than with capital. Land is also becoming the scarcest resource in some African countries such as Ethiopia. As a result, wide underemployment of labour is observed. Labour under-utilisation can be attacked on the supply side or the demand side of a labour market, but little can be done to bring about a supply-side adjustment. The labour force is growing faster than employment creation. It is quite hard to discourage people from seeking work. The only real supply-side option is to reduce the growth of labour supply by limiting population growth, which takes at least 15-20 years to stabilise the growth of the labour force. Hence policy has to concentrate on the demand side of the labour market in order to reduce or ameliorate underemployment of the rural labour force.

On the demand side, there are two different approaches to employment creation. The first is to stimulate output, especially in relatively high-productivity and

high wage sectors of the economy. The second one is to increase the amount of labour used to produce a given amount of output (Berry, 1974). The first one deals with the growth of export, output and industry (see chapter 17, 18, and 20 in Gills et al., 1992 for details). The second one implies making production more labour intensive. Production can be made more labour-intensive by changing the relative prices and thus creating incentives for businesses to substitute labour for capital. Certain restrictions should be avoided in order to provide incentives for businesses to substitute labour for capital. The restrictions include the imposition of artificially high wages on the modern sector, which can result from the minimum wage laws of the government and lobbying of trade unions; social security taxes on modern sector payrolls; interest rate ceiling; overvaluation of domestic currency; import licensing; and investment incentives proportional to the amount of capital invested. Such restrictions could be avoided by deregulation and exposure to open competition or could be offset by taxes and subsidies if the restrictions cannot be removed.

Production can be made more labour-intensive by developing technologies more appropriate to the factor proportions prevailing in the area. In fact it is controversial as to how such appropriate technology be acquired. However, broad-based acquisition of technological capacity has to be developed gradually through learning by doing. Income distribution in favour of the poor may sometimes accelerate job creation because the goods consumed by the poor are more labour intensive than the goods consumed by those who are better off (Mellor, 1966). Seeking investments that complement labour rather than substitute for it can help to increase employment. Examples of labour intensive investment are promoting irrigation rather than large-scale plantation farming and providing training to fill the skill gap so as to increase employment through increased absorption of complementary unskilled labour. Most importantly, the promotion of micro and small-scale enterprises (MSE) can ameliorate rural under-employment (Mead and Liedholm, 1998; Liedholm, McPherson and Chuta, 1994) because most of the products of MSE are more labour intensive than the products of large and medium scale industries.

Agriculture plays a crucial role in rural enterprises employment generation. Rising agricultural income stimulates the growth of non-farm activities in both rural areas and towns (Reardon et al., 1998). When agriculture is dynamic enough to bring about substantial change in household income and employment, it affects non-farm

activities (Reardon, 1997) in at least three ways (Haggblade and Hazell, 1989): through production, through consumption, and through labour market linkages. On the production side, a growing agricultural sector requires farm inputs such as fertiliser, insecticide, pumps, equipment, and repair services -either produced or distributed by non-farm enterprises (*backward linkages*). Increased agricultural output stimulates rural non-farm activities (*forward production linkages)* by providing raw materials that require milling, processing and distribution by non-farm enterprises.

Consumption linkages arise when growing farm income boosts the demand for basic consumer goods and services and results in the diversification of consumption spending on products other than food. Non-farm enterprises in rural areas or in rural towns can meet most of the demand by farm households for purchased farm inputs, basic non-farm consumption goods and services that are either produced or distributed locally. Average and marginal budget shares as well as the income elasticity of consumption goods can help to determine the magnitude of consumption linkages in an economy (Hazell and Hojjati, 1995). In particular, the decomposition of budget shares and elasticity can provide useful information on how expenditure is distributed across locations. To analyse the relative importance of different commodity groups in the demand linkages, marginal budget shares and expenditure elasticity can be derived from an Engel function with a non-linear relationship between consumption and income.

The third linkage is *labour market interactions*. A growing agricultural sector can raise agricultural wages and this in turn raises the opportunity cost of labour in non-farm activities. This induces farm households to alter the composition of non-farm activities and move out of very labour-intensive, low return activities into more skilled, higher-investment, high-return activities. In general raising agricultural productivity can be an instrument to induce structural transformation of the rural non-farm economy.

With a dynamic agriculture, these linkages can bring about a virtuous spiral of growth, employment and income for rural households (Reardon, et al., 1998). These linkages are minimal in marginal areas or in areas where the agroclimate is poor, and agriculture is risky and less dynamic. In marginal areas, the non-farm sector is rather important since it enables rural households economy to cope with risks such as a poor harvest. The non-farm sector can provide cash for buying food and farm inputs, and

so alleviates a vicious circle of poverty-extensification-degradation-poverty (Reardon, 1998; Reardon and Vosti, 1995).

If agriculture is stagnant and lacks the growth impulses that operate via demand-supply inter-linkages to the non-farm sector, the development of micro and small-scale enterprises could be the result of under-employment in the agricultural sector. In other words, the development of non-farm activities could be an outcome of excessive demographic pressure coupled with the inability of agriculture to absorb the expanding labour force rather than an outcome of transmission of positive growth from the farm to the non-farm sectors. They call this a *residual sector hypothesis* in Indian economic literature (Vaidyanathan, 1986; Verma and Verma, 1995; Shylendra and Thomas, 1995), which is similar to the *push and pull motives* of income diversification of farm households (Reardon, Delgado and Malton 1992; Reardon, 1997; Reardon et al. 1994). If the residual sector hypothesis is true, the development of the agricultural and rural non-farm sectors will be negatively correlated.

In addition to the performance of the agriculture sector, other factors such as the level of infrastructure, population density and growth, development of rural towns (Haggblade, Hazell and Brown, 1989), policies and government regulations, human capital, skill, caste, tradition, and the availability of non-agricultural raw materials as well as social and political environment influence the performance and development of the non-farm economy. The development of rural towns is very important for the centralised and cost effective way of providing key infrastructure and services. Infrastructure development reduces the cost of information and transportation which in turn improves the efficiency with which rural labour and financial markets channel inputs into activities yielding the highest returns. It also opens rural resources and markets to viable exploitation, and facilitates a change to a more specialised and productive rural economy. A higher density of population helps to attain a minimum efficient scale for non-farm production and service delivery. It may also limit the number of households that should survive from agriculture alone thereby forcing some of the rural households into non-farm activities.

Location, nearby urbanisation and competition from imports also influence the performance and growth of the rural non-farm sector (Haggblade, Hazell and Brown, 1989). The evidence from some African countries (for example, Ivory Coast) suggests that rural manufacturing is most vulnerable from urban and imported substitutes,

while services and commerce are better insulated from urban competition (Haggblade, 1995).

9.3 Performance of rural small-scale enterprises and constraints for development

9.3.1 Developments of micro and small-scale enterprises

In this section the development of small-scale non-farm activities will be discussed based on the information obtained from the Central Statistics Authority (CSA, 1997b, 1997c, 1997d) of Ethiopia and Tigray Regional State Bureau of Industry, Trade, and Transport (ITTB, 1998). This does not include the informal non-farm sector, as it is difficult to get data on this sector. A discussion about the rural informal non-farm activities as off-farm activities will be presented in the next section.

The following CSA classification of non-farm activities is used: (1) distributive and service trade and (2) manufacturing industries. Distributive and service trade is defined as an economic sector, which includes wholesale, retail trade and commercial services. Manufacturing industries are divided into three: (1) large and medium manufacturing industries are those which engage 10 or more persons and use power-driven machines; (2) small scale manufacturing establishments that engage less than 10 persons and use power driven machines such as bakeries, candy factory, electric workshop, edible oil extraction etc.; (3) cottage/handicrafts manufacturing establishments which perform their major activities manually (using mainly non-power-driven machines). Here in this study, small scale manufacturing industries, cottage/handicraft manufacturing establishment and distributive and service trade (that are formally registered by government offices) are considered to be micro and small-scale enterprises (MSE).

Statistics from ITTB (1998) show that small-scale manufacturing enterprises have been flourishing for the last seven years. In 1991, small-scale industry was almost non-existent except for cottage industries. In 1994 they showed a remarkable growth and were 206 in number. In 1997, they number 599 (Figure 9.1). These small-scale manufacturing enterprises provide employment for approximately five people per

establishment. The average capital investment per establishment is 153 thousand Birr. The most successful type of small-scale industry is a grain mill. About 20 % of the small-scale manufacturing enterprises are found in Mekelle, Capital City of the region. The rest (80%) are found in other zonal and district towns (Table 9.1). Most of the raw materials used for production is locally produced. Imported raw materials constitute about 14 % of the total raw materials used on the average. The ratio of imported raw materials to total raw materials for publishing and printing enterprises, manufacturing of machinery and metal products, and manufacturing of wearing apparels are 83%, 61% and 53%, respectively.

Table 9.1. Distribution of small-scale manufacturing enterprises in Tigray in 1996/97

	Count	Investment (000'Birr)	Employment
Tigray	599	91651	2957
Mekelle	117	34253	842
Southern zone	117	15551	765
East zone	93	20873	521
Central zone	105	9370	373
Western zone	168	11983	558

Source: Bureau of Industry and Trade and Transport of Tigray Region, Statistical Bulletin 1, February 1998.

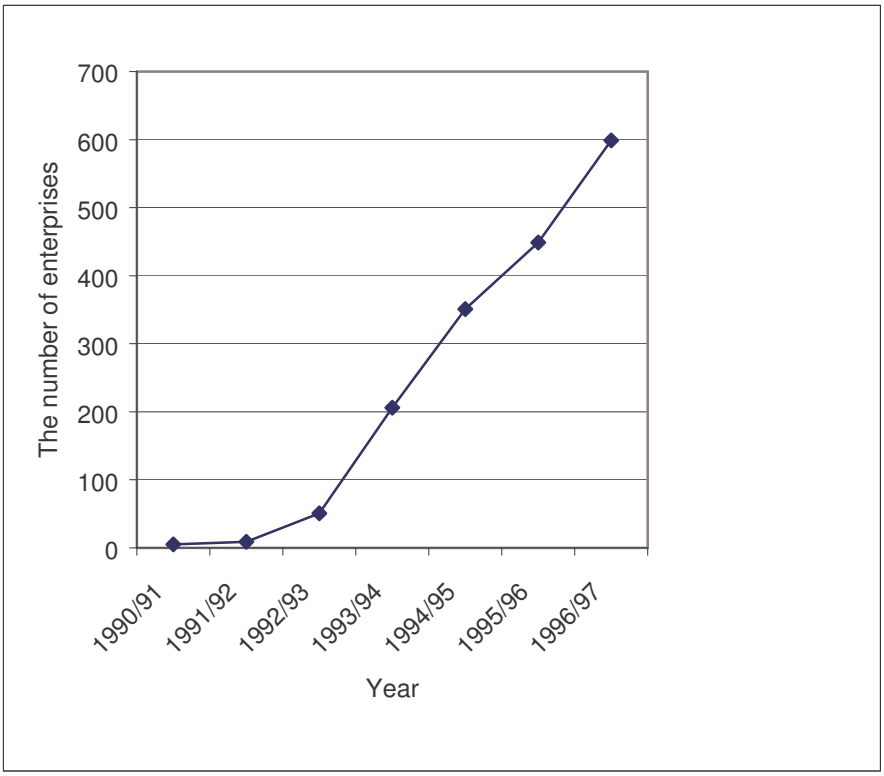

Figure 9.1 Development of Small Scale Manufacturing Enterprises in Tigray Region

The Central Statistics Authority has estimated cottage/handicraft enterprises to be 25,012 in number, of which nine percent are found in the metropolitan city of Mekelle. The rest is found in the other towns. Cottage industries are known to use more locally produced raw material in production than small-scale manufacturing industries. The cottage industry in the region covers a variety of industrial groups including the following major products: manufacturing of food products and beverages, manufacturing of textiles, and manufacturing of non-metallic mineral products. These three groups constitute 90 % of the overall regional cottage industry. The average initial capital invested per establishment for rural areas is 376 Birr, while it is 276 Birr for urban areas. Most of the finance for initial investment comes from own saving (44%). Assistance from friends and relatives is the second most important source of capital for initial investment. The dependence of small establishments like cottage industries on banks for investment is very minimal due to the high collateral requirement.

Distributive trade is the most common non-farm activity and has grown very fast over the last seven years. In 1995 the growth rate of this sector was 16 %. If the unlicensed trade activities undertaken by farm households were included (which are often underestimated in the GNP calculation), the growth rate estimate of the distributive trade would have been higher than 16 %. Here three kinds of trade are included: wholesale trade, retail trade and service rendering trade. The service rendering trade establishments include bars, barbers, beauty salons, building contractors, laundries, and typing and veterinary schools. About 16 % of them are found in the metropolitan city of Mekelle. The rest are found in the zonal and Woreda centres. The initial capital required for retail trade is lower than that for wholesale and service rendering trades. The educational statuses of the owners of wholesale and retail trades are comparable. People who have only elementary level education are the owners of the majority of the trade establishments. Most of the wholesale and retail trades establishments are owned by men (Table 9.2). Women own most (71%) of the service-rendering establishment such as bars, beauty salons and local drink houses, where the value added per unit of investment is the lowest. Most of the bars (86%), beauty salon (94) and *meisse*[1] houses (97 %) are owned by women. When these three

[1] *Meisse* is local liquor mainly made from honey and/or sugar.

trade establishments are excluded, women own only 20 % of the service rendering trade.

The dominant type of ownership is the sole-proprietorship. Share company and partnership are not well developed in business activity. In Mekelle wholesale trades are all individual proprietorships; in other urban areas 10.8% are individual proprietorships, 4.8% are partnerships. In retail trade in Mekelle, 98 % are individual proprietorships; the rest (2%) are partnerships and publicly owned. In other urban areas of Tigray, the retail trade consists of 97 % individual ownership, and the rest are partnerships, public owned and cooperatives. For service trade in Mekelle, 99% are individual proprietorships; the rest (one percent) are public owned and cooperatives. In other urban areas of the service trade, 99.8% are individual proprietorships and the rest (0.2%) are publicly owned. One possible reason for a sole-proprietorship to dominate is fear of friction and the transaction costs that would be involved during dispute. It takes several months to settle a dispute in a court. This coupled with the problem of working capital reported imply that if the share companies or partnerships are encouraged, the problem of lack of working capital and initial capital investment could have been solved.

Table 9.2 Characteristics of the distributive trade in Tigray

	Wholesale trade	Retail trade	Service rendering trade
Number of establishments	2734	11765	2799
Initial capital per establishment (Birr)	31,301	4,326	14,922
% of female owners	11	25	71
% of owners illiterate	16	22	34
% of owners % grade 1-6	56	61	42
% of owners high school	22	21	20
% of owners >12 grade	1.3	1.3	3.1

Source: Calculated from table provided by Industry, Trade and Transport Bureau of Tigray Regional State.

The cottage industry and small scale manufacturing industry have a more important role than the distributive trade in providing employment and generating income (Table 9.3). In Tigray, cottage and small scale manufacturing industry require 269 and 3,509 Birr capital investment per unit of employment, respectively. In the distributive trade, 202, 075 Birr capital investment is required to employ one person. The value added per unit of investment is also smaller for the distributive trade, which generates 0.004 Birr per Birr of initial investment. The cottage and small-scale industry generate 2.21 and 1.42 Birr per Birr of initial investment, respectively. In

terms of the value added per employee, small-scale industry performs the best followed by the distributive trade.

Table 9.3 Value added (Birr) and employment potential for non-farm activities in Tigray

Type of non-farm activity	Initial capital investment per unit of employment provided	Value added per Birr of investment	Value added per person engaged
Cottage industry	269	2.210	595
Small scale industry	3,508	1.420	4,966
Total distributive trade	202,075	0.004	804
Wholesale trade	156,941	0.040	6,023
Retail trade	18,000	----	----
Service rendering	426,406	0.004	1,828

Source: Calculated from CSA Statistical Bulletin no. 182

9.3.2 Constraints to the development of micro and small-scale enterprises

Constraints to the development of small and micro enterprises can be categorised as: (1) general infrastructure problem and (2) firm-specific financial and economic problems. The infrastructure problem arises from the low quality and insufficient supplies of roads, electric power and telephone lines. The region has very bad roads. Even the main road that connects other regions and the central government is not well maintained. There was no supply of electricity until May 1998 in most urban areas of the region for the manufacturing industry. The electric power in the regional centre, Mekelle, was not sufficient to run all the manufacturing industries. Since May 1998, most towns have hydroelectricity supply. Even then it takes several months to get electricity power due to the shortage of electrical equipment. The capacity of the government office responsible for the service is also very limited. The telephone line is not well developed. For these reasons businessmen have to spend a lot of time to order and get raw materials and other commodities.

The statistical abstracts of the Central Statistics Authority have documented the specific problems that exist in cottage and small scale manufacturing industries as well as the distributive and service trade. The problems are summarised in Table 9.4. In cottage/handicrafts and small scale manufacturing enterprises, the first major problem is lack of sufficient initial capital. Forty-eight percent and 36 % of the establishments in cottage and small-scale enterprises, respectively, are reported to have this problem. The second problem is lack of adequate skills to start the enterprise for cottage manufacturing enterprises and lack of supply of raw materials and working premises in small-scale enterprises. A few small-scale and cottage-manufacturing industries are not working at full capacity. The main reasons stated (in order of importance) were absence of market demand for the products, shortage of supply of

raw materials and lack of working capital. The main problems in operating cottage and small-scale enterprises (in order of importance) are absence of market demand, lack of working capital and shortage of supply of raw materials.

The main problems for trade enterprises during operation are lack of working premises, shortage of supply of raw material and lack of working capital. About 6 % of the establishments in retail trade and 4.2 % in service trade reported that government regulations were a problem in starting business. In the service trade, 9 % of the establishments in Tigray has reported government harassment during operation. The above problems seem less acute in wholesale trade. About forty-six percent of establishments responded that they do not have any problem in starting wholesale business enterprises.

To summarise, small and micro enterprises in Tigray have grown fast over the last seven years. Their finance comes from own saving and assistance from friends and relatives. The use of loans from formal financial institutions such as banks is very limited, especially for cottage industries due to the high collateral requirement. In general, the distributive trade is flourishing better than the small scale and cottage manufacturing industries. It is only recently that cottage and small-scale manufacturing have started to grow. Cottage and small-scale enterprises are very important for both employment and income generation, although the cottage industry has the lowest value added per person employed. Distributive trade requires more capital to generate employment. Among the distributive service trades, wholesale trade has better income generating capacity. Most women are engaged in the service rendering trade where the value added per unit of capital is the lowest. However, the development of MSE are extremely constrained by low quality and insufficient supply of infrastructure such as roads, telephones and electric power, lack of working capital, absence of demand for their products, and limited supply of raw materials. Promoting share companies together with the improvement of the judiciary system and the bureaucracy might help to solve the problem of working capital. Improving the quality and the level of supply of urban and rural roads as well as the supply of electric power and telephone lines can improve the supply of raw materials needed for the MSEs. Improving the quality of products of the MSEs through subcontracting with either domestic or foreign large firms may increase the product demand. The problem is less acute for relatively larger trade establishments such as wholesale trade. Since most of the products of MSEs have relatively higher income elasticity

(see Table 9.4), their demand can increase in the long run through the development of the agricultural sector (that is, through improvement of the consumption linkages with agriculture).

Table 9.4 Problems faced by small and micro enterprises in Tigray, Ethiopia

Business type	Problems to start business (response %)	Operational difficulties
Cottage/handcraft enterprises	Lack of sufficient initial capital (36%) Lack of continuous supply of raw materials (15%) Lack of working premises (12%)	Insufficient initial capital (48.1%) Lack of adequate skill (11.4%)
Small-scale enterprises	Lack of sufficient initial capital (36%) Lack of continuous supply of raw materials (15%) Lack of working premises (12%)	Absence of market demand (42%) Lack of working capital (16.7%) Short supply of raw materials (11.2%)
Wholesale	Lack of sufficient own capital (21.6%) Lack of working premises (19.8 %) No problem (45.7%)	Limited market (29.1%) Shortage of working capital (18.8%) Lack of working pace (9.4%) No problem (16.2%)
Retail trade	Lack of sufficient own capital (36.6%) Lack of working premises (17 %) Government regulations (6.3%)	Shortage of working capital (37.7%) Limited market (30.9%) Lack of working pace (5.5%)
Service trade	Lack of working premises (17%) Lack of sufficient own capital (8.8%) Access to raw materials (6.9%) Government regulations (4.2%)	Lack of working premises (37%) Shortage of working capital (24.1%) State harassment (9%)

Source: calculated from Central Statistics Authority Statistical Bulletin no. 172, 179, 182,

9.4 Production and consumption linkages

9.4.1 Production linkages

The backward and forward production linkages of the agricultural sector with the non-farm sector in the region are small (Table 9.5). The amount of farm inputs purchased such as fertiliser and pesticides is very low. For example, the average fertiliser use in the sample of farm household drawn from two districts is 62 Birr per household, which is only a very small percentage of farm output (3.2%). Similarly, the use of veterinary medicine is very low. The sale of crop and livestock is still at a very low level. Households consume most of their farm production. On the average a farm household sells only 13% of their crop, and 15% of their production from animal husbandry. At this stage, agriculture seems unable to support large-scale agro-processing industries. This could be one of the reasons for the existence of only two large-scale agro-industries in the region: one edible extraction industry and one tannery.

Table 9.5 Forward and backward production linkages agriculture with non-farm sectors

	Birr/household	% of household using
Backward production linkages	64.27	
Expenditure on fertiliser	61.78	29.6
Expenditure on insecticide	0.62	3.7
Expenditure on veterinary medicine	1.87	15.4
Labour market linkages		
Expenditure on hired farm labour	89.85	39.6
Forward production Linkages		
Sale of crop output	252.64	44.3
Sale of livestock products	72.94	18.2
Sale of livestock	176.99	23.1

Source: survey of 201 farm households

Consider the general relationship between farm and non-farm activities at district level. The data for district level farm income is obtained from the Tigray Bureau of Agriculture. The district level non-farm activities are obtained from the Industry, Trade, and Transport Bureau of Tigray Region. Since the non-farm activities include only those formally registered, the result should be interpreted cautiously. The correlation coefficients in Table 9.6 show that the district level non-farm activities (using capital invested as a proxy) are strongly related to population density. The correlation with farm income is very weak. This is due to the fact that agriculture has very limited backward and forward production linkages. The correlation of distributive trade with agricultural income is much higher than of service trade and small manufacturing industries. This indicates that the consumption linkage is stronger than the production linkages and the majority of the users of the distributive trade are the farming population. The service trade and micro and small-scale enterprises are negatively correlated with farm output. This is perhaps due the fact that when agriculture is unable to support the growing population, farmers are forced into non-farm activities. This supports the residual sector hypothesis that non-farm activities act a sponge that soaks up the workers that cannot be readily absorbed in agriculture or vice versa (Vaidyanathan, 1986). Rural centres are also an important stimulus for the performance of micro and small-scale enterprises. Districts that are nearer to the metropolitan city enjoy some of the services needed to run small scale manufacturing industries such as roads, energy and telephone lines. When districts are far from the metropolitan zone (Mekelle) and rural towns, a smaller amount of capital is invested on service rendering trade and small scale manufacturing enterprises.

Table 9.6 District level Correlation between farm income, population density and capital invested in non-farm income in Tigray

	Capital invested in				
	Total MSE*	retail trade	Wholesale trade	Service trade	Small manufact. Industry
Population density	0.45	0.57	0.26	0.62	0.26
Actual farm output (100 kg)	0.02	0.09	0.27	-0.10	-0.13
Farm output per capita	0.04	0.09	0.31	-0.09	-0.11
Potential farm production.	0.09	0.14	0.36	-0.05	-0.08
Distance from Mekelle	-0.09	0.03	0.12	-0.16	-0.20
Distance from zonal town	-0.19	-0.19	-0.05	-0.23	-0.16

Source: own calculation from data obtained from the Bureau of Agriculture and Bureau of Industry and Trade and Transport of Tigray.
** MSE denotes micro and small-scale enterprises, which includes small manufacturing industry, wholesale trade, retail trade and service rendering trade.*

9.4.2 Consumption linkages

Consumption linkages result from the expenditure of farm incomes on locally produced goods and services. In Tigray, consumption linkages arising from the households' expenditure on goods and services is the strongest type of linkage. While the demand for consumption goods in general increase as agricultural income increases, the commodity composition of that demand will change with some commodities and services increasing in importance while others diminish. Household consumption demands are complex with different income elasticities of demand for the various individual commodities. Hence analysis of consumption demand of the farming population deserves special attention. In the next sub section the methods and results of Engel function estimation are presented.

Model and estimation method of Engel functions. To analyse the relative importance of different commodity groups with respect to demand linkages, marginal budget shares and expenditure elasticity are derived from an Engel function. Consider a non-linear relationship between the consumption of the j^{th} good (C_j) and total expenditure (E): $C_j = g(E)$. Multiplying the Engel curve by the price of consumption good (P_{cj}) gives expenditure ($P_{cj}C_j$) on j^{th} good as a function of total expenditure (E). Since (P_{cj}) is the same for all households in our sample, the Engel curve is only scaled up by a fixed multiple. It does not affect the relationship. The curve can be used to classify goods into luxuries, necessities and inferior goods. Luxuries are goods that take up a larger share of the household budget when household income increases and vise versa for necessities. Different functional forms of Engel curves are discussed in

Deaton and Muellbauer (1980). Double logarithmic, sem-logarithmic and log reciprocal forms of the Engel curves were investigated by Praise and Houthakker (1955). More complex forms such as a cumulative distribution function of the log normal distribution has been suggested, which combines many of the desirable properties of the simpler forms explained above. However, none of these forms are consistent with the adding up restriction. The adding up restriction is crucial for a demand analysis since it implies that demand functions satisfy the budget constraint that households face. The useful form of Engel curve that satisfies the adding up restriction is the one first estimated by Working (1943) and successfully used by Leser (1963). This function[2] relates budget shares to the logarithm of outlays.

$$w_j = \beta_{1j} + \beta_{2j} \ln E + \varepsilon_j \qquad (9.1)$$

where w_j $(= C_j * P_{cj}/E)$ is the budget share of the j^{th} good, E is total household expenditure and β_1 and β_2 are parameters to be estimated and ε is the error term distributed. Adding up requires $\Sigma w_j = 1$, which is satisfied provided that $\Sigma\beta_{1j} = 1$ and $\Sigma\beta_{2j} = 0$. When equation (9.1) is estimated equation by equation for each category of expenditure, the adding up restriction will be automatically satisfied (Deaton and Muellbauer, 1980, p. 84). When both sides of equation (9.1) are multiplied by the total expenditure and after adding an intercept, the Engel curve can be written as

$$C_j = \beta_{0j} + \beta_{1j} E + \beta_{2j} E \ln E + \varepsilon_j . \qquad (9.2)$$

Households differ in size, age composition, educational level and other characteristics. Households with different characteristics have different expenditure patterns (Deaton and Muellbauer, 1980). The Engel curve (9.2) with household characteristics included is given by

$$C_j = \beta_{0j} + \beta_{1j} E + \beta_{2j} E \ln E + m(\alpha)_j + \varepsilon_j . \qquad (9.3)$$

where $m(\alpha)$ is household characteristics. The most important household characteristics are household composition, and the number, types and ages of the household members. For simplicity, $m(\alpha)$ *is* modelled as

$$\mathrm{m}(\alpha)_{\mathrm{j}} = \alpha_{1j} DEPRAT + \alpha_{2\mathrm{j}} \mathrm{FS} + \alpha_{3\mathrm{j}} \mathrm{age} + \alpha_{4\mathrm{j}} EDUC \qquad (9.4)$$

where *DEPRAT* is dependency ratio, *FS* is family size, *AGE* is age of the household head, *EDUC* is dummy for the education level of the household head. Family size is

[2] This model is consistent with Almost Ideal Demand Systems (AIDS) if it is extended to include prices (Deaton and Muellbauer, 1980).

put in adult equivalent term with household members below the age of 15 weighted by 0.63. This weight is calculated from the food composition table prepared by West (1987). Since a substantial part of the household income consists of food grown on the farm, subsistence ratio must be included in the list of explanatory variables (Massell, 1969). Combining equation (9.3) and equation (9.4) and adding taste shifters such as location dummies, the Engel curve can be written as

$$C_j = \beta_{0j} + \beta_{1j}E + \beta_{2j}E\ln E + \alpha_{1j}DEPRAT + \alpha_{2j}\mathrm{FS} + \alpha_{3j}\mathrm{AGE} + \alpha_{4j}EDUC + \alpha_{5j}DYEAR + \alpha_{6j}\sum_{k=1}^{m-1} LD_k + \varepsilon_j \quad . \qquad (9.5)$$

where *YEARD* is year dummy (1996=1 and 1997=0) and LD are village (location) dummies. Using OLS to estimate the Engel function could result in biased estimates of parameters when total consumption expenditure is used as a measure of income. Furthermore biases are likely to be introduced by the correlation of independent variables and the error term. Considering total consumption expenditure as an endogenous variable, therefore, the Engel function can be estimated using the instrumental variable estimation method. The instrumental variables used to predict total consumption expenditure are total land cultivated, farm equipment, non-farm income, location dummies and family size.

Then the average budget share (*ABS*), marginal budget share (*MBS*) and expenditure elasticities (*EEL*) are calculated using the following formulas respectively as:

$$ABS_j = \frac{C_j}{E};$$

$$MBS_j = \frac{\partial C}{\partial E} = \beta_{1j} + \beta_{2j} + \beta_{2j}\ln E \ ;$$

$$EEL_j = \frac{MBS_j}{ABS_j} \ .$$

The total consumption expenditure variable used in the regression is composed of the value of any purchased and own-produced foods and non-food goods consumed by the households. The local market price is used to impute the values of the own produced consumption foods.

Estimation results of the Engel functions. The estimation results of the Engel functions for different category of consumption goods is given in the Appendix. The parameter estimates of OLS have far higher *t-ratio*s than the parameters

estimated by instrumental variable method. This could be due to multicollinearity. Hazell and Röell (1983) reported the same problem. The coefficients of determinations are also in general higher for the OLS estimates than for the instrumental variable estimates. The OLS results are, therefore, used for the computation of marginal budget shares and elasticities. For comparison, the estimation results for both the OLS and the instrumental variable method are given in the appendix.

The data fit very well and the adjusted coefficient of determination is higher for most of the commodities ranging from 0.21 for consumption expenditure on oil crops to 0.94 for total food expenditure (Table A9.1). The standard errors are calculated using White heteroscedasticity consistent estimators (Greene, 1997, p. 505). Variables such as total expenditure, year dummy and subsistence ratio and location dummies have a significant effect on the consumption demand for all commodity groups. Family size and dependency ratio show a significant effect on the consumption of non-food commodity groups. Age and education of the household head do not significantly affect the consumption demand of all commodity groups. There was significant difference in the consumption pattern of all commodity groups between 1996 and 1997. Consumption of purchase non-food products was higher in 1996 than in 1997, which illustrates the strong consumption link between farm and non-farm sectors.

Table 9.7. summarises the expenditure behaviour of an average farm household. The results are obtained by evaluating the average budget share, marginal budget share and the expenditure elasticity at the sample mean value. The commodities consumed are categorised in to: (1) food and non-food items groups and (2) locational groups. The food items include cereals, pulses, oil crops, vegetables and animal products such as milk, butter and cheese as well as sugar, tea and salts. The non-food items are grouped into social expenses like services and ceremonial expenditure, contributions for local organisation and taxes, and industrial products such as household durable and clothing and footwear.

Food and non-food commodity groups. Total food accounts for 79% of household expenditure, leaving only a small share of the budget for non-foods. The marginal budget share of food items is 73%, which is less than its average budget share. The expenditure elasticity is also less than unity (0.91) implying that the budget share of food items will decline when total income rises. The result is comparable to

(slightly less than) those reported by Hazell and Hojjati (1995) for Zambia, and Hazell and Roëll (1983) for the Gusau Region of Northern Nigeria. The estimated expenditure elasticity for food items were 0.88 for the Eastern Province, Zambia and 0.81 for Northern Nigeria.

Among the food items, cereals account for a substantial share of the budget (0.50), but their importance declines as income rises. The expenditure elasticity is 0.52 and the marginal budget share is 0.26, that is, half of the average budget share. The food items group (which includes pulses, oil crops, animal products, vegetables and sugar, tea and salts) consists of relatively high value foods. Their expenditure elasticity is very high implying that their share will increase dramatically if the total income of the household increases. However, at the moment their average budget shares are very low. Expenditure on animal products and oil crops is in particular potentially very important and will grow fast if the income of the farm household rises.

Table 9.7 Food and non-food expenditure behaviour of farm households in Tigray.

	Average budget share	Marginal budget share	Expenditure elasticity
Total food expenditure	**0.80**	**0.73**	**0.91**
Cereals	0.50	0.26	0.52
Pulses	0.05	0.06	1.2
Oil crops	0.003	0.007	2.33
Vegetables	0.001	0.0001	0.10
Animal products	0.10	0.23	2.30
Coffee, sugar, tea, salt, spices	0.14	0.16	1.14
Total non food expenditure	**0.20**	**0.28**	**1.40**
Service, ceremonial and other social expense	0.05	0.09	2.25
Industrial products	0.16	0.19	1.19
Household goods	0.01	0.03	3.0
Clothes, shoes and cosmetics	0.15	0.18	1.2
Locational Group			
Own produced food	0.51	0.46	0.90
Purchased food local	0.15	0.11	0.75
Purchased non-local food	0.14	0.16	1.14
Industrial products non-food (not locally produced)	0.16	0.19	1.19
Purchased locally non-food	0.04	0.09	2.25

All non-food items group have an expenditure elasticity that is highly elastic implying that their importance in the budget share will increase as farm households' income rises. The relative increase will be greatest for expenditures on services, ceremonial and other social expenses, and expenditure on clothes and footwear. This clearly shows that agriculture has the potential to strengthen the local demand for non-food in Tigray, Northern Ethiopia.

Locational groups. The results of locational linkages in Table 9.7 show that about 70% of the total expenditure is on regionally produced food and non-food items, leaving the rest 30% for regionally imported food and non-food items. But the expenditure elasticity for imported items is higher than that for non-imported items. This implies that there are strong household demand linkages to the local economy which predominantly benefit the agricultural sector in the short-run, but these linkages will diminish if the income of the farm households rises. The average budget share and expenditure elasticity of the local products of the non-farm service sector is 0.04 and 2.2, respectively. The household demand linkages with the local non-farm sector through expenditures such as services and ceremonial expenses is very low at the moment, but it will increase substantially when farm households' income rises. Purchased food items imported from outside the region (such as sugar, coffee and salt) are also potentially important.

9.5 Summary and conclusions

The liberalisation of the economy has favoured non-farm activities in the urban areas of the region over the last seven years. Distributive and service trade are the dominant non-farm activities in the remote rural centres in the region. Small-scale manufacturing industries and handicraft are more concentrated in big towns and they are potentially very important for employment and income generation in the region. The involvement of women in the non-farm sector is mainly confined to activities with low value added per unit of capital invested such as service rendering trade like hotels, beauty salon, bar and restaurants. The development of micro and small-scale enterprises (MSE) is highly constrained by poor infrastructure due to low quality, inadequacy of urban and rural roads, and insufficient energy supplies. Lack of working capital, absence of a market for the products of MSE and insufficient supply of raw materials are the main problems that constrain the existing MSE. Share-company and partnership are not well developed in the non-farm sector due to the high transaction costs of settling disputes and ineffective judiciary systems. Rural centres or towns act as a focal point in providing infrastructure services to the rural areas. They also act as a centre for business enterprises that serve the rural population. However, the majority of the users of the small-scale manufacturing industries and handicraft are from urban population. Currently it is the distributive trade that serves

the rural as well as the urban population. In general rural non-farm activities act as a residual sector that absorbs the workers who cannot be readily absorbed in agriculture. When agriculture is unable to support the growing population, farmers are forced to be engaged in non-farm activities.

Consumption linkages are much higher than the production linkages in the region. The production linkages between the farm and non-farm sectors are very small. At the moment most of the consumption expenditure is focused on locally produced food items. In the long run, more of the incremental income of farm households will be spent on livestock products and on regionally imported food and non-food items as well on local non-food products, particularly on services and ceremonial expenditures.

Therefore, if rural farm and non-farm enterprises are to achieve their full potential for income generation and economic decentralisation, policy makers need to review their development policies, laws and institutions which hinders small farmers and small rural non-farm enterprises. Rural towns should be viewed as important focal points in the development of the rural economy. Through the rural towns, most of the soft and hard infrastructure services can be provided to farmers relatively easily. Other measures to improve the efficiency of the economy such as improving the bureaucratic and judiciary system may also help to develop partnership and share companies in the business communities which in turn will resolve the problem of working capital. A program of direct assistance can also facilitate the growth of the rural non-farm economy.

CHAPTER 10. SUMMARY OF RESULTS, POLICY IMPLICATIONS AND CONCLUSIONS

10.1 Introduction

The foregoing chapters (Chapter 4 to chapter 8) deal with specific issues in order to answer the research questions raised in Chapter 1. On the one hand, some of the questions raised in the introductory chapter exceed the scope of the separate chapters. On the other hand, the results of the different chapters need to be integrated. The link between farm and off-farm income; the relationship between factor inputs, marketing surplus and off-farm employment; the differential impact of family size and education on various categories of labour demand and supply; and the overall policy implication of the results are not yet made clear. Hence the objective of this chapter is to integrate and summarise the results presented in the foregoing chapters and to explain the issues concerning farm and off-farm linkages.

Farm off-farm income linkages at a household level are modelled in such a way that off-farm income (employment) affects agricultural production through income diversification, through the purchase of farm inputs and through the substitution of farm work by off-farm work. If there is disguised unemployment and agricultural activities are seasonal, the negative effect of off-farm employment on the farming activities can be very small. The net impact of off-farm employment on agricultural production can be positive or negative depending on the relative strength and direction of the forces. On the other hand, farm income in our model affects off-farm income (employment) through the return to family labour on the farm (shadow wage rate of farm labour or farm output).

The results indicate that off-farm income affects agricultural production positively through income diversification and the financing of farm activities such as purchase of farm labour, fertiliser, seeds and pesticides and negatively through on-farm labour supply. Farming activities also affect off-farm employment negatively through the competition for family labour and positively through the provision of liquidity for off-farm self-employment.

Family size also shows to have a positive effect on the farm and off-farm hours of labour supply, but with varying magnitude. The magnitude of the family size effects on farm and off-farm employment is found to be dependent on the gender composition of the household and the type of off-farm activities involved. The effect of education on the wage rates depends on the type of off-farm activities involved and on the kind of education farm households have acquired.

The questions dealt with in this chapter are the following:

1 What is the total net impact of off-farm income on farm income?
2 What is the net impact of farm income on off-farm employment in general and on off-farm wage employment versus self-employment and male-female off-farm work in particular?
3 What is the impact of off-farm income on the purchase and sale of farm output?
4 What is the general effect of an increase in family size?
5 What are the effects of education on the market wage rate and on the supply of labour for various activities?
6 What kind of program and policy implications can be drawn from the results of the study in general?

To answer these questions, the marginal effects and elasticities estimated in the foregoing chapters are combined and a simulation exercise is done to calculate the effect of farm income on the shadow value of family farm labour. The summary of the results regarding (1) the direct and indirect impact of off-farm income on farm income; (2) the impact of factor inputs and farm income on off-farm employment; (3) the impact of factor inputs and off-farm income on the marketing surplus of farm outputs; and (4) the impact of family size and education on farm and non-farm activities and on the marketing surplus of farm outputs are presented.

The direct impact of off-farm income on farm income consists of the production technology effect of diversifying income sources into off-farm activities. The indirect impact includes the contribution of off-farm income towards purchasing of farm inputs such as farm labour, fertiliser, seeds and pesticides. It also includes the competition for labour via the response of on-farm labour supply to the market wage rate. The impact of off-farm income on the marketing surplus is assumed to act in two ways: (1) directly on the sale and purchase of farm output by proving liquidity and (2) indirectly on the sale and purchase of farm output by supplementing farm output.

The impact of farm inputs and farm income on off-farm employment is analysed through their effect on the shadow wage rate and from there to the off-farm labour supply for various categories of off-farm employment and household members.

The rest of the chapter is organised as follows. In the next section a summary of the results from previous chapters and new simulations are presented. The program and policy implications of the book results are discussed in section three. In section four, issues that need further research are described. In the final section, the general summary and conclusions of the book are presented.

10.2 Summary of results

Farm off-farm income linkage. A substantial proportion of farm households (81%) diversifies their income into off-farm activities. The diversification of income sources into off-farm activities increases farm output directly by increasing their managerial skill and indirectly through the purchase of farm inputs such as hired labour, fertiliser and pesticides (see Chapter 5). Table 10.1 summarises the effect of off-farm income on farm income for an average farm household in the sample. When off-farm income increases by 10% (compensating for farm income), farm household's income diversification, measured by Simpson's index (see Chapter 5), increases by 1.4% and farm output increases by 1.2%.

The purchase of farm labour and variable capital farm inputs increases by 10.2% and 1.3%, respectively, when off-farm income increases by 10%. Consequently, an increase in off-farm income by 10% increases farm productivity by 1.2% via the hiring of farm labour and by 0.2% via the purchase of variable capital farm inputs. The increase in the use of hired labour is greater than the increase in the use of purchased variable capital farm inputs. Off-farm income is more important for the hiring of farm labour than for the purchase of capital inputs because of the bias of the public credit scheme against the hiring of farm labour. The public supply of credit is tied to the purchase of capital farm inputs only, so that farm households can get credit for the purchase of capital farm inputs (such as improved seeds, fertiliser and pesticides), but not for the hiring of farm labour (see Table 1.9 in chapter 1)[1].

[1] The bias in the public provision of credit against the hiring of farm labor may have come from the assumption that farm households are not constrained by labor. However, the fact that quite a lot of farmers (39%) are found to hire farm labor indicates that farm households are labor constrained.

Off-farm income also affects farm income negatively by competing for family labour (see Chapter 6). An increase in off-farm income by 10% reduces farm income by 0.07%, which is quite small. Consequently, the net impact of off-farm income on farm income is positive. When off-farm income increases by 10%, farm income increases by 2.5%, quite contrary to what the theory predicts in a perfect capital market. Due to the capital market imperfections coupled with the disguised unemployment in the area, off-farm employment is hardly a substitute to farming activities. Instead, off-farm employment is found to be rather complementary to farming activities. Therefore, the present focus of government policy to simultaneously increase agricultural productivity and provide alternative income earning opportunities for rural areas seems complementary. It seems that removal of the bias against the hiring of farm labour in the public provision of credit would be beneficial.

Table 10.1 Direct and indirect effects of off-farm income on farm income (elasticities)

	Direct effect of off-farm income on each input (and income diversification)	Implied effect of off farm income through farm inputs (and income diversification)
Hired farm labour	1.020	0.115
Variable capital farm inputs	0.130	0.024
Family farm labour	-0.026	-0.007
(Income diversification)	(0.140)	0.120
Net effect of off-farm income		0.252

Farm inputs and labour supply. The effect of farm income on farm and off-farm employment basically arises from the use of farm inputs. The use of farm inputs increases the return to family labour (marginal productivity of labour) for all types of farm inputs (Table 10.2). Hence the use of farm inputs increases on-farm employment and reduces the supply of male and female off-farm labour (Table 10.3). The highest contribution to on-farm employment comes from farm implements and variable capital farm inputs, while the lowest contribution comes from livestock. This indicates that the use of external inputs (such as fertiliser) is very important for on-farm employment.

Table 10.2 Effects of a 1% increase in farm inputs on farm employment (elasticity)

	On farm income	On shadow wage +	On farm labour supply++	On male off-farm labour supply+++	On female off-farm labour supply++++
Hired labour	0.113	0.118	0.146	-0.149	-0.080
Variable capital farm inputs	0.184	0.191	0.237	-0.241	-0.130
Farm implements	0.265	0.276	0.342	-0.348	-0.188
Livestock	0.047	0.049	0.061	-0.062	-0.033
Land	0.120	0.125	0.155	-0.158	-0.085

+ A 10% increase in farm income increases shadow wage rate by 0.13 Birr/hour, that is 10. 4%.
++ A 10% increase in shadow wage rate increases on farm family labour supply by 12.4%
+++ A 10% increase in shadow wage rate reduces male off-farm labour supply by 12.6%
++++ A 10% increase in shadow wage rate reduces female off-farm labour supply by 6.8%

In general farm households have an upward sloping labour supply curve for both farm work and off-farm work (Table 10.4). However, the responsiveness of labour supply to wages depends on the gender composition of the household and the type of off-farm employment involved. The supply of labour for farm work has the highest own wage elasticity (greater than unity), but its response to off-farm wage rates is very low implying lower competition with off-farm work for family labour. The wage elasticity of off-farm work is less than unity and the cross wage elasticity with respect to farm work is large and negative indicating that off-farm work will decrease as agricultural production intensifies. The own wage elasticity of off-farm labour supply is higher for males than for females. The cross wage elasticity of off-farm labour supply with respect to the return to farm work is negative for both males and females, but the magnitude of the cross wage elasticity is higher for males, implying that males' labour is really essential for farm work. Furthermore, male and female off-farm labour supplies are gross substitutes, but the elasticities are small. The income elasticity of labour supply is larger for female than for male members, and negative for both of them implying that leisure is a normal good. It also reveals the fact that if the economy grows and the income of households increase, the leisure time (or homework) will be more important for females than for males.

Table 10.3 Effects of a 1% increase in farm inputs on the hours of on and off-farm employment

	Farm labour	Male off-farm labour	Female off-farm labour
Hired labour	0.718	-1.486	-0.280
variable capital farm inputs	1.165	-2.403	-0.454
Farm implements	1.688	-3.470	-0.657
Livestock	0.300	-0.618	-0.115
Land	0.762	-1.576	-0.297

There is a difference in the nature of off-farm labour supply for wage and self-employment. When farm income increases, the supply of labour for off-farm wage employment decreases and the supply of labour for off-farm self-employment increases (Table 10.2). This can be explained by the fact that off-farm self-employment is undertaken by a relatively rich household while poorer farm households face entry barriers (Reardon, 1997). The results also reveal that the wage elasticities of off-farm labour supply of households for wage and self-employment is positive but inelastic. Income elasticity is negative for both types of labour supply, but the magnitude is higher for wage employment than for self-employment. The larger income elasticity for wage employment relative to that for self-employment implies that households will work less for wage employment than for self-employment when the economy grows.

Table 10.4 Summary of wage* and income elasticities for farm and off-farm labour supply

	W_s	W_{mm}	W_{mf}	W_{mw}	W_{mo}	S
On-farm labour supply	1.24	-0.026	-0.0001			
Male members' off-farm labour supply	-1.26	0.701	-0.049			-0.048
Female members' off-farm labour supply	-0.68	-0.038	0.813			-0.143
Off-farm labour supply for wage employ.				0.46	0.02	-0.080
Off-farm labour Supply of self-employ.				-0.04	0.41	-0.044

** Wage elasticity is calculated based on the expected marginal effects of natural logarithm of wage rates on a labour supply. W_s = shadow wage rate of family labour on the farm; W_{mm} = market wage rate of male members; W_{mf} = Market wage rate of female members; W_{mw} = market wage rate for wage employment; W_{mo} = Market wage rate for off-farm self-employment; S = non-labour income;*

The elasticity estimates of this study are higher than those estimated for Asian countries for both men and females, and closer to (but still lower than) Ghanaian farm households (Table 10.5). Unlike Asian farm households, females have a higher own wage elasticity of off-farm labour supply than males in Tigray, which is similar to that for Ghanaian farm households. However, the difference in own wage elasticity between females and males is smaller for the Tigryan farm households than for the Ghanaian farm households. The magnitude of the cross wage elasticity of labour supply between male and female is the same as that for Indian farm households, but smaller than and opposite in sign to that for Ghanaian farm households. The income elasticity estimate is also the same as those for India and Peruvian Sierra, but much lower than that for Ghana.

Table 10.5 Comparison of elasticities with other studies

Study area [author(s)]	Cross wage Male to female (female to male)	Own wage elasticity		Income elasticity	
		Male	Female	Male	Female
Tigray, Ethiopia (this study)	-0.049 (-0.38)	0.701	0.813	-0.048	-0.143
For India (Skoufias, 1994)	-0.076 (0.056)	0.107	-0.0.69	-0.05	-0.013
Peruvian Sierra (Jacoby, 1993)	-0.010 (0.006)	0.102	0.079	-0.058	-0.058
Ghana (Abdulai and Delgado, 1999)	0.187 (-0.198)	0.33	0.66	-0.272	-2.08

Market wage rate and household income. The aforementioned results show that farm and off-farm labour supply are substitutes in the sense that when the return to off-farm work (market wage rate) increases, the supply of labour for farm work decreases and the supply of labour for off-farm work increases. But what happens to total household income when the market wage rate increases? To answer this question, the effect of a one-percent increase in the market wage rate on off-farm income and farm income and on total household income is calculated using the estimated labour supply functions (Table 10.6). In our estimate, the effect of the market wage on the supply of farm labour is very low. As a result, the increase in off-farm income is much higher than the decrease in farm income when the market wage rate increases by one percent. The net effect of an increase in the market wage rate by one percent on total household income (compensating for an income effect) is calculated to be 8.13 Birr. This implies that improving the market wage rate is an important policy instrument for increasing household incomes in rural areas.

Table 10.6 The effect of a 1% increase in the market wage rate on the supply of labour hours and household income

	Substitution effect	Income effect	Net effect
Hours off-farm labour			7.174
Hours of on-farm labour			-0.247
Off-farm income (Birr)	13.057	-4.592	8.466
Farm income (Birr)	-0.347	0.010	-0.337
Household income (Birr)	12.710	-4.581	8.129

Off-farm income and marketing surplus. If farm households do not have another source of income (such as off-farm income), the main source of cash income is the sale of farm output. To buy the necessary food and non-food items that cannot be produced on their farm (such as salt, spices, clothes and taxes), farm households have to sell farm output. When the farm households obtain off-farm income, they can stop selling farm output and use the cash obtained from off-farm work to purchase the

food and non-food items required. The results show, however, that off-farm employment can help farm households to finance their farming activities through the purchase of farm inputs such as hired labour, fertiliser, and improved seeds.

In a drought prone area, off-farm income can help to purchase food for consumption and keep farmers productive on their farm. As a result, off-farm employment increases farm output and its negative impact on the sale of farm output could be very low. Therefore, in a less dynamic agricultural area, the impact of off-farm employment on the marketing surplus of farm outputs could be positive. The results support the view that off-farm income increases the marketing surplus of farm outputs (Table 10.7, see also Chapter 8). Hence off-farm income in marginal areas should not been seen as a substitute for farm income. Instead off-farm employment is complementary to farming activities and it helps to achieve the objective of food self-sufficiency.

The effect of farm output on the marketing surplus basically comes from the use of farm inputs such as variable capital farm inputs, hired labour, family labour, land, and farm implements. Since these farm inputs affect the farm output positively (see Chapter 5), their effect on the market surplus of farm output is positive. The relative contribution of the various farm inputs to the market surplus is, however, different. The highest contribution to the marketing surplus comes from the use of variable capital farm inputs followed by farm implements (capital) and family labour used. The contribution of livestock to the marketing surplus is the lowest among all the farm inputs. The fact that variable capital farm inputs contribute more to the marketing surplus implies that the promotion of external inputs is effective in achieving the objective of food self-sufficiency.

Table 10.7 Effect of farm and off-farm incomes on marketing surplus crop output (elasticity)

	Farm income	Purchase	Sales	Surplus
Hired labour	0.113	-0.040	0.147	0.187
Variable capital farm inputs	0.184	-0.065	0.240	0.305
Family labour	0.255	-0.090	0.332	0.422
Farm implements	0.265	-0.094	0.345	0.439
Livestock	0.047	-0.017	0.061	0.078
Land	0.120	-0.043	0.156	0.199
Off-farm income	0.228	0.064	0.310	0.246
(=direct + indirect)		(=-0.089 + 0.153)	(=0.328 -0.018)	

The elasticity of purchase and sales with respect to farm output is -0.354 and 1.303, respectively. The effect of off-farm income on purchase and sale of farm output includes also the indirect effect through the farm income (0.252 times -0.354 on the purchase function and 0.252 times 1.303 on the sales function).

Family size and labour allocation. With population growing at 3.1% per annum in Ethiopia, family size will not remain constant in the future. If appropriate family planning measures are not implemented, or if labour is not withdrawn from agriculture, most probably family size and thus the pressure on agriculture will increase. The increased family size will have an impact on farm size, the supply of labour for farm and off-farm work, and household income.

The effect on the labour allocation of an average household as a result of an increase in family size by one person is given in Table 10.8. The result in general indicates that family size increases the supply of labour for both farm and off-farm work, but the magnitude of the increase depends on the sex (gender) composition of the household and the type of off-farm activities involved. The effect of an increase in family size is smaller for farm work than for off-farm work. The effect is also larger for wage employment than for off-farm self-employment, and for male members' hours of labour supply than for female members' hours of labour supply. The effect of family size on farm work is lower in magnitude than that on off-farm work because the opportunity to work on the farm is very limited by the small farm size. Therefore, given the current trend in population growth, the better option seems to be to promote off-farm employment so as to increase employment in rural areas. The effect of family size on off-farm wage-employment is larger than that on off-farm self-employment because off-farm self-employment requires more capital and it is less labour intensive than off-farm wage employment. When family size increases, female labour is more important than male labour in home activities (such as preparing meals and childcare). As a result, the response of female members' off-farm labour supply is smaller than that of male members.

Family size also affects the demand for hired farm labour and the marketing surplus of farm outputs negatively, although the effect on the marketing surplus is statistically not significant. This suggests that with the ever-increasing population, the long-term prospect for improving national food self-sufficiency is under question. To resolve this problem, considerable effort must be made to increase off-farm employment on one hand and agricultural productivity on the other hand. If the population grows unabated or alternative employment opportunities are not designed, farm households may become more subsistence-oriented producers instead of being more commercially oriented producers.

Table 10.8 The marginal and percentage effect of an increase in family size by one person

	Marginal increase	Percentage increase
Hours of off-farm employment	501.77	37.26
Probability of off-farm employment	0.14	0.14
Hours of off-farm wage employment	687.23	55.02
Probability of off-farm wage employment	0.26	0.26
Hours of off-farm self employment	13.09	13.42
Probability of off-farm self employment	0.05	0.05
Hours of male members off-farm work	428.27	42.95
Probability of male members off-farm work	0.15	0.15
Hours of female members off-farm work	10.49	3.00
Probability of female members off-farm work	0.02	0.02
Hours of demand for hired farm labour	-67.39	-75.7
Hours of supply for farm work	19.09	3.55
Marketing surplus (Birr)	-26.23	-2.31

Education, market wage rate and labour supply. The effect of education on wages is summarised in Table 10.9. The education of the household head (measured by the ability to read and write) is associated with a lower wage rate for both male and female members of a household, which is quite contrary to the theory of human capital (Schultz, 1961; Becker, 1964). The results reveal a remarkable picture when the wage for wage-employment and self-employment are considered individually, and when education is decomposed into traditional education (can read and write without going to formal school) and modern education (has attended elementary school). On the one hand, the wage rate a household receives from off-farm wage employment is lower (but only little and statistically insignificant) when a head is able to read and write through a traditional education and is higher when a head has attended a modern school. The lack of a relationship between education (particularly traditional education) and the wage rate for off-farm wage employment may be that most of the off-farm wage work is manual work, which does not require education at all. If the activities involved in wage-employment require education, merely reading and writing without other literacy skills might not help to increase productivity (Rosenzweig, 1988). If there is no demand for traditional education by the employers in the local labour market or if traditional education is not marketable (even if it is productive), traditional education may not result in higher wage rate. To benefit from the knowledge acquired from traditional education, therefore, one has to be self-employed. If education does not have any influence on the market wage or on the return to own business activities, education must be obtained by households for

consumption purpose (Schultz, 1961), and not for future productivity increase (Becker, 1964; Schultz, 1961).

On the other hand, the return (wage rate) to off-farm self-employment is higher when the head is able to read and write regardless of the type of education. The magnitude of the increase in the wage rate is higher for traditional education than for modern education. The fact that traditional education increases the return to off-farm self-employment (but not the market wage) reveals that households make use of the knowledge they get from a traditional education (which is not demanded directly by the employers in the local market).

Table 10.9 The effects of education on logarithm of wage rate

	EDUCH	EDUCT	EDUCM
Wage rate of off-farm wage empl.		-0.009	1.046
Wage rate of off-farm self-empl.		0.81	0.04
Wage rate of male members	-0.22		
Wage rate of female members	-0.038		

EDUCH =household head can read and write; EDUCT = household head can read and write without going to school; EDUCM = modern education (household has joined primary education).

Controlling for the indirect effect of education arising from the wage rate, the supply of labour on the farm is higher when the head of a household reads and writes (Table 10.10). The effect of education on the supply of labour for off-farm activities depends on the gender composition of the household labour and the type of off-farm employment involved. When the household head is able to read and write, the supply of labour by male-members is lower and the supply of labour by female-members is higher. When the household head can read and write without attending modern school (i.e. by attending traditional education), the supply of labour for wage employment is lower and the supply of labour for self-employment is higher. Whereas when a head is able to read and write from a modern education, the supply of labour for both wage and self-employment is lower.

The fact that education results in a higher supply of labour for farm work and off-farm self-employment, and in a lower supply of labour for off-farm wage employment signifies that farm households prefer working on their own business to working under the supervision of others. This implies that education helps farm households to transform their unmarketable education (such as traditional education) into income by working very hard on their farm and off-farm own businesses; even

though a low level of primary education is not expected to bring about a significant change in attitude and productivity. Studies show that at least elementary education above the 4th grade is necessary for an increase in agricultural productivity (Colclough, 1982; Wier, 1999). For education to be beneficial in traditional farming areas, fundamental economic and, possibly, social changes are needed (Schultz, 1964). When the change in economic conditions creates a disequilibrium, therefore, educated individuals could exploit the benefits of economic development more effectively (Schultz, 1975). Hence for substantial rural development, it is quite necessary to create a demand for educated people and improve the 'traditional sector' of the economy.

Table 10.10 Marginal effects of education on the hours of labour supply

	Directly			
	EDUCH	EDUCT (EDUCM)	Indirectly via wage	Total Increase
On-farm labour supply	77.2		0.036	77.24
Male mem. off-farm labour supply	-83.8		-1.538	-85.34
Female mem. off-farm labour supply	44.08		-0.108	43.97
Off-farm wage empl. labour supply		-197.6	-0.052	-197.65
		(220.8)	(-6.06)	(-3.853)
Off-farm self-empl. labour supply		-15.1	0.323	14.77
		(-2.7)	(0.016)	(-2.68)

EDUCH =household head can read and write; EDUCT = household head can read and write without going to school; EDUCM = modern education (household has attended primary education).

The results of this study could not confirm that education helps the labour force to participate in non-farm activities (Huffman, 1980; Burger, 1994) because the study has been conducted in an area where traditional farming and non-farm activities are dominant and the demand for education is very low. However, the study confirms that education is very helpful in motivating farmers to work on their own farm and non-farm businesses. Further study is necessary to investigate the role of education in traditional farm and non-farm activities in the region.

10.3 Program and policy implications

In this section, program and policy implications of the main findings are discussed. The policy implications are categorised based on the policies required to tackle problems. The program and policy implications discussed here are (1) the need for

alternative employment opportunities, (2) development of complementary policies, (3) exploitation of potential farm-non-farm linkage, (4) targeting of the vulnerable groups, (5) the role of rural towns in rural development, and (6) updating the existing policies and institutions.

The need for alternative employment opportunities. It is becoming very difficult to increase regional employment in agriculture. The growth in population has resulted in a smaller farm size. Because of the growing population, expansion into marginal land and steeper slopes is widely practised. The result has been wide degradation of hills due to erosion. Crop residue and animal dung is used as fuel for cooking in the region, not for enriching the soil. Increasing the land under cultivation in the region is difficult because of land scarcity and malaria in low land areas such as the western zone of Tigray. Livestock production is not promising either. The forage supplies come from unimproved and overgrazed pastures and crop residue competing with food crops. Poverty is forcing farmers to search for wage employment. The reduction in farm size would not result unemployment if a transition is made to intensive land use and irrigation agriculture. However, the use of irrigation (which requires high investment cost) and agricultural intensification is so slow that it is unlikely to absorb the growing population in the near future. It is therefore necessary to reduce the dependence on land. To reduce the pressure on land, rural non-farm activities have to be expanded. The results indicate that diversifying income sources into off-farm activities increases agricultural production and productivity. Employing the rural population in rural non-farm activities may have additional advantages: it helps to keep farmers in the rural areas and reduces rural-urban migration (Todaro, 1969; Harris and Todaro, 1970). It provides farmers with additional income and reduces the pressure on land (Reardon et al., 1998; Reardon and Vosti, 1995).

Development of complementary policies and organised promotional activities. Off-farm income has an important role in the rural economy in the Tigray Regional State. Farm households with a more diversified source of income realise a higher productivity in agriculture. Expenditure on farm inputs is dependent not only on agricultural production, but also on off-farm income because off-farm income helps to finance farming activities. Farmers who are involved in relatively high wage jobs such as masonry and carpentry are in a better position to hire farm labour. Off-farm income also helps farm households to increase the marketing surplus of farm outputs. In general, the positive link between farm and off-farm income implies that

increased agricultural output and raising agricultural productivity cannot be seen in isolation in the Tigray Region. Complementary policies and programs could be developed to strengthen the link between farm and non-farm activities. The current agricultural extension program should encompass both farm and non-farm activities and encourage the growth of small-scale business and create non-farm employment opportunities in rural areas. However, agricultural growth still remains central to attack rural poverty and to promote rural non-farm activities by generating demand (Mellor, 1976).

There are attempts in the region to promote rural non-farm activities in order to provide farm households with alternative income sources and to supplement farm income. For example, public employment schemes such as 'food for work' has increased farm households' access to off-farm work. However, the efforts are disorganised and insufficient, and the links between farm and non-farm activities are not fully recognised. Because the majority of the population is engaged in agriculture, most governmental and non-governmental organisations have focused exclusively on agriculture. Promotion of non-farm activities should not be confined to urban areas and should not be left to the industry and trade ministries.

Institutional support might be necessary as well to create an enabling environment for rural non-farm enterprises. Therefore, some sort of government organisation must be established to coordinate the presently dispersed and unorganized promotion of rural non-farm activities. Then this organisation can be responsible for formulating, upgrading, coordinating, and implementing enabling measures such as economic and financial policies as well as assistance programs to promote rural non-farm activities. Since rural non-farm enterprise owners do not have the capacity to organize themselves because they are many in number and are less prosperous, the new institution can lobby for policies that favour the rural non-farm activities and the development of assistance programs (Binswanger and Deininger, 1997).

Exploiting the potential farm non-farm linkage. The results show that the consumption linkage dominates the production linkage. This implies that the government should focus on commerce (distributive and service trade) as the main non-farm activities in the short-run. To exploit this potential, infrastructure such as roads and telephone connections should be improved. Other measures that improve the efficiency of the economy such as improving the bureaucratic and judiciary

system may also help. Improving the efficiency of the distributive and service trade means creating a favorable market for industrial products especially for the products of small-scale and cottage manufacturing industries.

Service-providing enterprises are scarce and the demand for the services of non-farm activities are to a great extent not satisfied. This implies that there is quite some potential to increase the economic activity of the region in rural areas by promoting rural non-farm activities. On the one hand, there is still a huge unsatisfied demand for industrial and agricultural products that are not produced locally in the rural areas. Farmers have to travel several hours or even days to shop for many commodities. On the other hand, there is surplus labour in some places and disguised unemployment in most of the rural areas. There is no labour shortage in farming except in the peak agricultural seasons such as harvesting and threshing. There is still rationing in the farm and non-farm labour market. Agriculture is not dynamic enough to provide sufficient employment for the rural communities. If basic facilities are provided such as infrastructure, credit provision, technical and management training, and sufficient business advice, the enormous potential can be easily exploited[2].

Targeting of the vulnerable group. Women participate to a considerable extent in non-farm activities. However, they are engaged in activities with lower value added per unit of investment and lower wage non-farm activities such as public work programs and manual work in construction sites. The wealthy farm households dominate the most lucrative forms of non-farm activity, particularly masonry, carpentry and non-farm self-employment such as trading. So poverty-focused rural non-farm investment should need to focus on non-farm activities, which are accessible to the poor and to women. The underlying factors that hinder entry into non-farm activities must be removed.

The need for reviewing and updating the existing policies and institutions. Government policies affect not only the magnitude of agricultural growth but also the ability of rural non-farm enterprises to respond to agriculturally induced increase in demand. Rural non-farm enterprises are the second most important sources in generating employment in the country and the nation (next to agriculture). If rural non-farm enterprises are to achieve their full potential for income generation and

[2] Although our analysis does not include all of the proposed improvement, it quite clear that credit provision for liquidity constrained households, and technical and management training and business advice for traditional farmers are very important.

economic decentralisation, policy makers need to review their agricultural, investment, commercial and infrastructure development policies that stands against small farmers and small rural non-farm enterprises. A specific policy that should be reformed is the proclamation that provides investment incentives such as income tax relief to local investors with over 250, 000 Birr capital. This tax relief does not encourage rural non-farm activities that require smaller capital investment. Likewise, policies should be formulated to improve small rural non-farm enterprises' access to formal financial institutions such as commercial and development banks (Binswanger and Deininger, 1997).

The role of rural towns in rural development. Rural towns act as a focal point in the development of the rural non-farm economy. The results indicate that vegetable production, off-farm employment, and rural non-farm enterprises perform better in locations nearer to bigger towns and rural centres because of their access to infrastructure. It is essential to assure adequate economic and social infrastructure to develop the demand for high value agricultural products such as vegetables and to support the nascent modern rural non-farm activities and to renovate and develop the already available traditional non-farm activities. Efficient rural institutional infrastructures centred in rural towns may be critical for fostering the transition to a more productive rural farm and non-farm economy.

10.4 Suggestion for future research

There are other important issues that are less well explored in this study and hence require further investigation: the general equilibrium effects of a change in farm and non-farm incomes, rural towns as a focal point in rural development, and consideration of risk in analysing the farm non-farm linkages.

The need for a general equilibrium (CGE) analysis. The approach used in this book is a partial equilibrium analysis, which does not deal with the general equilibrium feed back effect of income changes. In our study, we use a non-separable farm household model with missing markets which assumes that a farm household faces an internal general-equilibrium constrained by time and liquidity (De Janvry et al., 1992). Outputs and virtual prices adjust to ensure that the household is in equilibrium when the markets for labour, inputs or outputs are missing (De Janvry et

al., 1991). However, an agricultural household model does not explicitly deal with the interaction among households within and outside a village (community) and the general equilibrium effects of a change in income (income linkages) that can influence the outcome of policy change (Taylor and Adelman, 1996).

The level of economic interaction among farm households can be categorised into three situations. The first extreme situation is when all farm households are self-sufficient and all goods are non-tradable. Under this situation, production and expenditure linkages among households (within and outside their village) would be non-existent. Therefore, a non-separable farm household model would be able to deal with the analysis of the production and consumption decisions of farm households. The other extreme situation is when all farm households are perfectly integrated with the goods and factors market within and outside the village, and all goods and factor inputs are village tradable. In this situation, the production and expenditure linkages among village households will be the same as the linkage among household outside the village (at the regional, national and global level). Hence the standard computable general equilibrium (CGE) model would be sufficient to deal with the feed-back effects of policies and economic activities in rural areas. The third situation is between these two extreme situations. If goods and factors inputs are exchanged among households within the community (village), but not between the village and the outside (village non-tradable), prices are determined neither by the internal equilibrium conditions within a household (as in a self-sufficient household) nor by the regional, national, or world markets. Instead prices are determined within a village. In this case, a village (micro) computable general equilibrium (VCGE) model (Taylor and Adelman, 1996) is quite necessary to deal with the growth linkages in rural areas.

However, in most developing countries, particularly in our study area, a combination of goods could exist whose prices are determined either by the internal equilibrium of a household, or by the interaction of households within a village, or by the interaction of households outside the village (regional, national, or global). Therefore, when interaction among farm households exists at all levels of markets, a model that combines a farm household model, a village-wide economic model, and general equilibrium model has to be developed. Future research must focus on formulating and using an applied model that makes use of a non-separable farm household model (Singh et al., 1986; De Janvry et al., 1992), a village-wide model

(Taylor, 1995; Taylor and Adelman, 1996) and a computable general equilibrium model (Shoven and Whalley, 1984) in analysing the farm and non-farm growth linkages in developing countries.

The importance of rural towns in rural development. The market town approach has long been recognised as a means of taking jobs to rural areas (to the rural labour force) and consequently reducing social overhead investment in urban centres and tapping provincial sources of capital (Mellor, 1976). However, the market town approach has failed in the past because the basic strategy of growth (capital intensive, industrial oriented growth) did not provide the essential foundation for raising rural income. As pointed out by Mellor (1976), with changes in the strategy, the market towns can become the cornerstone of the development effort. Within the rural-led employment-oriented context of development, the market town (small or rural towns) could be the focal point for organisation and decision making. Evans (1992), using data from Kenya, finds that small towns help to raise agricultural productivity by allowing farmers to diversify income and by increasing the demand for farm outputs.

Nevertheless, a rural development strategy which focuses attention on small towns still rests on the assumption that rural towns are scattered over a wide area and are integrated with the countryside. The idea is that the benefit derived from increased economic activity within the rural towns will trickle down to the surrounding area. However, development in a wider economy and globalisation may reduce the economic linkages between the towns and the surrounding rural people and weaken local multipliers to such an extent as to lead to the death of the local economy (Curran and Blackburn, 1994). Hence if the 'small town' option for rural development is to be given serious consideration, it is important to assess whether there is a strong economic linkage between the rural town and the surrounding rural areas, and if rural towns are spatially well distributed to provide efficient services for rural people.

Risk consideration. Since the study area is located in the semi-arid zone where there is recurrent drought and incidences of crop pests and diseases, incorporation of risk in the production and consumption analysis might be useful (Dillon and Scandizzo, 1978; Newbery and Stiglitz, 1981; Reo and Graham-Tomasi, 1986). However, analysis of production and consumption with risk consideration requires time series data on each individual in a sample, which is very difficult to get from this survey. Another possibility is to use hypothetical questions to measure

farmers' attitude towards risk (Dillon and Scandizzo, 1978; Binswanger, 1980; Binswanger and Sillers, 1983). Using the information on households' attitude towards risk, one can study the structural production decision of farm households. However, the risk characteristics of hypothetical or experimental decisions do not necessarily correspond to the actual production decision taken by farmers (Buschena and Zilberman, 1994). Moreover, it is not clearly known how and to what extent the findings of the hypothetical method which abstracts from farmers' actual production decisions are relevant to the analysis of producer behaviour or to policy analysis (Antle, 1988). The data set we have in this study is not equipped to incorporate risk in the analysis. Therefore, establishment of panel data should be the task of future research in the area of farm labour market and farm non-farm income linkage.

10.5 Summary and conclusions

The analyses on farm and off-farm employment for the Tigray Region, Northern Ethiopia, and the review of the policy implications give clear directions for policy makers and practitioners interested in understanding the labour market and strengthening the farm non-farm growth linkages. It provides a new insight into the role of off-farm income in a less dynamic and risky agriculture (as opposed to dynamic and less risky agriculture).

In response to initial differences in relative factor endowment, farm households integrate themselves in the labour market as employers and as labourers. The exchange of labour tends to reduce the absolute and relative gap in the farm-labour used per unit of land among farm households. However, the extent of hired labour is small due to the high transaction cost for monitoring work effort, liquidity constraints and limited farm size. Nevertheless, the exchange of labour has equalised the returns per unit of labour and land among different farm size classes implying that the farm labour market is capable of making agricultural growth trickle down to the poor.

Spot contracts dominate the labour market. Permanent labour does not exist in the farm labour market because of the seasonality of farm labour demand, the counter-cyclic nature of off-farm employment, and the risk associated with agriculture. The wage rate in the non-farm labour market varies across agricultural seasons and skill

requirements implying that the wage rates respond to forces of demand and supply. Despite the absence of permanent contracts in the labour market, an efficiency wage is observed in both the farm and non-farm labour market. Most employers provide workers with food during work to stimulate their morale (effort). Most of the people working as masons and carpenters acquire their skill after a long time of practice, which is very slow and unproductive.

Agricultural productivity increases with increased use of farm inputs such as family labour, variable farm inputs, fixed capital inputs and livestock wealth. Variable farm inputs (such as fertiliser, pesticides, improved seed and hired labour) have the highest output elasticity of all the factor inputs used on the farm. When variable capital inputs increase by 10%, farm output increases by 3.2 %. The elasticity of output with respect to livestock is very low, that is, 0.05. Family labour and farm-equipment have comparable elasticities. When family labour increases by 10%, farm output increases by 2.6% (and in case of farm implements, by 2.7 %). The elasticity of output with respect to total land cultivated is calculated to be 0.12, which is greater than the contribution of livestock, but less than that of family labour and farm implements and variable inputs.

Off-farm income plays an important role in the rural economy of the region. Farm households with more diversified sources of income have a higher agricultural productivity. Expenditure on farm input is dependent not only on agricultural production, but also on off-farm income because of capital market imperfections (borrowing constraints). Farmers involved in better paying off-farm activities such as masonry and carpentry are in a better position to hire farm labour. Because of the bias in the public provision of credit against the hiring of farm labour, off-farm income is found to be more important for the hiring of farm labour than for the purchasing of other variable inputs.

Off-farm labour supply is reasonably responsive to the own wage rate. Farm labour supply has a wage elasticity greater than unity (1.24) and is a substitute for off-farm labour supply, but the cross wage elasticity is very small. Nevertheless, the effect of the return to farm labour on off-farm work is high enough to make farmers reduce the amount of labour supplied for off-farm work. The own wage elasticities for off-farm labour supply are found to be higher than those estimated for other countries such as India (Skoufias, 1994) and Peruvian Sierra (Jacoby, 1993). They are also slightly higher than that estimated for Northern Ghana (Abdulai and Delgado, 1999).

The income elasticity estimate is the same as those for India and Peruvian Sierra, but much lower than that for Ghana. The supply of labour for off-farm activities depends on the gender composition of the household and the type of off-farm activities involved. Male and female members of a household have different wage elasticities. The own wage elasticity of female members (0.8) is higher than that of male members (0.7). The cross wage elasticity between male and female off-farm labour supply is negative, but very small. Off-farm self-employment increases with increasing ownership of off-farm equipment and transport animals, and off-farm wage employment increases with the ownership of off-farm equipment. As a result wealthy farm households have been able to dominate the most lucrative form of non-farm activity such as masonry, carpentry and trading. This has resulted in an increase in income inequality among farm households in the rural areas. The main source of the inequality is non-farm activities namely non-farm skilled and unskilled wage work and non-farm self-employment. The present public work program is unequally distributed but it favours the poor and hence helps to reduce the income inequality that exists in the rural areas.

Self-employment is undertaken by farm households in order to reap the attractive return, and wage employment serves as residual employment and is undertaken by farm households due to push factors. The supply of labour for off-farm wage employment is slightly more elastic than that for off-farm self-employment. There is no significant cross wage elasticity between off-farm wage and self-employment labour supply.

Off-farm employment does not strongly influence the crop choices of farm households. Instead farm households adjust their off-farm activities to their farming conditions. However, off-farm employment influences the land and labour allocation decisions of farm households. It increases the allocation of land for legumes and oil crops, which are less productive, less labour using and land improving. Off-farm employment also reduces the use of labour for cereals implying that off-farm employment competes with farming activities for labour. Although off-farm employment competes with farming activities for family labour, the net impact of off-farm income on farm income is positive. It also has a positive impact on the marketing surplus of farm outputs because of capital market imperfections and risky agriculture and the seasonality of farming activities.

The present structure of the economy indicates that the distributive and service sectors dominate the non-farm activities in rural centres (towns) in the region. Small-scale manufacturing and handicrafts are more concentrated in big towns and they are potentially very important for employment and income generation in the region. The development of small scale and micro enterprises (SME) is highly constrained by the poor infrastructure: low quality urban and rural roads, and insufficient roads and energy supplies. Lack of working capital, absence of markets for the products, and insufficient supply of raw materials are the main problems that constrain the development of SME. Rural centres or towns act as a focal point in providing infrastructure services to the rural areas. They also act as a centre for business enterprises that serve the rural population. In general rural non-farm activities act as residual sector which absorbs the workers who cannot be readily absorbed in agriculture.

Consumption linkages are much stronger than the production linkages in the region. At the moment most of the consumption expenditure is on locally produced food items. In the long run, more of the incremental income of farm households will be spent on livestock products and on regionally imported food and non-food items as well as on local non-food products, particularly on services and ceremonial expenditures. Even though the production linkages between agricultural and non-farming sectors is very small at the household level, farm income can support considerable non-farm activities at an aggregate level. Therefore, agriculture is an engine of growth for economic development (Mellor, 1976). However, given the considerable underemployment in rural areas, agriculture is still a source of labour for industrial development (Lewis, 1954; Fei and Ranis, 1964), but it is not economically stagnant. Agricultural production can be increased through the intensive use of fixed and variable capital inputs.

The positive link between farm and off-farm income indicates that complementary policies and programs must be developed to strengthen the link between farm and non-farm activities. Hence, the current agricultural research and extension program, which focuses only on agricultural activities, should encompass both farm and non-farm activities and encourage the growth of small-scale business and create non-farm employment opportunities in rural areas.

If rural farm and non-farm enterprises are to achieve their full potential for income generation and economic decentralisation, policy makers need to review their

development policies, laws and institutions to ensure that they benefit small farmers and small rural non-farm enterprises. The efficiency of the distributive and service trade must be improved so as to create a favourable market for agricultural and industrial products especially for the products of small-scale and cottage manufacturing industries. Public provision of labour market information such as wage rates and the magnitude and type of labour demand (type of skill required) by specific sites and a list of job seekers by skill might be necessary in the short-run until the market supports the emergence of dealers in the labour market.

In order to reduce the income inequality effect of non-farm activities certain measures need to be taken. First, rural non-farm investments intended to attack rural poverty need to focus on non-farm activities in which the poor can participate. Second, the underlying factors that hinder farm households' participation in non-farm activities must be eliminated. This requires the establishment of training centres to eliminate the skill barrier, provision of credit for the poor together with business-extension advice, and expansion of public employment schemes.

Education does not have any significant association with the market wage rate because most of the off-farm wage work is manual work and the level of education is too low to be productive. However, education has a positive effect on the return to labour on own business. Although studies show that at least the 4^{th} grade is necessary for education to increase agricultural productivity, a lower level education still helps farm households to transform their unmarketable education (such as traditional education) into income by working very hard on their farm and off-farm own businesses. Substantial rural development might be necessary to create a demand for educated people and improve the 'traditional sector' of the economy (Schultz, 1961, 1964). In fact, further study is necessary to investigate the role of education in traditional farm and non-farm activities in the region.

Three broad areas for future research are suggested by this study. First, future research may focus on formulating an applied model that combines a non-separable farm household model, a village-wide model, and a computable general equilibrium model so as to analyse the general equilibrium effects of a change in income in the study area. Second, it is important to assess whether there is a strong economic linkage between the rural town and the surrounding rural areas and whether rural towns are spatially well distributed to provide efficient services for rural people before adopting '*the development of small towns*' as a focal point for rural

development. Third, future research activities should be able to develop a panel data set in order to incorporate risk into the analysis of the production and consumption decisions of farm households.

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SAMENVATTING (SUMMARY IN DUTCH)

Overheden van ontwikkelingslanden beschouwen de landbouw als het centrum van economische ontwikkeling. Om de productiviteit van de landbouw te verbeteren, zelfvoorziening in voedsel te bevorderen en om boeren alternatieve inkomensmogelijkheden te bieden, mengen zij zich in de rurale economie (agrarische en niet-agrarische sectoren) met prijsbeleid en investeringsprojecten. Het succes van investeringen in de landbouw en de industrie en de mate waarin de baten doordringen tot de landlozen en/of armen hangen af van de harmonisering van arbeidsvraag en –aanbod, het probleemloos functioneren van de arbeidsmarkt, en de loonvorming (Collier and Lal, 1986). Het doel van dit proefschrift is het analyseren van de agrarische en niet-agrarische arbeidsmarkten, de relaties tussen landbouw en niet-landbouw op het niveau van de huishoudens, waarbij speciaal aandacht wordt besteed aan het effect van externe werkgelegenheid op de landbouwproductiviteit, en het bestrijden van rurale armoede. Het proefschrift gebruikt data die zijn verzameld door middel van interviews met 201 boerenhuishoudens in twee jaren, 1996 en 1997, in twee districten in de Tigray regio in noord Ethiopië. Verder wordt er gebruik gemaakt van een informeel onderzoek naar de arbeidsmarkt, arbeiders en belangrijke werkgevers in de steden *Mekelle*, *Quiha* en *Adigudom*. Een bron van secundaire data zijn overheidsinstellingen zoals de 'Central Statistics Authority of Ethiopia' (CSA, 1997a, 1997b, 1997c, 1997d) en de 'Industry, Trade, and Transport Bureau of Tigray Regional State' (ITTB, 1998).

Er wordt een niet-separeerbaar agrarisch huishoudensmodel ontwikkeld (Cailavet, Guyomard, and Lifran, 1994; Singh, Squire and Strauss, 1986; Strauss and Thomas, 1995; Strauss and Thomas, 1998). Het model wordt gebruikt voor het analyseren van verschillende problemen, zoals een afwezige kapitaalmarkt, transactiekosten in input- en productmarkten en transactiekosten en rantsoenering in de arbeidsmarkt (De Janvry, Fafchamps, and Sadoulet, 1991; De Janvry et al., 1992). Er worden econometrische schattingen verricht die rekening houden met de steekproef selectiebias die mogelijk ontstaat door aftopping van de data (Maddala, 1983). De landbouw-niet-landbouw relaties worden geanalyseerd op micro niveau (Haggblade and Hazell, 1989; Haggblade, Hazell, and Brown 1989; Reardon, 1997). De analyses voor de Tigray regio, noord Ethiopië, over werkgelegenheid in en buiten het landbouwbedrijf en het overzicht van de beleidsimplicaties geven duidelijke richtlijnen voor beleidsmakers en –uitvoerders die geïnteresseerd zijn in de

arbeidsmarkt en het versterken van koppelingen tussen groei in de landbouw en de niet-landbouw. Het proefschrift levert nieuw inzicht in de rol van extern inkomen in een weinig dynamische, risicovolle landbouw (in tegenstelling tot dynamische en weinig risicovolle landbouw).

Als reactie op initiële verschillen in de verhouding tussen de productiefactoren, mengen boerenhuishoudens zich in de arbeidsmarkt als werkgevers en werknemers. De uitwisseling van arbeid verlaagt het absolute en relatieve verschil tussen boerenhuishoudens in de hoeveelheid arbeid die gebruikt wordt per eenheid land. Het aandeel van gehuurde arbeid is echter klein als gevolg van hoge transactiekosten voor het controleren van de arbeidsinspanning, liquiditeits-beperkingen en een beperkte bedrijfsgrootte. Desondanks heeft de uitwisseling van arbeid de opbrengsten per eenheid arbeid en land gelijkgetrokken tussen de verschillende bedrijfsklassen. Dit betekent dat de agrarische arbeidsmarkt in staat is om agrarische groei door te sluizen naar de armen.

Loco-contracten domineren de arbeidsmarkt. Vanwege de seizoens-gebondenheid van de agrarische arbeidsvraag, het anticyclische karakter van niet-agrarische werkgelegenheid en het aan landbouw gerelateerde risico, zijn er geen vaste contracten in de agrarische arbeidsmarkt. Het feit dat de niet-agrarische loonvoet varieert met de agrarische seizoenen en met vaardigheden, betekent dat loonvoeten reageren op de krachten van vraag en aanbod. Ondanks de afwezigheid van vaste contracten in de arbeidsmarkt, is er een efficiëntieloon in zowel de agrarische- als de niet-agrarische arbeidsmarkt. De meeste werkgevers verschaffen hun arbeiders maaltijden tijdens werktijd om hun moreel (inzet) te stimuleren. De meeste metselaars en timmerlieden verkrijgen hun vakmanschap na een langdurige periode van oefening, die traag en onproductief is.

De productiviteit van de landbouw neemt toe met het gebruik van agrarische inputs zoals familiearbeid, variabele inputs, vast kapitaal en veebezit. Variabele inputs (zoals kunstmest, pesticiden, verbeterd zaaizaad en gehuurde arbeid) hebben de hoogste output elasticiteit van alle op het bedrijf gebruikte factorinputs. Als de variabele kapitaalgoederen met 10% toenemen, stijgt de output met 3,2%. De elasticiteit van output met betrekking tot de veevoorraad is erg laag, namelijk 0,05. Familiearbeid en gereedschap hebben vergelijkbare elasticiteiten. Als familiearbeid met 10% toeneemt, neemt de output toe met 2,6% (en in het geval van gereedschap met 2,7%). De elasticiteit van de output met betrekking tot het oppervlak gecultiveerd

land is 0,2. Dit is groter dan de bijdrage van vee, maar kleiner dan die van familiearbeid, gereedschap en variabele inputs.

Inkomen van buiten het boerenbedrijf speelt een belangrijke rol in de rurale economie van de regio. Boerenhuishoudens met meer diverse inkomensbronnen hebben een hogere agrarische productiviteit. Door imperfecties in de kapitaalmarkt (beperkte leningen) wordt niet alleen de landbouwproductie beïnvloedt, maar ook het extern inkomen en de uitgaven voor agrarische inputs. Boeren die actief zijn in goed-betalende niet-landbouwactiviteiten zoals metselen en timmeren verkeren in een betere positie om arbeid te huren. Vanwege de bias in de publieke verschaffing van krediet tegen het huren van agrarische arbeid, is inkomen van buiten het bedrijf belangrijker voor het huren van arbeid dan voor het aanschaffen van andere variabele inputs.

Het aanbod van arbeid buiten de landbouw reageert redelijk goed op de eigen loonvoet. De loonelasticiteit van het arbeidsaanbod in de landbouw is groter dan één (1,24). Arbeid op het eigen landbouwbedrijf is een substituut voor externe arbeid, maar de kruisloonelasticiteit is erg laag. Desondanks is het effect van de opbrengsten van landbouwarbeid op externe arbeid groot genoeg om boeren de hoeveelheid arbeid die geleverd wordt voor externe activiteiten te doen verlagen. De eigen loonelasticiteiten voor arbeidsaanbod buiten het boerenbedrijf zijn lager dan die geschat voor landen zoals India (Skoufias, 1994) en de Peruviaanse Sierra (Jacoby, 1993). Ze zijn bovendien lager dan de geschatte elasticiteit voor noord Ghana (Abdulai and Delgado, 1999). De inkomenselasticiteit is vergelijkbaar met die voor India en de Peruviaanse Sierra, maar veel lager dan die voor Ghana. Het aanbod van arbeid voor activiteiten buiten het boerenbedrijf hangt af van de geslachtsverhoudingen binnen het huishouden en van het type activiteiten. Mannelijke en vrouwelijke leden van een huishouden hebben verschillende loonelasticiteiten. De eigen loonelasticiteit van vrouwen (0,8) is hoger dan die van mannen (0,7). De kruisloonelasticiteit tussen mannelijke en vrouwelijke arbeid buiten het landbouwbedrijf is negatief, maar erg laag. Er is een toename van zelfstandige activiteiten buiten het boerenbedrijf met een stijging in eigendom van niet-landbouw werktuigen en transportdieren, en een toename van loonarbeid met een stijging in niet-landbouw werktuigen. Hierdoor domineren rijke boerenhuishoudens de meest lucratieve niet-agrarische activiteiten, zoals metselen, timmeren en handel. Dit heeft geresulteerd in een toename van de inkomensongelijkheid tussen boerenhuishoudens

in rurale gebieden. De belangrijkste bron van ongelijkheid is niet-agrarische activiteiten, namelijk niet-agrarische gekwalificeerde en niet gekwalificeerde loonarbeid en niet-agrarische zelfstandige activiteiten. Het huidige programma voor arbeidsverschaffing is onevenwichtig verdeeld, maar het bevoorrecht de armen en helpt daardoor de inkomensongelijkheid in rurale gebieden te verlagen.

Boerenhuishoudens ondernemen zelfstandige activiteiten vanwege de aantrekkelijke opbrengsten. Loonarbeid dient als restactiviteit die huishoudens ondernemen vanwege 'push' factoren. Het arbeidsaanbod voor loonarbeid is iets elastischer dan dat voor zelfstandige activiteiten buiten het boerenbedrijf. Er bestaat geen significante kruisloonelasticiteit tussen loonarbeid en zelfstandige activiteiten.

Werkgelegenheid buiten het boerenbedrijf heeft geen sterk effect op de gewaskeuze van boerenhuishoudens. Daarentegen passen huishoudens hun externe activiteiten aan hun agrarische omstandigheden aan. Externe activiteiten beïnvloeden bovendien huishoudensbeslissingen met betrekking tot de allocatie van land en arbeid. Ze vergroten de toewijzing van land aan leguminosen en oliegewassen, die weinig productief zijn, weinig arbeid behoeven en het land verbeteren. Activiteiten buiten het boerenbedrijf verminderen bovendien het gebruik van arbeid voor granen. Dit betekent dat activiteiten buiten het bedrijf met de eigen landbouwproductie concurreren om arbeid. Hoewel activiteiten binnen en buiten het boerenbedrijf dus concurreren om familiearbeid, is het netto effect van extern inkomen op inkomen van het boerenbedrijf positief. Vanwege imperfecties in de kapitaalmarkt, het risico van landbouw en de seizoensgebondenheid van landbouwactiviteiten heeft extern inkomen ook een positief effect op het verhandelde surplus van landbouwproducten.

In de huidige economische structuur domineren de distributie- en de servicesector de niet-agrarische activiteiten in de rurale centra (kleine en middelgrote steden) van de regio. Kleinschalige industrie en handvaardigheid zijn sterker geconcentreerd in de grote steden en ze zijn potentieel erg belangrijk voor de werkgelegenheid en inkomensverwerving in de regio. De ontwikkeling van kleinschalige bedrijfjes wordt sterk belemmerd door de slechte infrastructuur: slechte kwaliteit van urbane en rurale wegen en onvoldoende wegen en energieaanbod. Gebrek aan werkkapitaal, de afwezigheid van productmarkten en onvoldoende aanbod van ruwe materialen zijn de belangrijkste problemen die de ontwikkeling van kleinschalige bedrijfjes beperken. Rurale centra of steden dienen vaak als restsector die de arbeiders opneemt die niet vlot worden opgenomen in de landbouw.

De consumptiekoppelingen in de regio zijn veel sterker dan de productiekoppelingen. Momenteel worden de meeste consumptieve uitgaven gedaan aan locaal geproduceerde goederen. Op de lange termijn zal meer van het extra inkomen van boerenhuishoudens worden besteed aan veeproducten en regionaal geïmporteerde voedings- en niet-voedingsartikelen zowel als aan locale niet-voedsel producten, in het bijzonder diensten en ceremoniële uitgaven. Ook al zijn de produktiekoppelingen tussen landbouw en niet-landbouw op huishoudniveau erg klein, op geaggregeerd niveau kan landbouwinkomen niet-landbouwactiviteiten aanzienlijk ondersteunen. Landbouw is dan ook een motor voor groei van de economische ontwikkeling (Mellor, 1976). Gegeven de onvolledige werkgelegenheid in rurale gebieden is landbouw nog steeds een bron van arbeid voor industriële ontwikkeling (Lewis, 1954; Fei and Ranis, 1964). De landbouw stagneert echter niet en de agrarische productie kan worden verhoogd door het intensieve gebruik van vaste en variabele kapitaalinputs.

Het positieve verband tussen inkomen van binnen en buiten het bedrijf wijst op de noodzaak om complementaire programma's en beleid te ontwikkelen teneinde de koppeling tussen beide bronnen van inkomsten te versterken. Het agrarische onderzoeks- en voorlichtingsprogramma zou zowel agrarische- als niet-agrarische activiteiten moeten omvatten, de groei van kleinschalige bedrijven moeten aanmoedigen en niet-agrarische werkgelegenheid in rurale gebieden moeten creëren. Het huidige programma richt zich echter uitsluitend op agrarische activiteiten.

Beleidsmakers dienen hun ontwikkelingsbeleid, wetten en instituties te herzien om er zeker van te zijn dat deze ten gunste komen van kleine boeren en kleine rurale niet-agrarische ondernemingen. Alleen dan kunnen rurale agrarische en niet-agrarische ondernemingen hun volle potentieel voor inkomensvorming en economische decentralisatie bereiken. De efficiëntie van distributie en de handel in diensten moeten worden verhoogd om een gunstige markt voor agrarische en industriële producten te creëren. Dit geldt met name voor de producten van kleinschalige bedrijven en huisvlijt. Totdat de markt het opkomen van handelaren in de arbeidsmarkt ondersteunt, kan het publiek verschaffen van arbeidsmarktinformatie op korte termijn noodzakelijk zijn. Hierbij wordt gedacht aan loonvoeten, grootte en type arbeidsvraag (benodigde vaardigheden) per specifieke locatie en aan een lijst van werkzoekenden per vaardigheid.

Het verminderen van het effect van niet-landbouw activiteiten op de inkomensongelijkheid vergt bepaalde activiteiten. In de eerste plaats dienen rurale niet-agrarische investeringen, die bedoeld zijn om de rurale armoede aan te pakken, zich toespitsen op die activiteiten waaraan de armen kunnen deelnemen. Ten tweede moeten de onderliggende factoren die boerenhuishoudens belemmeren in hun participatie in niet-agrarische activiteiten geëlimineerd worden. Dit vereist de oprichting van trainingscentra voor het uitbannen van de vaardigheidsbarrière, het verschaffen van krediet aan de armen in combinatie met bedrijfsvoorlichting, en de uitbreiding van publieke werkgelegenheidsprogramma's.

Scholing heeft geen significant verband met het marktloon omdat het meeste werk buiten het landbouwbedrijf handwerk is en omdat het scholingsniveau te laag is om productief te zijn. Scholing heeft echter wel een positief effect op de opbrengst van arbeid in de eigen onderneming. Hoewel studies aantonen dat minstens de vierde klas nodig is om de agrarische productiviteit te verhogen, helpt ook een lager opleidingsniveau boerenhuishoudens om hun niet vermarktbare scholing (zoals traditionele scholing) in inkomen om te zetten door erg hard te werken op hun boerenbedrijf en andere privé-ondernemingen. Substantiële rurale ontwikkeling zou noodzakelijk kunnen zijn om een vraag naar opgeleide mensen te creëren en om de 'traditionele sector' van de economie te verbeteren (Schultz, 1961, 1964). In feite is verder onderzoek naar de rol van onderwijs in traditionele agrarische en niet-agrarische activiteiten in de regio noodzakelijk.

Deze studie suggereert drie brede velden voor toekomstig onderzoek. Ten eerste kan toekomstig onderzoek zich richten op het formuleren van een toegepast model dat een niet-separeerbaar agrarisch huishoudensmodel, een dorpsmodel en een toegepast algemeen evenwichtsmodel met elkaar combineert om op die manier de algemene evenwichtseffecten van een verandering in inkomen in het studiegebied te analyseren. Ten tweede is het belangrijk om te bepalen of er een sterk economisch verband is tussen de stad in het rurale gebied en de omringende rurale gebieden en of rurale steden ruimtelijk goed verdeeld zijn om efficiënte diensten te verschaffen voor de rurale bevolking. Pas dan is het zinvol om '*de ontwikkeling van kleine steden'* te lanceren als een kernpunt voor rurale ontwikkeling. Ten derde, toekomstige onderzoeksactiviteiten dienen een paneldataset te ontwikkelen om risico te kunnen incorporeren in de analyse van productie en consumptie beslissingen van boerenhuishoudens.

APPENDICES

Appendix A2[1]. Outline of Tigray Rural Household Survey (1996-1997) Questionnaire for Farm and Off-Farm Employment Study

A questionnaire survey was conducted in the *Enderta* and *Adigudom* Districts located in the Southern Zone of the Tigray Region, Northern Ethiopia. The survey includes 201 farm households chosen randomly from a stratified sample area. The survey was conducted for two years (1996 and 1997) with the help of two enumerators recruited from the survey area. The respondents were the heads of the households. The survey data includes detailed information on the seasonal allocation of labour (for home, farm, off-farm activities and for each crop), the sources of income (crop, livestock, wage employment, off-farm self employment, non-labour income), the purchase of farm outputs and inputs (including hired labour), the sale of farm outputs, expenditure on the consumption of home grown and purchased goods and services, credit, household compositions, and anthropometrics. Since it was found too big to annex the 42-pages survey questionnaire, we give the outline of the questionnaire below. The whole questionnaire is available at the following web site: www.sls.wau.nl/twoldehanna/.

OUTLINE OF THE QUESTIONAIRE

INTRODUCTION
PART ONE: HOUSEHOLD DEMOGRAPHIC, EDUCATION AND TIME ALLOCATION
- SECTION 1: HOUSEHOLD CHARACTERISTICS
- SECTION 2: HOLYDAYS
- SECTION 3: HOUSEHOLD TIME ALLOCATION SHEET

PART TWO: HOUSEHOLD ASSET, CREDIT AND NON-FOOD EXPENDITURE
- SECTION 1. HOUSEHOLD ASSET
- SECTION 2: CREDIT

PART THREE: NON-FARM EMPLOYMENT AND INCOME
- SECTION 1: EMPLOYMENT FOR WAGE
- SECTION 2: OWN BUSINESS ACTIVITIES
- SECTION 2.1. SPECIAL: MONTHLY OFF-FARM EMPLOYMENT RECORD
- SECTION 3: TRANSFERS (REMITTANCE AND AID)
- SECTION 4: MIGRATION AND INCOME

PART FOUR: AGRICULTURE
- SECTION 1. LAND USE INFORMATION
- SECTION 2: CROP AND PERSON SPECIFIC INPUTS
- SECTION 3: GENERAL INPUTS
- SECTION 4: LABOR ALLOCATION ROSTER
- SECTION 5: CROP OUTPUT AND SALES
- SECTION 6: LAND RENTED TO OTHER HOUSEHOLDS

PART FIVE: LIVESTOCK OWNERSHIP, EXPENDITURE AND INCOME
- SECTION 1: LIVESTOCK OWNERSHIP
- SECTION 2: LIVESTOCK EXPENDITURE AND INCOME

PART SIX: FOOD CONSUMPTION, HEALTH AND WOMEN'S ACTIVITIES
- SECTION 1: ANTHROPOMETRICS
- SECTION 2: CONSUMPTION HABIT
- SECTION 3: FOOD EXPENDITURE AND CONSUMPTION
- SECTION 4: NON-FOOD EXPENDITURE
- SECTION 5: ENERGY, WATER AND HOUSEHOLD CONSUMABLE

PART SEVEN: FARMERS EVALUATION OF CROP PERFORMANCE RECORD

[1] Appendix starts with A2 in order to match with the numbering of chapters.

Appendix A5 Estimation results of production function, demand for variable input and off-farm labour supply presented in Chapter 5

Table A5.1 Parameters estimation of a Cobb-Douglas production function (tobit model)

					Marginal effects		
	Coefficient	Std. Err.	T-ratio	P>|T|	Unconditional	Uncensored	Prob. uncensored
Lfmshlnf	0.362	0.096	3.766	0.000	0.324	0.255	0.091
Lvrinpnf	0.448	0.142	3.147	0.002	0.401	0.316	0.112
LP2V2ND	0.375	0.072	5.228	0.000	0.336	0.265	0.094
LTANIMND	0.066	0.037	1.779	0.076	0.0595	0.047	0.017
SHVCBF	1.253	1.458	0.859	0.391	1.122	0.883	0.314
CDF	2.42	0.925	2.624	0.009	2.173	1.710	0.609
INDF	2.454	1.026	2.392	0.017	2.197	1.729	0.616
SOILI	0.337	0.302	1.117	0.265	0.302	0.238	0.085
DYEAR	0.291	0.118	2.462	0.014	0.261	0.205	0.073
DTAA	0.905	0.188	4.801	0.000	0.810	0.638	0.227
DTAF	1.488	0.202	7.359	0.000	1.332	1.049	0.373
DTEF	-0.168	0.241	-0.696	0.487	-0.151	-0.119	-0.042
DTEM	-0.126	0.2019	-0.634	0.526	-0.114	-0.090	-0.032
Constant	-3.309	1.052	-3.148	0.002			
Standard error	0.722	0.027					

Lfmshlnf = natural log of family labour used on the farm (instrumented); Lvrinpnf = natural log of total variable input used on the farm (instrumented); LP2V2ND = natural log of one-year depreciation value of agricultural equipment per unit of land cultivated; LTANIMN = natural log of one-year depreciation value of livestock per unit of land cultivated; DTAA, DTAF, DTEF, DTEM, are location dummies; DYEAR = Year dummy (1996=1); SHVCB = share of high value crop; CDF = crop diversification index (instrumented); INDF = income diversification index (instrumented).

Table A5.2 Tobit estimation of expenditure on variable farm inputs

					Marginal effect		
	Coefficient	Std. Err.	T-ratio	P>|T-ratio|	unconditional	Uncensored	Prob. Uncensored
Deprat	0.28	0.29	0.971	0.332	0.251	0.196	0.051
Dden	0.93	0.16	5.808	0.000	0.825	0.644	0.168
Dyear	-0.16	0.12	-1.386	0.166	-0.142	-0.111	-0.029
Walkap	5.89	0.41	14.528	0.000	5.230	4.083	1.065
Hutsap	5.78	0.38	15.182	0.000	5.129	4.004	1.044
Bakelp	6.04	0.40	15.177	0.000	5.366	4.189	1.092
Llandc	0.081	0.13	0.616	0.538	0.072	0.056	0.015
Lnfinf	0.15	0.056	2.677	0.008	0.133	0.104	0.027
Lfarmqf	0.16	0.047	3.184	0.002	0.132	0.103	0.027
Constant	-2.91	0.432	-6.736	0.000			
Standard error	1.053	0.040					

Deprat = dependency ratio; Dyear = year dummy (1996=1); Dden = district dummy (enderta=1); Walkap=proportion of black soil; Hutsap = proportion of sandy soil; Bakelp = proportion of loam soil; Llandc = natural log of land cultivated; Lnfinf = natural log of non-farm income (instrumented); Lfarmqf = natural log of farm income (instrumented).

Table A5.3 Off-farm hours of labour supply (NFH1)

					Marginal effects at observed censoring rate		
	Coefficient	Std. Err.	T-ratio	P>|T|	Unconditional expected value	Conditional on being Uncensored	Probability uncensored
Age	-32.437	50.076	-0.648	0.518	-26.22	-19.20	-0.007
age2	.503	0.514	0.978	0.329	0.41	0.30	0.0001
Dyear	-346.569	136.63	-2.537	0.012	-280.19	-205.16	-0.077
Educh	4.245	153.54	0.028	0.978	3.43	2.51	0.001
Lvarinpf	-144.32	60.87	-2.371	0.018	-116.68	-85.43	-0.032
lp2v2	-105.20	81.26	-1.295	0.196	-85.05	-62.28	-0.023
Ltanim	101.24	47.16	2.147	0.032	81.85	59.93	0.022
lp2v3	-45.788	69.80	-0.656	0.512	-37.01	-27.11	-0.010
Llandc	-602.18	139.93	-4.303	0.000	-486.84	-356.48	-0.133
Ltranin1	-154.40	35.331	-4.370	0.000	-124.826	-91.40	-0.034
Lwage1f	887.39	79.68	11.137	0.000	717.42	525.32	0.196
p1v5	620.65	106.50	5.828	0.000	501.77	367.42	0.137
p1v63	-500.43	117.47	-4.260	0.000	-404.57	-296.24	-0.110
Dtaa	1236.75	246.69	5.013	0.000	999.86	732.134	0.273
Dtaf	52.86	236.928	0.223	0.824	42.74	31.29	0.012
Dtef	616.8	233.123	2.646	0.008	498.69	365.16	0.136
Dtem	722.39	253.448	2.850	0.005	584.026	427.65	0.160
_cons	1863.16	1190.474	1.565	0.118			
_se	1235.30	48.581					

Age = age of the household head; Age2 = age of the household head squared; Dyear = Year dummy (1996=1); Educh = dummy for the education of the household head; Lvarinpf= natural log of expenditure on variable farm inputs; Lp2v2 = natural log of value of farm implements; Lp2v3 = log of value of non-agricultural equipment; Llandc = log of land cultivated; Ltranin1 = natural log of non-labour income; Lwage1f = log of predicted market wage rate; p1v5 = family size; p1v63 = number of dependent; Dtaa, Dtaf, Dtef, Dtem, are location dummies.

Appendix A5.4 Derivation of marginal effects in a Tobit model

The marginal effects on the unconditional expected value, on conditional being uncensored and on the probability uncensored can be calculated at the observed censoring rate of the dependent variable (McDonald and Moffitt, 1980). Given the off-farm labour supply of farm households

$$L_{mi} = X\beta + u \text{ if } L_{mi} > 0; \text{ and } L_{mi} = 0 \text{ if } L_{mi} = 0 ,$$

the expected value of off-farm hours of work is (individual subscript are suppressed for notational convenience).

$$EL_m = X\beta\Phi(z) + \sigma\phi(z)$$

where $z = X\beta / \sigma$

σ is the standard error of u

$\phi(.)$ is unit normal density

$\Phi(.)$ is cumulative normal distribution function

The expected value of off-farm hours worked for observations with the limit is

$$E(L_{mi} / L_{mi} > 0) = X\beta + \sigma\phi(z) / \Phi(z) .$$

From these basic relationships, we can calculate the marginal effect at mean values of the explanatory variables.

1. The marginal effect on unconditional expected value of the dependent variable:

$$\frac{\partial E(L_m)}{\partial X_j} = \beta_j \Phi(z) .$$

2. The marginal effect on the dependent variable conditional on being uncensored:

$$\frac{\partial E(L_m / L_m > 0)}{\partial X_j} = \beta_j [1 - z\phi(z) / \Phi(z) - \phi(z)^2 / \Phi(z)^2] .$$

3. The marginal effect on the probability of being uncensored:

$$\frac{\partial \Phi(z)}{\partial X_j} = \frac{\beta_j}{\sigma}\phi(z) .$$

To give an example, let us see how marginal effect of log of market wage rate (lwage1f) on the supply of labour for off-farm work is calculated in Table A5.3. The observed censoring rate of the dependent variable, $\Phi(z)$, in our sample is 0.8085, the scaling factor used to get the marginal effects on the unconditional expected value of the dependent variable. The inverse of cumulative normal distribution of 0.808 is given by $z = 0.872$. The normal probability density $\phi(z)$ is calculated as 0.2727. The other scaling factor used to get the marginal effects explanatory variables on the dependent variable conditional on being uncensored is given by:

$[1 - z\phi(z) / \Phi(z) - \phi(z)^2 / \Phi(z)^2] = 0.592$.

Consequently, (1) the marginal effect of log of market wage rate on the unconditional expected value of off-farm labour supply is

$$\frac{\partial E(L_m)}{\partial lwage1f} = 887.39 \times 0.8085 = 717.42 ;$$

(2) the marginal effect of log wage on the supply of labour for off-farm work conditional on being uncensored is :

$$\frac{\partial E(L_m / L_m > 0)}{\partial lwage1f} = 887.39 \times 0.592 = 525.32 ,$$

(3).the marginal effect of log wage on the probability of being uncensored is

$$\frac{\partial \Phi(z)}{\partial lwage1f} = \frac{0.887}{12335.3} \times 0.2727 = 0.196 .$$

See Wiggins (1998) for an application in Stata, statistical software.

Appendix A6 Estimation results of production function, labour demand and labour supply equations presented in Chapter 6

Table A6.1 Description of variables used in the econometric estimations

Variables	Descriptions
Age	Age of the household head
Age2	Age squared of household head
Dtaa	Dummy for Tabia Araasegda
Dtaf	Dummy for Tabia fekre alem
Dtef	Dummy for Tabia Felegeselam
Dtem	Dummy for Tabia Mytsedo
Dyear	Year dummy (1996=1, 1997=0)
Educh	Education dummy (head read and write=1, 0 otherwise)
Educw	Education dummy (wife read and write=1, 0 otherwise)
Lfmshlaf	Ln of family labour supplied on the farm
Lhirlabf	Ln of hired farm labour used
Linqbf	Ln of variable farm input excluding hired farm labour
Llandc	Ln of land cultivated in Tsimid (4 tsimdi = one hectare)
lp2v2d	Ln of one-year depreciation value of farm implement
lp6v2d	Ln of one-year depreciation of oxen owned
Lshdnewf	Ln of Shadow wage of on-farm family labour
Lwagegmf	Predicted ln of market wage rate of male members
Lwagegnf	Predicted ln of market wage rate of female members
Lyof	Ln of non-labour income plus intercept of the linearized profit function
Fmshla	On-farm family labour supplied
Nfh1gf	Female members' off-farm family labour supplied
Nfh1gm	Male members' off-farm family labour supplied
P1v5	Family size
p1v63	Number of dependants
Shvcbf	Share of high value crops

Ln stands for natural logarithm

Table A6.2 Parameter estimates of production function (dependent variable log of value of crop output)

Explanatory variables	Coef.	Std.Err.	P>|t|	Marginal effect
Lfmshlaf	0.648	0.184	0.000	0.451***
Lhirlabf	0.163	0.088	0.066	0.113*
Linqbf	0.265	0.166	0.113	0.184
Lp2v2d	-0.035	0.060	0.558	-0.025
Lp6v2d	-0.012	0.035	0.723	-0.009
Llandc	0.431	0.166	0.010	0.300***
Shvcbf	3.393	0.921	0.000	2.365***
Dyear	0.435	0.101	0.000	0.303***
Dtaa	0.196	0.159	0.218	0.136
Dtaf	0.279	0.196	0.155	0.194
Dtef	0.191	0.176	0.278	0.133
Dtem	-0.407	0.167	0.015	-0.284**
Constant	-1.109	0.229	0.000	
Sigma	0.790	0.030		

Log likelihood = - 445.16; χ^2=971.04; Prob > χ^2 = 0.000

Table A6.3 Estimates of demand for total farm labour [dependent variable = ln (total farm labour)

	Coef.	Std. Err.	P>|t|	Marginal
p1v5	-0.088	0.06	0.144	-0.061
p1v63	0.058	0.051	0.263	0.04
Llandc	0.568	0.058	0.000	0.396***
Dyear	0.147	0.064	0.022	0.103**
Dtaa	-0.15	0.094	0.114	-0.104
Dtaf	0.38	0.213	0.076	0.265*
Dtef	-0.528	0.17	0.002	-0.368**
Dtem	-0.274	0.128	0.032	-0.191*
Lnfinf	0.217	0.097	0.026	0.152*
lp2v2	-0.124	0.039	0.001	-0.087***
Ltanim	-0.006	0.029	0.84	-0.004
Linqbf	1.099	0.038	0	0.766***
Constant	-1.462	0.581	0.012	
_Sigma	0.552	0.021		

Log likelihood = -312.02; χ^2=1126.91; Prob > χ^2 = 0.000

Table A6.4 Estimates of demand for hired labour [dependent variable = ln (hired farm labour)]

	Coef.	Std. Err.	P>|t|	Marginal
p1v5	-2.435	0.519	0	-0.757***
p1v63	1.697	0.455	0	0.527***
Llandc	3.538	0.528	0	1.1***
Dyear	2.309	0.548	0	0.718***
Dtaa	-1.519	0.801	0.059	-0.472*
Dtaf	3.477	1.718	0.044	1.081**
Dtef	-4.972	1.349	0	-1.545***
Dtem	-1.706	1	0.089	-0.53*
Lnfinf	3.256	0.759	0	1.012***
lp2v2	-0.16	0.36	0.657	-0.05
Ltanim	1.124	0.28	0	0.349***
Linqbf	0.291	0.422	0.491	0.091
_cons	-26.671	4.843	0	
_se	4.019	0.258		

Log likelihood = -566.92; χ^2=168.29; Prob > χ^2 = 0.000

Table A6.5 Parameter estimates of on-farm family labour supply (Fmshla)

				Marginal effects*		
	Coef.	Std. Err.	P>|t|	Unconditional Expected value	Conditional on being uncensored	Probability uncensored
Lshdnewf	748.567	59.571	0.000	666.634	521.80	0.502
Lwagegmf	-15.515	9.581	0.106	-13.816	-10.81	-0.01
Lwagegnf	-0.047	8.106	0.995	-0.042	-0.032	-0.00003
Lyof	4.408	13.614	0.746	3.925	3.07	0.003
Educh	86.712	33.907	0.011	77.221	60.44	0.058
Educw	-118.050	51.615	0.023	-105.129	-82.29	-0.079
Age	11.236	10.642	0.292	10.007	7.83	0.008
Age2	-0.130	0.109	0.234	-0.116	-0.09	-0.0001
P1v5	21.433	28.038	0.445	19.087	14.94	0.014
P1v63	-18.135	34.766	0.602	-16.150	-12.64	-0.012
Dyear	-190.288	34.325	0.000	-169.460	-132.64	-0.128
Dtaa	-185.352	97.745	0.059	-165.064	-129.20	-0.124
Dtaf	-225.350	98.300	0.022	-200.685	-157.08	-0.151
Dtef	172.130	60.691	0.005	153.290	119.99	0.115
Dtem	58.911	55.904	0.293	52.463	41.065	0.04
Constant	125.821	253.606	0.620			
Sigma	279.341	10.489				

*Log likelihood = - 2543.09; χ^2=350.8; Prob > χ^2 = 0.000; *Marginal effects on conditional on being uncensored means the marginal effect on level of off-farm work being off-farm work is positive. Marginal effects on probability being uncensored means the marginal effect on the probability of participation in off-farm activities.*

Table A6.6 Parameter estimates of male members' off-farm family labour supply (Nfh1gm)

				Marginal effects*		
	Coef.	Std. Err.	P>|t|	Unconditional Expected value	Conditional on being uncensored	Probability uncensored
Lshdnewf	-1603.62	236.784	0.000	-1260.554	-912.09	-0.431
Lwagegmf	889.494	109.834	0.000	699.204	505.918	0.239
Lwagegnf	-61.755	32.491	0.058	-48.544	-35.124	-0.017
Lyof	-60.567	59.996	0.313	-47.610	-34.449	-0.016
Educh	-106.607	146.844	0.468	-83.801	-60.635	-0.029
Educw	533.617	226.604	0.019	419.460	303.506	0.143
Age	-64.643	45.901	0.16	-50.814	-36.767	-0.017
Age2	0.7699	0.4781	0.108	0.605	0.438	0.0002
p1v5	544.828	118.462	0.000	428.273	309.882	0.146
p1v63	-419.916	145.307	0.004	-330.083	-238.836	-0.113
Dyear	5.160	146.918	0.972	4.056	2.935	0.0013
Dtaa	813.510	432.977	0.061	639.476	462.701	0.218
Dtaf	789.656	455.734	0.084	620.725	449.133	0.212
Dtef	-256.372	255.27	0.316	-201.526	-145.817	-0.069
Dtem	176.681	241.801	0.465	138.883	100.490	0.047
Constant	1137.256	1065.45	0.286			
Sigma	1084.749	43.241				

*Log likelihood = -2662.15; χ^2=329.89; Prob > χ^2 = 0.000; *Marginal effects on conditional on being uncensored means the marginal effect on level of off-farm work being off-farm work is positive. Marginal effects on probability being uncensored means the marginal effect on the probability of participation in off-farm activities.*

Table A6.7 Parameter estimates of female members' off-farm family labour supply (Nfh1gf)

				Marginal effects*		
	Coef.	Std. Err.	P>|t|	Unconditional Expected value	Conditional on being uncensored	Probability uncensored
Lshdnewf	-571.944	246.995	0.021	-237.599	-182.692	-0.349
Lwagegmf	-32.332	52.824	0.541	-13.431	-10.328	-0.020
Lwagegnf	683.740	86.900	0.000	284.041	218.402	0.417
Lyof	-120.534	54.206	0.027	-50.073	-38.501	-0.074
Educh	106.108	122.406	0.387	44.080	33.893	0.065
Educw	-278.660	220.114	0.206	-115.762	-89.010	-0.170
Age	-14.291	38.691	0.712	-5.937	-4.565	-0.008
Age2	0.31504	0.402	0.433	0.131	0.1006	0.0002
p1v5	25.245	100.032	0.801	10.487	8.064	0.015
p1v63	113.309	125.948	0.369	47.071	36.193	0.069
Dyear	117.230	123.206	0.342	48.700	37.446	0.072
Dtaa	928.195	417.258	0.027	385.593	296.486	0.566
Dtaf	823.097	442.642	0.064	341.933	262.916	0.502
Dtef	245.052	288.067	0.395	101.800	78.275	0.150
Dtem	249.742	283.649	0.379	103.749	79.773	0.152
Constant	696.404	912.394	0.446			
Sigma	639.121	35.065				

Log likelihood = -1318.22; χ^2=484.28; Prob > χ^2 = 0.000

**Marginal effects on conditional on being uncensored means the marginal effect on level of off-farm work being off-farm work is positive. Marginal effects on probability being uncensored means the marginal effect on the probability of participation in off-farm activities.*

Appendix A7 Estimation results of labour supply for off-farm wage employment and off-farm self-employment presented in Chapter 7

Table A7.1 Description of variables

Variables	Description
Age	Age of the household head
Age2	Age of the household head squared
Dden	District dummy with Enderta district = 1 and Adigudom = 0
DWH1	Hours supplied for off-farm wage employment per year
DWP	Participation dummy in off-farm wage employment
Dyear	Year dummy with 1996=1 and 1997=0
Educm	Education dummy with read and write through formal education =1 and 0 otherwise
Educt	Education dummy with read and write through informal learning =1 and 0 otherwise
Group one	Households who do participate in off-farm wage employment only
Group two	Households who do participate in off-farm self-employment only
Group zero	Households who do not participate in off-farm employment at all
Groupthree	Households who do participate in both off-farm wage employment and off-farm self-employment
landc	Amount of cultivated land in Tsimdi (one hectare = 4 Tsimdi)
Ldwage1f	Predicted log of wage rate for off-farm wage employment
Lfarmqf2	Predicted log of farm income in Birr
Lobwge1f	Predicted log of wage rate for off-farm self employment
lp2v3	Log of owned equipment for off-farm work measured in Birr
ltanim1	Log of livestock wealth in Birr
Ltranin1	Log of non-labour income
OBH1	Hours supplied for off-farm self-employment per year
OBP	Participation dummy in off-farm self-employment
p1v5	Family size
p1v63	Number of dependent
p6v25	Number of donkeys and horses owned.

Table A7.3 Tobit model of labour supply for off-farm employment in hours (dwh1)

					Marginal effects[+]		
	Coef.	Std. Err.	T-ratio	P>|T|	Unconditional Expected value	Conditional on being uncensored	Probability uncensored
Age	-142.080	56.497	-2.515	0.012	-102.495	-72.470	-0.038
age2	1.567	0.583	2.689	0.007	1.131	0.799	0.0005
Dyear	-742.270	180.968	-4.102	0.000	-535.469	-378.608	-0.204
Dden	146.190	185.022	0.790	0.430	105.460	74.567	0.040
Educt	-273.900	225.238	-1.216	0.225	-197.590	-139.707	-0.075
Educm	306.080	201.116	1.522	0.129	220.804	156.122	0.084
Lfarmqf2	-110.401	32.813	-3.365	0.001	-79.642	-56.312	-0.030
Landc	-7.543	5.245	-1.438	0.151	-5.442	-3.847	-0.002
Ltanim1	-95.203	46.059	-2.067	0.039	-68.679	-48.560	-0.026
p6v25	-236.243	104.180	-2.268	0.024	-170.424	-120.499	-0.065
lp2v3	-238.312	81.833	-2.912	0.004	-171.916	-121.555	-0.065
Ltranin1	-139.172	39.341	-3.538	0.000	-100.398	-70.989	-0.038
Ldwage1f	803.201	88.664	9.059	0.000	579.423	409.687	0.220
Lobwge1f	31.058	25.544	1.216	0.225	22.405	15.841	0.009
p1v5	952.641	121.675	7.829	0.000	687.229	485.911	0.261
p1v63	-773.470	128.356	-6.026	0.000	-557.976	-394.522	-0.212
Constant	5010.859	1292.673	3.876	0.000			
Std. Error	1226.226	51.075					

Log likelihood = -2478.15; χ^2 = 412.22; pseudo R^2 = 0.0768. [+]Marginal effects on conditional on being uncensored means the marginal effect on level of off-farm work being off-farm work is positive. Marginal effects on probability being uncensored means the marginal effect on the probability of participation in off-farm activities.

Table A7.5 Tobit model of labour supply off-farm self-employment (OBH1),

					Marginal effects [+]		
	Coef.	Std. Err.	T-ratio	P>|t|	Unconditional Expected value	Conditional on being uncensored	Probability uncensored
Age	-15.667	20.516	-0.764	0.446	-4.36	-3.990	-0.017
Age2	0.128	0.212	0.602	0.547	0.036	.0325	0.0001
Dyear	62.607	69.557	0.900	0.369	17.443	15.947	0.067
Dden	87.496	76.569	1.143	0.254	24.377	22.287	0.093
Educt	-54.196	88.099	-0.615	0.539	-15.100	-13.804	-0.058
Educm	-9.695	80.080	-0.121	0.904	-2.701	-2.469	-0.010
Lfarmqf2	59.840	14.857	4.028	0.000	16.672	15.2425	0.064
Landc	-40.902	10.539	-3.881	0.000	-11.395	-10.418	-0.043
Ltanim1	-53.725	20.262	-2.652	0.008	-14.968	-13.685	-0.057
P6v25	-1.488	26.977	-0.055	0.956	-0.415	-0.379	-0.002
Lp2v3	86.398	25.446	3.395	0.001	24.071	22.007	0.092
Ltranin1	-15.524	13.321	-1.165	0.245	-4.325	-3.954	-0.017
Ldwage1f	-12.114	11.386	-1.064	0.288	-3.375	-3.088	-0.013
Lobwge1f	143.219	13.119	10.917	0.000	39.902	36.481	0.152
P1v5	46.980	40.678	1.155	0.249	13.089	11.967	0.050
P1v63	-53.843	46.439	-1.159	0.247	-15.001	-13.715	-0.057
Constant	201.450	473.995	0.425	0.671			
Std. Error	315.554	21.31955					

**P value is the minimum significant level that rejects the null hypothesis that the parameter is zero; Log likelihood = -816.79; χ^2 = 381.67; pseudo R^2 = 0.19; [+]Marginal effects on conditional on being uncensored means the marginal effect on level of off-farm work being off-farm work is positive. Marginal effects on probability being uncensored means the marginal effect on the probability of participation in off-farm activities.*

Table A7.4 Estimates of multinomial logit model of off-farm work choice

	Comparison group=no off-farm work				Comparison group = off-farm wage employment			
	Coef.	RRR	Std. Err.	P>|T|	Coef.	RRR	Std. Err.	P>|T|
Group	Off-farm wage employment only				No off-farm work			
Age	0.010	1.010	0.105	0.925	-0.010	0.990	0.105	0.925
Age2	-0.001	0.999	0.001	0.587	0.001	1.001	0.001	0.587
Dyear	-1.574	0.207	0.322	0.000	1.574	4.825	0.322	0.000
Dden	0.171	1.187	0.368	0.641	-0.171	0.842	0.368	0.641
Educt	-0.537	0.584	0.490	0.273	0.537	1.711	0.490	0.273
Educm	-0.993	0.371	0.397	0.012	0.993	2.699	0.397	0.012
Lfarmqf2	0.020	1.021	0.069	0.768	-0.020	0.980	0.069	0.768
Landc	-0.003	0.997	0.006	0.577	0.003	1.003	0.006	0.577
Ltanim1	-0.223	0.800	0.087	0.011	0.223	1.250	0.087	0.011
P6v25	-0.837	0.433	0.211	0.000	0.837	2.310	0.211	0.000
Ltranin1	-0.064	0.938	0.074	0.389	0.064	1.066	0.074	0.389
P1v5	0.919	2.506	0.271	0.001	-0.919	0.399	0.271	0.001
P1v63	-0.664	0.515	0.290	0.022	0.664	1.943	0.290	0.022
_cons	1.615		2.516	0.521	-1.615		2.516	0.521
Group	Off-farm self-employment				Off-farm self-employment			
Age	-0.031	0.970	0.167	0.855	-0.040	0.960	0.158	0.798
Age2	-0.0002	1.000	0.002	0.920	0.0004	1.000	0.002	0.805
Dyear	1.063	2.896	0.578	0.066	2.637	13.976	0.555	0.000
Dden	2.501	12.191	0.665	0.000	2.329	10.271	0.638	0.000
Educt	0.208	1.231	0.766	0.786	0.745	2.107	0.718	0.300
Educm	-0.171	0.843	0.623	0.784	0.822	2.275	0.592	0.165
Lfarmqf2	0.346	1.414	0.118	0.003	0.326	1.385	0.114	0.004
Landc	-0.116	0.890	0.060	0.054	-0.113	0.893	0.060	0.061
Ltanim1	-0.522	0.593	0.182	0.004	-0.299	0.741	0.178	0.092
P6v25	-0.033	0.967	0.179	0.853	0.804	2.234	0.238	0.001
Ltranin1	0.003	1.003	0.096	0.974	0.067	1.069	0.092	0.467
P1v5	0.305	1.357	0.390	0.433	-0.613	0.542	0.357	0.086
P1v63	-0.469	0.625	0.429	0.274	0.195	1.216	0.396	0.622
_cons	-3.340		3.960	0.399	-4.954		3.680	0.178
Group	Both off-farm wage and self-employment				Both off-farm wage and self-employment			
Age	-0.103	0.902	0.124	0.404	-0.113	0.893	0.105	0.281
Age2	0.0004	1.000	0.001	0.778	0.001	1.001	0.001	0.391
Dyear	-0.073	0.930	0.392	0.853	1.501	4.487	0.322	0.000
Dden	1.731	5.646	0.439	0.000	1.560	4.757	0.367	0.000
Educt	0.169	1.184	0.556	0.761	0.706	2.027	0.451	0.117
Educm	-1.077	0.341	0.497	0.030	-0.084	0.919	0.430	0.845
Lfarmqf2	0.254	1.289	0.091	0.005	0.233	1.263	0.080	0.004
Landc	-0.174	0.840	0.054	0.001	-0.171	0.843	0.054	0.002
Ltanim1	-0.307	0.736	0.113	0.007	-0.084	0.919	0.104	0.418
P6v25	-0.363	0.696	0.200	0.070	0.474	1.607	0.224	0.034
Ltranin1	-0.071	0.932	0.084	0.401	-0.007	0.993	0.073	0.923
P1v5	0.969	2.636	0.306	0.002	0.051	1.052	0.231	0.827
P1v63	-0.899	0.407	0.334	0.007	-0.235	0.791	0.260	0.366
Constant	0.817		2.927	0.780	-0.797		2.407	0.740

**P value is the minimum significant level that rejects the null hypothesis that the parameter is zero; Log likelihood = -361.35; χ^2 = 277.77; pseudo R^2 = 0.24; RRR is the relative risk ratio.*

Table A7.5 Estimates of multinomial logit model of off-farm work choice

	Comparison group is off-farm self-employment only				Comparison group = off-farm wage and self employment			
	Coef.	RRR	Std. Err.	P>|T|	Coef.	RRR	Std. Err.	P>|T|
Group	*No off-farm work*				**No off-farm work**			
Age	0.031	1.031	0.167	0.855	0.103	1.109	0.124	0.404
age2	0.0002	1.000	0.002	0.920	-0.0004	1.000	0.001	0.778
Dyear	-1.063	0.345	0.578	0.066	0.073	1.075	0.392	0.853
Dden	-2.501	0.082	0.665	0.000	-1.731	0.177	0.439	0.000
Educt	-0.208	0.812	0.766	0.786	-0.169	0.844	0.556	0.761
Educm	0.171	1.186	0.623	0.784	1.077	2.936	0.497	0.030
Lfarmqf2	-0.346	0.707	0.118	0.003	-0.254	0.776	0.091	0.005
Landc	0.116	1.123	0.060	0.054	0.174	1.191	0.054	0.001
ltanim1	0.522	1.686	0.182	0.004	0.307	1.359	0.113	0.007
p6v25	0.033	1.034	0.179	0.853	0.363	1.437	0.200	0.070
Ltranin1	-0.003	0.997	0.096	0.974	0.071	1.073	0.084	0.401
p1v5	-0.305	0.737	0.390	0.433	-0.969	0.379	0.306	0.002
p1v63	0.469	1.599	0.429	0.274	0.899	2.458	0.334	0.007
_cons	3.340		3.960	0.399	-0.817		2.927	0.780
Group	*Off-farm wage employment only*				*Off-farm wage employment only*			
Age	0.040	1.041	0.158	0.798	0.113	1.120	0.105	0.281
age2	-0.0004	1.000	0.002	0.805	-0.001	0.999	0.001	0.391
Dyear	-2.637	0.072	0.555	0.000	-1.501	0.223	0.322	0.000
Dden	-2.329	0.097	0.638	0.000	-1.560	0.210	0.367	0.000
Educt	-0.745	0.475	0.718	0.300	-0.706	0.493	0.451	0.117
Educm	-0.822	0.440	0.592	0.165	0.084	1.088	0.430	0.845
Lfarmqf2	-0.326	0.722	0.114	0.004	-0.233	0.792	0.080	0.004
Landc	0.113	1.119	0.060	0.061	0.171	1.186	0.054	0.002
ltanim1	0.299	1.349	0.178	0.092	0.084	1.088	0.104	0.418
p6v25	-0.804	0.448	0.238	0.001	-0.474	0.622	0.224	0.034
Ltranin1	-0.067	0.935	0.092	0.467	0.007	1.007	0.073	0.923
p1v5	0.613	1.846	0.357	0.086	-0.051	0.951	0.231	0.827
p1v63	-0.195	0.823	0.396	0.622	0.235	1.265	0.260	0.366
_cons	4.954		3.680	0.178	0.797		2.407	0.740
Group	*Both ff-farm wage and self-employment*				*Off-farm self-employment only*			
Age	-0.073	0.930	0.158	0.645	0.073	1.075	0.158	0.645
age2	0.001	1.001	0.002	0.747	-0.001	0.999	0.002	0.747
Dyear	-1.136	0.321	0.566	0.045	1.136	3.115	0.566	0.045
Dden	-0.770	0.463	0.651	0.237	0.770	2.159	0.651	0.237
Educt	-0.039	0.962	0.696	0.956	0.039	1.040	0.696	0.956
Educm	-0.906	0.404	0.603	0.133	0.906	2.475	0.603	0.133
Lfarmqf2	-0.093	0.912	0.116	0.424	0.093	1.097	0.116	0.424
Landc	-0.058	0.943	0.071	0.413	0.058	1.060	0.071	0.413
Ltanim1	0.215	1.240	0.173	0.214	-0.215	0.806	0.173	0.214
p6v25	-0.329	0.719	0.204	0.106	0.329	1.390	0.204	0.106
Ltranin1	-0.074	0.929	0.092	0.424	0.074	1.077	0.092	0.424
p1v5	0.664	1.942	0.357	0.063	-0.664	0.515	0.357	0.063
p1v63	-0.430	0.651	0.396	0.278	0.430	1.537	0.396	0.278
_cons	4.157		3.622	0.251	-4.157		3.622	0.251

**P value is the minimum significant level that rejects the null hypothesis that the parameter is zero; Log likelihood = -361.35; χ^2 = 277.77; pseudo R^2 = 0.24; RRR is the relative risk ratio.*

Table A7.6 Estimates of marginal effect in a multinomial logit model of off-farm work choices (group zero and one as comparison groups)

	Comparison group=no off-farm group				Comparison group = off-farm wage employment only			
	Wage employment				No off-farm work			
	Coef.	Std. Err.	T	P>|T|	Coef.	Std. Err.	T	P>|T|
Group	*Wage employment*				**No off-farm work**			
Age	0.011	0.019	0.586	0.558	0.001	0.016	0.093	0.926
age2	-0.0002	0.0002	-0.804	0.421	0.0001	0.0002	0.411	0.681
Dyear	-0.370	0.060	-6.124	0	0.201	0.051	3.932	0.000
Dden	-0.144	0.067	-2.136	0.033	-0.079	0.056	-1.417	0.156
Educt	-0.140	0.088	-1.593	0.111	0.064	0.075	0.853	0.394
Educm	-0.135	0.074	-1.825	0.068	0.157	0.060	2.625	0.009
lfarmqf2	-0.022	0.013	-1.683	0.092	-0.011	0.011	-1.019	0.308
landc	0.015	0.004	4.300	0	0.005	0.002	3.483	0.000
ltanim1	-0.017	0.017	-0.990	0.322	0.039	0.013	2.921	0.003
p6v25	-0.161	0.045	-3.588	0	0.118	0.032	3.741	0.000
ltranin1	-0.009	0.014	-0.640	0.522	0.010	0.011	0.899	0.369
p1v5	0.125	0.046	2.709	0.007	-0.145	0.041	-3.537	0.000
p1v63	-0.070	0.050	-1.393	0.164	0.111	0.044	2.524	0.012
_cons	0.355	0.451	0.786	0.432	-0.214	0.385	-0.555	0.579
Group	*Self-employment only*				*Self-employment only*			
Age	-0.001	0.004	-0.157	0.876	-0.001	0.004	-0.157	0.876
age2	0.000004	0.00004	0.105	0.916	0.000004	0.00004	0.105	0.916
Dyear	0.051	0.020	2.525	0.012	0.051	0.020	2.525	0.012
Dden	0.052	0.020	2.599	0.009	0.052	0.020	2.599	0.009
Educt	0.013	0.017	0.769	0.442	0.013	0.017	0.769	0.442
Educm	0.015	0.014	1.097	0.273	0.015	0.014	1.097	0.273
Lfarmqf2	0.007	0.003	2.416	0.016	0.007	0.003	2.416	0.016
Landc	-0.002	0.001	-1.678	0.093	-0.002	0.001	-1.678	0.093
ltanim1	-0.008	0.004	-1.839	0.066	-0.008	0.004	-1.839	0.066
p6v25	0.014	0.007	2.034	0.042	0.014	0.007	2.034	0.042
ltranin1	0.001	0.002	0.631	0.528	0.001	0.002	0.631	0.528
p1v5	-0.010	0.009	-1.150	0.25	-0.010	0.009	-1.150	0.250
p1v63	0.002	0.009	0.236	0.814	0.002	0.009	0.236	0.814
_cons	-0.109	0.088	-1.240	0.215	-0.109	0.088	-1.240	0.215
Group	*Both off-farm wage and self-employment*				*Both off-farm wage and self-employment*			
Age	-0.012	0.011	-1.107	0.268	-0.012	0.011	-1.107	0.268
age2	0.0001	0.0001	0.769	0.442	0.0001	0.0001	0.769	0.442
Dyear	0.118	0.040	2.983	0.003	0.118	0.040	2.983	0.003
Dden	0.170	0.042	4.022	0	0.170	0.042	4.022	0.000
Educt	0.062	0.048	1.304	0.192	0.062	0.048	1.304	0.192
Educm	-0.037	0.046	-0.810	0.418	-0.037	0.046	-0.810	0.418
Lfarmqf2	0.025	0.007	3.392	0.001	0.025	0.007	3.392	0.001
Landc	-0.019	0.004	-4.558	0	-0.019	0.004	-4.558	0.000
Ltanim1	-0.014	0.011	-1.298	0.194	-0.014	0.011	-1.298	0.194
p6v25	0.029	0.022	1.293	0.196	0.029	0.022	1.293	0.196
Ltranin1	-0.003	0.008	-0.345	0.73	-0.003	0.008	-0.345	0.730
p1v5	0.031	0.024	1.284	0.199	0.031	0.024	1.284	0.199
p1v63	-0.044	0.028	-1.582	0.114	-0.044	0.028	-1.582	0.114
_cons	-0.032	0.253	-0.126	0.9	-0.032	0.253	-0.126	0.900

**P value is the minimum significant level that rejects the null hypothesis that the parameter is zero; Log likelihood = -361.35; χ^2 = 138.29; pseudo R^2 = 0.24;*

Table A7.7 Estimates of marginal effect in a multinomial logit model of off-farm work choices (group two and three as comparison groups)

	Comparison group = off-farm self-employment only				Comparison group = both wage and self-employment			
	Coef.	Std. Err.	T	P>|T|	Coef.	Std. Err.	T	P>|T|
Group	*no off-farm work*				*No off-arm work*			
Age	0.001	0.016	0.093	0.926	0.001	0.016	0.093	0.926
age2	0.0001	0.0002	0.411	0.681	0.0001	0.0002	0.411	0.681
dyear	0.201	0.051	3.932	0.000	0.201	0.051	3.932	0.000
dden	-0.079	0.056	-1.417	0.156	-0.079	0.056	-1.417	0.156
educt	0.064	0.075	0.853	0.394	0.064	0.075	0.853	0.394
educm	0.157	0.060	2.625	0.009	0.157	0.060	2.625	0.009
lfarmqf2	-0.011	0.011	-1.019	0.308	-0.011	0.011	-1.019	0.308
landc	0.005	0.002	3.483	0.000	0.005	0.002	3.483	0.000
ltanim1	0.039	0.013	2.921	0.003	0.039	0.013	2.921	0.003
p6v25	0.118	0.032	3.741	0.000	0.118	0.032	3.741	0.000
ltranin1	0.010	0.011	0.899	0.369	0.010	0.011	0.899	0.369
p1v5	-0.145	0.041	-3.537	0.000	-0.145	0.041	-3.537	0.000
p1v63	0.111	0.044	2.524	0.012	0.111	0.044	2.524	0.012
_cons	-0.214	0.385	-0.555	0.579	-0.214	0.385	-0.555	0.579
Group	Off-farm wage employment only				Off-farm wage employment only			
Age	0.011	0.019	0.586	0.558	0.011	0.019	0.586	0.558
age2	-0.000	0.000	-0.804	0.421	-0.0002	0.0002	-0.804	0.421
Dyear	-0.370	0.060	-6.124	0.000	-0.370	0.060	-6.124	0.000
Dden	-0.144	0.067	-2.136	0.033	-0.144	0.067	-2.136	0.033
Educt	-0.140	0.088	-1.593	0.111	-0.140	0.088	-1.593	0.111
Educm	-0.135	0.074	-1.825	0.068	-0.135	0.074	-1.825	0.068
Lfarmqf2	-0.022	0.013	-1.683	0.092	-0.022	0.013	-1.683	0.092
Landc	0.015	0.004	4.300	0.000	0.015	0.004	4.300	0.000
ltanim1	-0.017	0.017	-0.990	0.322	-0.017	0.017	-0.990	0.322
p6v25	-0.161	0.045	-3.588	0.000	-0.161	0.045	-3.588	0.000
Ltranin1	-0.009	0.014	-0.640	0.522	-0.009	0.014	-0.640	0.522
p1v5	0.125	0.046	2.709	0.007	0.125	0.046	2.709	0.007
p1v63	-0.070	0.050	-1.393	0.164	-0.070	0.050	-1.393	0.164
_cons	0.355	0.451	0.786	0.432	0.355	0.451	0.786	0.432
Group	*both off-farm wage and self employment*				*Off-farm self-employment only*			
Age	-0.012	0.011	-1.107	0.268	-0.001	0.004	-0.157	0.876
age2	0.0001	0.0001	0.769	0.442	0.000004	0.00004	0.105	0.916
Dyear	0.118	0.040	2.983	0.003	0.051	0.020	2.525	0.012
Dden	0.170	0.042	4.022	0.000	0.052	0.020	2.599	0.009
Educt	0.062	0.048	1.304	0.192	0.013	0.017	0.769	0.442
Educm	-0.037	0.046	-0.810	0.418	0.015	0.014	1.097	0.273
Lfarmqf2	0.025	0.007	3.392	0.001	0.007	0.003	2.416	0.016
Landc	-0.019	0.004	-4.558	0.000	-0.002	0.001	-1.678	0.093
ltanim1	-0.014	0.011	-1.298	0.194	-0.008	0.004	-1.839	0.066
p6v25	0.029	0.022	1.293	0.196	0.014	0.007	2.034	0.042
ltranin1	-0.003	0.008	-0.345	0.730	0.001	0.002	0.631	0.528
p1v5	0.031	0.024	1.284	0.199	-0.010	0.009	-1.150	0.250
p1v63	-0.044	0.028	-1.582	0.114	0.002	0.009	0.236	0.814
_cons	-0.032	0.253	-0.126	0.900	-0.109	0.088	-1.240	0.215

**P value is the minimum significant level that rejects the null hypothesis that the parameter is zero; Log likelihood = -361.35; χ^2 = 138.29; pseudo R^2 = 0.24;*

Appendix A8 Estimation of crop choice, labour and land allocation equations presented in Chapter 8

AppendixA8.1 Description of variables used in the econometric estimations

Variables	Description
AGE	Age of the household head
AGE2	Age squared of household head
BAKELP	Proportion of loam (bakel) soil cultivated
BARCSH	Share of barley in total consumption
BARVINB	Value of variable input used for barley
BARYKF	Barley yield in kilogram
DEPRAT	Dependency ratio
DFMYKF	Sorghum and finger millet yield in kilogram
DTAA	Dummy for Tabia Araasegda
DTAF	Dummy for Tabia Fekre alem
DTEF	Dummy for Tabia Felegeselam
DTEM	Dummy for Tabia Mytsedo
DYEAR	Year dummy (1996=1, 1997=0)
EDUCH	Education dummy (head read and write=1, 0 otherwise)
EDUCW	Education dummy (wife read and write=1, 0 otherwise)
HUTSAP	Proportion of sandy soil (Hutsa) cultivated
IMR	Inverse mills ratio
LEGCSHF	Share of legumes in total consumption
LEGLAN	Land allocated to legumes
LEGVINB	Value of variable input used for legumes
LEGYKF	Legume crops yield in kilogram
NFHF	Hours worked off the farm (fitted value)
NFIN1	Non-farm income (Birr)
NFIN1F	Non-farm income
NFIN1F0	Non-farm income in 100 Birr (fitted value)
OILCSHF	Share of oil crop in total consumption
OILVINB	Value of variable input used for oil crops
OILYKF	Oil crops yield in kilogram
P1V5	Family size
P1V63	Number of dependants
P2V2	Value of farm implements (replacement cost in Birr)
P5V67	Land allocated to barley
P5V68	Labour hours allocated to barley
P5V79	Land allocated to oil crops
P5V80	Labour hours allocated to oil crops
P6V1	The number of oxen owned
P6V2	Value of oxen owned IN Birr (at replacement cost)
P6V26	Value of transport animal owned (at replacement cost)
RHO(1,2)	Correlation between the error terms of the probability of buying and selling farm outputs
SFMCSHF	Share of sorghum and finger millet in total consumption
SFMLAN	Land allocated to sorghum and finger millet
SFMVINB	Value of variable input used for sorghum and finger millet
Sigma	Standard error
SOILI	Soil depth index
TANIM	Total livestock wealth
TANIM0	Total livestock wealth in 1000 Birr
TEFCSHF	Share of teff in total consumption
TEFLAN	Land allocated to teff
TEFVINB	Value of variable input used for teff
TEFYKF	Teff yield in kilogram
TEQUIP	Total value of equipment households own in Birr
TEQUIP0	Total value of equipment households own in 1000 Birr
TLANDCR	Total land allocated to crops in tsimdi (one hectare = 4 tsimdi)
TYLDB1F	Fitted value of crop output in Birr
VEGCSHF	Share of vegetables in total consumption
VEGLAN	Land allocated to vegetables
VEGVINB	Value of variable input used for vegetables
VEGYKF	Vegetables yield in kilogram
WALKAP	Proportion of clay (walka) soil cultivated
WHTCSHF	Share of wheat in total consumption
WHTLAN	Land allocated to wheat
WHTVINB	Value of variable input used for wheat
WHTYKF	Wheat yield in kilogram

One US Dollar was equivalent to seven Birr during the time of surveying

Appendix A8.2 Logit model of probability of growing crops using instrumental variable approach

Table A8.2.1 Logit Model of Probability of growing teff

	Coef.	Std. Err.	T-ratio	P>|T|	Marginal
Age	0.091	0.106	0.860	0.390	0.019
age2	-0.001	0.001	-1.366	0.172	-0.0003
p1v5	0.100	0.130	0.767	0.443	0.021
Deprat	-0.804	0.990	-0.812	0.417	-0.171
Dyear	-0.986	0.337	-2.925	0.003	-0.209
Dtaa	0.490	0.546	0.898	0.369	0.104
Dtaf	0.972	0.704	1.380	0.168	0.206
Dtef	-0.720	0.521	-1.381	0.167	-0.153
Dtem	0.305	0.582	0.524	0.601	0.065
Walkap	1.250	0.618	2.023	0.043	0.265
Hutsap	0.079	0.491	0.160	0.873	0.017
Soili	1.738	0.561	3.096	0.002	0.369
Nfin1f	0.0003	0.001	0.629	0.529	0.0001
p2v2	0.003	0.002	2.003	0.045	0.001
p6v1	-0.035	0.118	-0.296	0.767	-0.007
Tlandcr	0.180	0.053	3.406	0.001	0.038
Tefcshf	7.279	6.352	1.146	0.252	1.545
Constant	-5.022	2.574	-1.951	0.051	-1.066

Table A8.2.2 Logit Model of Probability of growing wheat

	Coef.	Std. Err.	T	P>|T|	Marginal
Age	-0.138	0.101	-1.365	0.172	-0.026
age2	0.002	0.001	1.551	0.121	0.0003
p1v5	0.147	0.145	1.018	0.308	0.028
Deprat	0.848	1.019	0.832	0.405	0.160
Dyear	0.206	0.344	0.601	0.548	0.039
Dtaa	-0.680	0.582	-1.167	0.243	-0.128
Dtaf	-1.196	0.798	-1.499	0.134	-0.225
Dtef	-0.181	0.588	-0.308	0.758	-0.034
Dtem	0.541	0.636	0.851	0.395	0.102
Walkap	-0.226	0.593	-0.382	0.702	-0.043
Hutsap	1.040	0.513	2.028	0.043	0.196
Soili	0.786	0.537	1.463	0.143	0.148
nfin1f	-0.001	0.001	-1.213	0.225	-0.0001
p2v2	-0.001	0.002	-0.340	0.733	-0.0001
p6v1	0.231	0.192	1.202	0.229	0.044
Tlandcr	0.249	0.060	4.150	0.000	0.047
Whtcshf	0.842	6.696	0.126	0.900	0.159
Constant	0.948	2.817	0.337	0.736	0.179

Table A8.2.3 Logit Model of Probability of growing barley

	Coef.	Std. Err.	T	P>|T|	Marginal
Age	0.046	0.123	0.378	0.706	0.004
age2	-0.001	0.001	-0.462	0.644	-0.00004
p1v5	0.207	0.186	1.110	0.267	0.016
Deprat	-0.185	1.219	-0.152	0.879	-0.014
Dyear	0.093	0.486	0.192	0.848	0.007
Dtaa	-0.919	0.798	-1.152	0.249	-0.071
Dtaf	-1.726	1.165	-1.481	0.139	-0.134
Dtef	-0.630	0.807	-0.780	0.435	-0.049
Dtem	-0.496	0.817	-0.607	0.544	-0.038
Walkap	0.337	0.802	0.420	0.675	0.026
Hutsap	0.961	0.628	1.532	0.125	0.075
Soili	1.846	0.687	2.687	0.007	0.143
nfin1f	-0.001	0.001	-1.155	0.248	-0.0001
p2v2	-0.005	0.002	-2.533	0.011	-0.0004
p6v1	0.662	0.269	2.458	0.014	0.051
Tlandcr	0.372	0.094	3.948	0.000	0.029
Barcshf	11.259	6.885	1.635	0.102	0.873
Constant	-3.419	3.327	-1.028	0.304	-0.265

Table A8.2.4 Logit Model of Probability of growing sorghum and finger millet

	Coef.	Std. Err.	T	P>|T|	Marginal
Age	0.067	0.132	0.505	0.614	0.003
age2	-0.001	0.001	-0.655	0.513	-0.00004
p1v5	0.241	0.172	1.405	0.160	0.011
Deprat	-2.098	1.431	-1.466	0.143	-0.096
Dyear	2.663	0.554	4.804	0.000	0.121
Dtaa	1.317	0.659	1.999	0.046	0.060
Dtaf	1.069	0.898	1.190	0.234	0.049
Dtef	-2.708	1.137	-2.383	0.017	-0.123
Dtem	-1.957	0.974	-2.009	0.045	-0.089
Walkap	-1.151	0.823	-1.398	0.162	-0.052
Hutsap	0.892	0.651	1.370	0.171	0.041
Soili	0.450	0.712	0.632	0.527	0.020
nfin1f	-0.0002	0.001	-0.329	0.743	-0.00001
p2v2	-0.0001	0.001	-0.119	0.905	-0.00001
p6v1	0.015	0.197	0.077	0.938	0.001
Tlandcr	0.116	0.053	2.184	0.029	0.005
Sfmcshf	-17.542	36.637	-0.479	0.632	-0.799
Constant	-5.985	3.505	-1.707	0.088	-0.273

Table A8.2.5 Logit Model of Probability of growing legumes

	Coef.	Std Err.	T	P>|T|	Marginal
Age	0.006	0.103	0.055	0.956	0.001
age2	-0.0003	0.001	-0.285	0.776	-0.0001
p1v5	0.137	0.124	1.106	0.269	0.032
Deprat	-0.803	1.063	-0.755	0.450	-0.187
Dyear	-0.110	0.313	-0.352	0.725	-0.026
Dtaa	-0.003	0.512	-0.006	0.995	-0.001
Dtaf	-0.526	0.660	-0.796	0.426	-0.122
Dtef	-0.039	0.498	-0.079	0.937	-0.009
Dtem	0.111	0.521	0.214	0.831	0.026
Walkap	1.845	0.576	3.202	0.001	0.429
Hutsap	0.135	0.525	0.258	0.796	0.031
Soili	0.491	0.601	0.816	0.414	0.114
nfin1f	-0.0001	0.0005	-0.257	0.797	-0.00003
p2v2	-0.001	0.001	-0.525	0.599	-0.0001
p6v1	-0.200	0.163	-1.227	0.220	-0.046
Tlandcr	0.352	0.054	6.527	0.000	0.082
Legcshf	13.245	96.826	0.137	0.891	3.077
Constant	-3.639	5.525	-0.659	0.510	-0.845

Table A8.2.6 Logit Model of Probability of growing oil crops

	Coef.	Std Err.	T	P>|T|	Marginal
Age	0.060	0.170	0.350	0.726	0.004
age2	-0.0005	0.002	-0.280	0.779	-0.00003
p1v5	0.017	0.180	0.096	0.924	0.001
Deprat	2.356	1.772	1.330	0.184	0.141
Dyear	-0.037	0.438	-0.085	0.933	-0.002
Dtaa	0.029	0.741	0.039	0.969	0.002
Dtaf	-1.194	0.910	-1.311	0.190	-0.071
Dtef	0.223	0.763	0.293	0.770	0.013
Dtem	0.866	0.779	1.112	0.266	0.052
Walkap	0.893	0.824	1.084	0.278	0.053
Hutsap	1.057	0.758	1.394	0.163	0.063
Soili	1.094	0.884	1.237	0.216	0.065
nfin1f	-0.001	0.001	-1.999	0.046	-0.0001
p2v2	-0.003	0.002	-1.560	0.119	-0.0002
p6v1	-0.001	0.190	-0.003	0.998	-0.00003
Tlandcr	0.077	0.054	1.408	0.159	0.005
Oilcshf	-0.587	168.442	-0.003	0.997	-0.035
Constant	-4.869	4.418	-1.102	0.270	-0.291

Table A8.2.7 Logit Model of Probability of growing vegetables

	Coef.	Std Err.	T	P>|T|	Marginal
Age	0.645	0.284	2.269	0.023	0.021
Age2	-0.006	0.003	-2.307	0.021	-0.0002
p1v5	-0.503	0.272	-1.847	0.065	-0.016
Deprat	2.644	1.927	1.372	0.170	0.087
Dyear	-0.632	0.531	-1.189	0.234	-0.021
Dtaa	-1.095	0.820	-1.336	0.182	-0.036
Dtaf	-1.989	1.135	-1.752	0.080	-0.065
Dtem	-1.286	0.862	-1.491	0.136	-0.042
Walkap	2.830	1.131	2.501	0.012	0.093
Hutsap	3.504	0.977	3.587	0.000	0.115
Soili	2.055	1.283	1.601	0.109	0.067
Nfin1f	0.001	0.001	0.927	0.354	0.00003
p2v2	0.001	0.001	0.445	0.656	0.00002
p6v1	-0.208	0.276	-0.755	0.450	-0.007
Tlandcr	-0.007	0.074	-0.088	0.929	-0.0002
Vegcshf	-2647.5	884.577	-2.993	0.003	-86.782
Constant	-17.090	7.132	-2.396	0.017	-0.560

Appendix A8.3 Parameter estimates of Tobit model for the land allocation of different crops

Table A8.3.1 Parameter estimates of share of land allocated to teff

	Coef.	Std. Err.	T	P>|t|	Marginal
Nfin1f0	-0.0043	0.0015	-2.9490	0.0030	-0.0028
Tanim0	-0.0004	0.0019	-0.2130	0.8320	-0.0003
Tequip0	-0.0339	0.0140	-2.4240	0.0160	-0.0219
Tlandcr	-0.0236	0.0024	-9.7610	0.0000	-0.0152
Tefykf	0.0015	0.0001	21.3990	0.0000	0.0009
Tefcshf	-0.0371	0.2926	-0.1270	0.8990	-0.0239
p1v63	-0.0116	0.0124	-0.9330	0.3520	-0.0075
p1v5	0.0206	0.0118	1.7440	0.0820	0.0133
Educh	-0.0032	0.0169	-0.1880	0.8510	-0.0021
Dyear	-0.1485	0.0176	-8.4530	0.0000	-0.0957
Walkap	0.1194	0.0331	3.6120	0.0000	0.0769
Hutsap	0.0746	0.0286	2.6110	0.0090	0.0481
Soili	0.1150	0.0309	3.7250	0.0000	0.0741
Constant	0.0309	0.0492	0.6280	0.5310	
Sigma	0.1318	0.0061			

Table A8.3.2 Parameter estimates of share of land allocated to wheat

	Coef.	Std. Err.	T	P>|t|	marginal
Nfin1f0	-0.0046	0.0016	-2.9240	0.0040	-0.0031
Tanim0	0.0003	0.0017	0.1980	0.8430	0.0002
Tequip	-0.0306	0.0149	-2.0620	0.0400	-0.0207
Tlandcr	-0.0275	0.0029	-9.4000	0.0000	-0.0186
Whtykf	0.0007	0.0000	20.6170	0.0000	0.0005
Whtcshf	0.5818	0.3870	1.5030	0.1340	0.3922
p1v63	-0.0317	0.0129	-2.4590	0.0140	-0.0214
p1v5	0.0445	0.0126	3.5320	0.0000	0.0300
Educh	0.0140	0.0178	0.7860	0.4320	0.0095
Dyear	-0.0658	0.0183	-3.6020	0.0000	-0.0444
Walkap	0.0612	0.0357	1.7120	0.0880	0.0412
Hutsap	0.1190	0.0296	4.0170	0.0000	0.0802
Soili	0.1916	0.0321	5.9770	0.0000	0.1292
Constant	-0.1189	0.0821	-1.4470	0.1490	
Sigma	0.1449	0.0067			

Table A8.3.3 Parameter estimates of share of land allocated to barley

	Coef.	Std. Err.	T	P>|t|	marginal
nfin1f0	-0.0104	0.0022	-4.8190	0.0000	-0.0084
Tanim0	-0.0053	0.0024	-2.1460	0.0330	-0.0042
Tequip	-0.0593	0.0207	-2.8600	0.0040	-0.0476
Tlandcr	-0.0177	0.0038	-4.7040	0.0000	-0.0142
Barykf	0.0004	0.0000	12.6300	0.0000	0.0003
Barcshf	0.2037	0.3747	0.5440	0.5870	0.1637
p1v63	-0.0222	0.0181	-1.2240	0.2220	-0.0178
p1v5	0.0329	0.0172	1.9160	0.0560	0.0265
educh	-0.0123	0.0249	-0.4960	0.6210	-0.0099
dyear	-0.0937	0.0255	-3.6700	0.0000	-0.0753
walkap	0.0475	0.0495	0.9610	0.3370	0.0382
hutsap	0.1078	0.0415	2.5940	0.0100	0.0866
soili	0.2690	0.0446	6.0370	0.0000	0.2161
Constant	0.0783	0.0898	0.8720	0.3840	
Sigma	0.2084	0.0086			

Table A8.3.4 Parameter estimates of share of land allocated to sorghum and f millet

	Coef.	Std. Err.	T	P>|t|	marginal
nfin1f0	-0.0025	0.0035	-0.7140	0.4760	-0.0004
tanim0	0.0022	0.0037	0.5880	0.5570	0.0003
tequip	0.0005	0.0460	0.0110	0.9910	0.0001
tlandcr	-0.0237	0.0058	-4.1200	0.0000	-0.0034
sfmykf	0.0015	0.0001	12.4920	0.0000	0.0002
sfmcshf	-1.3995	3.7026	-0.3780	0.7060	-0.1984
p1v63	-0.0328	0.0260	-1.2600	0.2080	-0.0046
p1v5	0.0344	0.0248	1.3870	0.1660	0.0049
educh	0.0070	0.0354	0.1990	0.8420	0.0010
dyear	0.0704	0.0460	1.5310	0.1270	0.0100
walkap	0.0487	0.0711	0.6850	0.4940	0.0069
hutsap	0.0403	0.0571	0.7060	0.4810	0.0057
soili	0.0764	0.0588	1.3000	0.1940	0.0108
Constant	-0.3196	0.0895	-3.5720	0.0000	
Sigma	0.1486	0.0149			

Table A8.3.5 Parameter estimates of share of land allocated to legumes

	Coef.	Std. Err.	T	P>|t|	Marginal
nfin1f0	0.0016	0.0016	0.9500	0.3430	0.0006
tanim0	0.00003	0.0020	0.0160	0.9870	0.00001
Tequip	-0.0368	0.0171	-2.1480	0.0320	-0.00002
Tlandcr	-0.0147	0.0028	-5.2230	0.0000	-0.0060
Legykf	0.0015	0.0001	18.5990	0.0000	0.0006
Legcshf	-3.6485	3.9717	-0.9190	0.3590	-1.4884
p1v63	-0.0194	0.0146	-1.3310	0.1840	-0.0079
p1v5	0.0198	0.0139	1.4190	0.1570	0.0081
Educh	0.0227	0.0193	1.1750	0.2410	0.0093
Dyear	-0.0728	0.0188	-3.8600	0.0000	-0.0297
Walkap	0.0924	0.0389	2.3770	0.0180	0.0377
Hutsap	0.0086	0.0342	0.2510	0.8020	0.0035
Soili	0.1268	0.0371	3.4130	0.0010	0.0517
Constant	0.0105	0.1968	0.0530	0.9580	
Sigma	0.1332	0.0080			

Table A8.3.6 Parameter estimates of share of land allocated to oil crops

	Coef.	Std. Err.	T	P>|t|	marginal
nfin1f0	0.0007	0.0023	0.3100	0.7570	0.0001
tanim0	-0.0004	0.0015	-0.2980	0.7660	-0.00004
tequip	0.0082	0.0196	0.4170	0.6770	0.0008
tlandcr	-0.0067	0.0039	-1.7210	0.0860	-0.0006
oilykf	0.0038	0.0003	11.6580	0.0000	0.0004
oilcshf	-9.5240	7.3016	-1.3040	0.1930	-0.8766
p1v63	0.0139	0.0204	0.6790	0.4980	0.0013
p1v5	-0.0171	0.0197	-0.8650	0.3880	-0.0016
educh	0.0233	0.0211	1.1070	0.2690	0.0021
dyear	-0.0507	0.0246	-2.0610	0.0400	-0.0047
walkap	0.0482	0.0390	1.2360	0.2170	0.0044
hutsap	0.0036	0.0397	0.0920	0.9270	0.0003
soili	0.0570	0.0457	1.2460	0.2130	0.0052
Constant	-0.1093	0.0630	-1.7370	0.0830	
Sigma	0.0748	0.0091			

Table A8.3.7 Parameter estimates of share of land allocated to vegetables

	Coef.	Std. Err.	T	P>|t|	Marginal
nfin1f0	-0.0004	0.0025	-0.1750	0.8610	-0.00003
tanim0	-0.0001	0.0036	-0.0410	0.9670	-0.00001
tequip	-0.0133	0.0175	-0.7590	0.4480	-0.0010
tlandcr	-0.0007	0.0038	-0.1910	0.8490	-0.0001
vegykf	0.0004	0.0000	8.0170	0.0000	0.00003
vegcshf	-38.6948	47.8076	-0.8090	0.4190	-2.7914
p1v63	-0.0004	0.0231	-0.0160	0.9870	-0.00003
p1v5	0.0040	0.0227	0.1750	0.8610	0.0003
educh	-0.0515	0.0292	-1.7640	0.0790	-0.0037
dyear	-0.0572	0.0267	-2.1470	0.0320	-0.0041
walkap	0.0831	0.0562	1.4790	0.1400	0.0060
hutsap	0.1222	0.0515	2.3730	0.0180	0.0088
soili	0.0205	0.0568	0.3610	0.7180	0.0015
Constant	-0.1901	0.0953	-1.9940	0.0470	
Sigma	0.0823	0.0120			

Appendix A8.4 Parameter estimates of tobit model of labour allocation for different crops

Table A8.4.1 Parameter estimates of labour allocation for teff

	Coef.	Std. Err.	T	P>|t|	Uncond. marginal	Cond. Marginal
Age	8.749	8.067	1.085	0.279	5.637	3.952
age2	-0.103	0.081	-1.271	0.205	-0.066	-0.047
p1v5	8.682	9.820	0.884	0.377	5.593	3.922
Deprat	-16.085	89.731	-0.179	0.858	-10.363	-7.266
Dyear	37.310	22.810	1.636	0.103	24.038	16.853
Dtaa	-150.663	40.344	-3.734	0.000	-97.069	-68.056
Dtaf	-180.385	42.598	-4.235	0.000	-116.218	-81.482
Dtef	27.585	40.938	0.674	0.501	17.773	12.461
Dtem	11.235	39.024	0.288	0.774	7.239	5.075
Walkap	-10.175	49.868	-0.204	0.838	-6.556	-4.596
Hutsap	18.361	42.963	0.427	0.669	11.830	8.294
Soili	170.414	48.308	3.528	0.000	109.794	76.978
Nfhf	-0.088	0.029	-2.998	0.003	-0.057	-0.040
p2v2	0.251	0.080	3.149	0.002	0.162	0.114
p6v2	-0.001	0.013	-0.095	0.924	-0.001	-0.001
Teflan	172.977	11.956	14.467	0.000	111.445	78.135
Tefvinb	0.116	0.201	0.576	0.565	0.074	0.052
Constant	-318.273	194.010	-1.640	0.102		
Sigma	187.389	8.384				

Table A8.4.2 Parameter estimates of labour allocation for wheat

	Coef.	Std. Err.	t	P>|t|	Uncond. marginal	Cond. Marginal
Age	2.064	6.145	0.336	0.737	1.391	0.976
age2	-0.019	0.061	-0.307	0.759	-0.013	-0.009
p1v5	15.729	7.743	2.031	0.043	10.603	7.441
Deprat	-10.893	69.138	-0.158	0.875	-7.343	-5.153
Dyear	-11.300	17.286	-0.654	0.514	-7.618	-5.346
Dtaa	-67.930	29.705	-2.287	0.023	-45.794	-32.138
Dtaf	-100.508	32.511	-3.092	0.002	-67.755	-47.550
Dtef	-68.813	32.920	-2.090	0.037	-46.389	-32.555
Dtem	-14.401	31.286	-0.460	0.646	-9.708	-6.813
Walkap	13.910	38.860	0.358	0.721	9.377	6.581
Hutsap	54.963	32.772	1.677	0.094	37.052	26.003
Soili	101.742	36.966	2.752	0.006	68.587	48.134
Nfhf	-0.052	0.024	-2.130	0.034	-0.035	-0.025
p2v2	-0.134	0.063	-2.120	0.035	-0.090	-0.063
p6v2	0.018	0.010	1.699	0.090	0.012	0.008
Whtlan	66.483	7.098	9.366	0.000	44.818	31.453
Whtvinb	0.186	0.065	2.841	0.005	0.125	0.088
Constant	-161.198	150.387	-1.072	0.284		
Sigma	148.864	6.365				

Table A8.4.3 Parameter estimates of labour allocation for barley

	Coef.	Std. Err.	T	P>|t|	Uncond. marginal	Cond. Marginal
Age	2.261	3.182	0.711	0.478	1.822	1.332
age2	-0.024	0.032	-0.738	0.461	-0.019	-0.014
p1v5	4.374	3.970	1.102	0.271	3.525	2.577
Deprat	-18.418	35.177	-0.524	0.601	-14.844	-10.854
Dyear	18.701	9.221	2.028	0.043	15.072	11.021
Dtaa	-38.506	15.667	-2.458	0.014	-31.035	-22.692
Dtaf	-50.054	17.245	-2.903	0.004	-40.342	-29.497
Dtef	-4.187	16.633	-0.252	0.801	-3.375	-2.468
Dtem	13.537	16.075	0.842	0.400	10.910	7.977
Walkap	26.560	20.003	1.328	0.185	21.407	15.652
Hutsap	42.936	16.793	2.557	0.011	34.605	25.303
Soili	55.177	18.583	2.969	0.003	44.471	32.517
Nfhf	-0.031	0.012	-2.469	0.014	-0.025	-0.018
p2v2	0.032	0.034	0.931	0.352	0.026	0.019
p6v2	-0.003	0.005	-0.607	0.544	-0.003	-0.002
p5v67	52.610	3.364	15.638	0.000	42.402	31.004
Barvinb	0.203	0.032	6.352	0.000	0.164	0.120
Constant	-91.153	77.629	-1.174	0.241		
Sigma	80.126	3.158				

Table A8.4.4 Parameter estimates of labour allocation for sorghum and finger millet

	Coef.	Std. Err.	T	P>|t|	Uncond. marginal	Cond. Marginal
Age	19.547	11.016	1.774	0.077	2.772	3.731
age2	-0.200	0.111	-1.808	0.071	-0.028	-0.038
p1v5	8.913	12.409	0.718	0.473	1.264	1.701
Deprat	-132.501	103.686	-1.278	0.202	-18.787	-25.287
Dyear	63.597	32.026	1.986	0.048	9.017	12.137
Dtaa	-0.201	41.343	-0.005	0.996	-0.028	-0.038
Dtaf	-68.407	49.309	-1.387	0.166	-9.700	-13.055
Dtef	-141.196	69.112	-2.043	0.042	-20.020	-26.947
Dtem	-78.878	56.285	-1.401	0.162	-11.184	-15.054
Walkap	-26.794	61.919	-0.433	0.665	-3.799	-5.114
Hutsap	42.544	49.008	0.868	0.386	6.032	8.119
Soili	84.080	55.493	1.515	0.131	11.922	16.046
Nfhf	-0.037	0.036	-1.027	0.305	-0.005	-0.007
p2v2	-0.169	0.109	-1.550	0.122	-0.024	-0.032
p6v2	0.005	0.015	0.304	0.761	0.001	0.001
Sfmlan	77.274	12.101	6.386	0.000	10.957	14.748
Sfmvinb	2.922	0.779	3.751	0.000	0.414	0.558
Constant	-629.139	269.711	-2.333	0.020		
Sigma	132.254	13.812				

Table A8.4.5 Parameter estimates of labour allocation for legumes

	Coef.	Std. Err.	T	P>|t|	Uncond. marginal	Cond. Marginal
Age	-2.380	4.033	-0.590	0.555	-0.983	-0.757
age2	0.010	0.041	0.252	0.801	0.004	0.003
p1v5	4.417	4.976	0.888	0.375	1.824	1.405
Deprat	5.694	46.362	0.123	0.902	2.351	1.812
Dyear	7.866	10.738	0.733	0.464	3.248	2.503
Dtaa	1.447	19.181	0.075	0.940	0.598	0.460
Dtaf	0.906	21.350	0.042	0.966	0.374	0.288
Dtef	-19.548	20.668	-0.946	0.345	-8.072	-6.220
Dtem	12.088	19.518	0.619	0.536	4.992	3.846
Walkap	-3.598	25.031	-0.144	0.886	-1.486	-1.145
Hutsap	16.693	21.984	0.759	0.448	6.893	5.312
Soili	75.402	25.635	2.941	0.003	31.136	23.992
Nfhf	-0.024	0.015	-1.605	0.109	-0.010	-0.008
p2v2	0.006	0.036	0.156	0.876	0.002	0.002
p6v2	-0.006	0.007	-0.961	0.337	-0.003	-0.002
Leglan	70.540	6.579	10.722	0.000	29.129	22.445
Legvinb	0.497	0.100	4.965	0.000	0.205	0.158
Constant	-50.586	94.721	-0.534	0.594		
Sigma	78.807	4.401				

Table A8.4.6 Parameter estimates of labour allocation for oil crops (linseed)

	Coef.	Std. Err.	T	P>|t|	Uncond. marginal	Cond. Marginal
Age	0.741	4.444	0.167	0.868	0.068	0.122
age2	-0.002	0.044	-0.047	0.962	0.000	0.000
p1v5	-6.277	5.804	-1.081	0.280	-0.578	-1.034
Deprat	44.383	52.276	0.849	0.396	4.085	7.310
Dyear	-3.391	12.403	-0.273	0.785	-0.312	-0.558
Dtaa	37.785	25.994	1.454	0.147	3.478	6.223
Dtaf	40.728	25.107	1.622	0.106	3.749	6.708
Dtef	-19.943	32.487	-0.614	0.540	-1.836	-3.284
Dtem	40.151	26.276	1.528	0.127	3.695	6.613
Walkap	16.940	23.645	0.716	0.474	1.559	2.790
Hutsap	18.823	23.031	0.817	0.414	1.732	3.100
Soili	-12.976	27.776	-0.467	0.641	-1.194	-2.137
Nfhf	-0.010	0.018	-0.547	0.585	-0.001	-0.002
p2v2	0.046	0.042	1.099	0.272	0.004	0.008
p6v2	-0.005	0.007	-0.751	0.453	0.000	-0.001
p5v79	114.724	13.541	8.472	0.000	10.559	18.894
Oilvinb	0.339	0.315	1.076	0.283	0.031	0.056
Constant	-139.051	109.367	-1.271	0.204		
Sigma	44.639	5.651				

Table A8.4.7 Parameter estimates of labour allocation for vegetables

	Coef.	Std. Err.	T	P>|t|	Uncond. marginal	Cond. Marginal
Age	41.522	24.530	1.693	0.091	3.099	6.413
age2	-0.407	0.240	-1.695	0.091	-0.030	-0.063
p1v5	4.890	18.535	0.264	0.792	0.365	0.755
Deprat	97.788	173.268	0.564	0.573	7.298	15.103
Dyear	23.768	39.435	0.603	0.547	1.774	3.671
Dtaa	42.353	58.419	0.725	0.469	3.161	6.541
Dtaf	-165.948	74.085	-2.240	0.026	-12.384	-25.631
Dtef	-570.251	.	.	.	-42.556	-88.076
Dtem	-30.003	55.545	-0.540	0.589	-2.239	-4.634
Walkap	-181.797	110.227	-1.649	0.100	-13.567	-28.079
Hutsap	147.911	77.941	1.898	0.058	11.038	22.845
Soili	15.801	93.928	0.168	0.866	1.179	2.440
Nfhf	-0.114	0.053	-2.163	0.031	-0.008	-0.018
P2v2	0.052	0.112	0.461	0.645	0.004	0.008
P6v2	-0.031	0.028	-1.118	0.264	-0.002	-0.005
Veglan	339.750	49.511	6.862	0.000	25.355	52.475
Vegvinb	0.562	0.354	1.590	0.113	0.042	0.087
Constant	-1197.379	622.938	-1.922	0.055		
Sigma	119.864	16.330				

Appendix A8.5 Estimates of buying and selling equations

Table A8.5.1 Bivariate probit estimation of being Buyer and Seller (line 1-14 for buyers and 15 – 30 for sellers)

Variable	Coeffici	S.E	T-ratio	P>|T|
Constant	2.86210	1.68590	1.69800	0.08958
DTAA	-0.82876	0.49693	-1.66800	0.09536
DTAF	-0.73943	0.49648	-1.48900	0.13639
DTEF	-0.45957	0.53932	-0.85200	0.39414
DTEM	-0.53466	0.53124	-1.00600	0.31421
DYEAR	0.20726	0.25698	0.80600	0.41996
AGE	-0.05091	0.07244	-0.70300	0.48220
AGE2	0.00058	0.00074	0.78500	0.43261
EDUCH	-0.25803	0.21558	-1.19700	0.23134
P1V5	-0.11136	0.08968	-1.24200	0.21435
DEPRAT	1.43710	0.80619	1.78300	0.07466
P6V26	-0.00008	0.00011	-0.72600	0.46775
TYLDB1F	-0.00016	0.00009	-1.80600	0.07090
NFIN1	0.00032	0.00015	2.17400	0.02968
Constant	-1.42470	1.17600	-1.21100	0.22572
DTAA	-0.59702	0.23822	-2.50600	0.01220
DTAF	0.05711	0.25456	0.22400	0.82248
DTEF	0.00057	0.26203	0.00200	0.99825
DTEM	-0.28210	0.27685	-1.01900	0.30822
DYEAR	-0.07513	0.16040	-0.46800	0.63950
AGE	0.04408	0.05115	0.86200	0.38887
AGE2	-0.00042	0.00052	-0.82300	0.41072
EDUCH	0.04999	0.16444	0.30400	0.76114
P1V5	0.06218	0.05802	1.07200	0.28387
DEPRAT	-0.06697	0.53782	-0.12500	0.90091
P6V26	0.00031	0.00031	0.98200	0.32600
TYLDB1F	0.00037	0.00008	4.67600	0.00000
NFIN1	-0.00012	0.00006	-1.97300	0.04846
RHO(1,2)	0.00703	0.14657	0.04800	0.96175

Table A8.5.2 Probit model of probability of being a buyer

Variable	Coefficient	Marginal	Std. Error	T-ratio.	P>|T|
Constant	2.85640	0.36610	1.60920	1.77500	0.07590
DTAA	-0.82853	-0.10619	0.38610	-2.14600	0.03188
DTAF	-0.73979	-0.09482	0.38711	-1.91100	0.05600
DTEF	-0.45866	-0.05879	0.44212	-1.03700	0.29954
DTEM	-0.53407	-0.06845	0.41671	-1.28200	0.19997
DYEAR	0.20781	0.02664	0.20685	1.00500	0.31508
AGE	-0.05065	-0.00649	0.06896	-0.73400	0.46267
AGE2	0.00058	0.00007	0.00070	0.82900	0.40698
EDUCH	-0.25751	-0.03301	0.19304	-1.33400	0.18221
P1V5	-0.11165	-0.01431	0.07623	-1.46500	0.14301
DEPRAT	1.43890	0.18442	0.74693	1.92600	0.05405
P6V26	-0.00008	-0.00001	0.00010	-0.75500	0.45054
TYLDB1F	-0.00016	-0.00002	0.00008	-2.18000	0.02929
NFIN1	0.00032	0.00004	0.00013	2.52900	0.01145

Table A8.5.3 Probit model of probability of being a seller

Variable	Coefficient	Marginal	Std. Error	T-ratio.	P>|T|
Constant	-1.42470	-0.51422	1.10970	-1.28400	0.19919
DTAA	-0.59696	-0.21546	0.23268	-2.56600	0.01030
DTAF	0.05705	0.02059	0.24583	0.23200	0.81650
DTEF	0.00024	0.00009	0.25420	0.00100	0.99925
DTEM	-0.28169	-0.10167	0.26896	-1.04700	0.29495
DYEAR	-0.07518	-0.02714	0.15764	-0.47700	0.63341
AGE	0.04409	0.01591	0.04760	0.92600	0.35436
AGE2	-0.00043	-0.00015	0.00048	-0.88500	0.37598
EDUCH	0.04966	0.01792	0.15948	0.31100	0.75551
P1V5	0.06220	0.02245	0.05323	1.16900	0.24257
DEPRAT	-0.06753	-0.02437	0.50311	-0.13400	0.89323
P6V26	0.00031	0.00011	0.00025	1.25800	0.20845
TYLDB1F	0.00037	0.00013	0.00008	4.88200	0.00000
NFIN1	-0.00012	-0.00004	0.00006	-2.11200	0.03467

Table A8.5.4 Three stages least square estimation of purchase function

	Coefficient	S.E	T ratio	P Value
Constant	804.51000	272.20000	2.95600	0.00312
DTAA	-371.00000	55.12700	-6.73000	0.00000
DTAF	-387.24000	56.01700	-6.91300	0.00000
DTEF	-347.84000	58.93900	-5.90200	0.00000
DTEM	-170.02000	61.63700	-2.75800	0.00581
DYEAR	130.25000	37.29700	3.49200	0.00048
AGE	-15.76600	11.63700	-1.35500	0.17549
AGE2	0.17218	0.11704	1.47100	0.14125
EDUCH	-15.30800	37.42100	-0.40900	0.68248
P1V5	16.21200	12.58300	1.28800	0.19759
DEPRAT	157.39000	123.25000	1.27700	0.20157
P6V26	-0.01578	0.02253	-0.70000	0.48376
TYLDB1	-0.06527	0.01417	-4.60700	0.00000
NFIN1	0.04039	0.01305	3.09400	0.00197
IMR	141.47000	30.43300	4.64900	0.00000

Table A8.5.5 Three stages least square estimation of crop sales function

	Coefficient	S.E	T ratio	P-Value
Constant	357.24000	369.14000	0.96800	0.33316
DTAA	-185.90000	74.76000	-2.48700	0.01290
DTAF	28.52700	75.96700	0.37600	0.70727
DTEF	-2.93300	79.93000	-0.03700	0.97073
DTEM	-121.57000	83.59000	-1.45400	0.14585
DYEAR	10.65700	50.58400	0.21100	0.83314
AGE	-17.43600	15.78200	-1.10500	0.26923
AGE2	0.19386	0.15872	1.22100	0.22193
EDUCH	-85.84800	50.74900	-1.69200	0.09072
P1V5	-10.02600	17.06400	-0.58800	0.55684
DEPRAT	74.59800	167.14000	0.44600	0.65536
P6V26	0.01251	0.03056	0.40900	0.68227
TYLDB1	0.24177	0.01922	12.57800	0.00000
NFIN1	-0.00479	0.01770	-0.27100	0.78675
IMR	185.01000	31.43500	5.88600	0.00000

Appendix A9 Estimated results of Engel functions for different categories of consumption goods presented in Chapter 9

Table A9.1. Description of variables used in estimation

Variables	Descriptions
_cons	Constant (intercept)
Adeqfs	Adult equivalent family size
Age	Age of the household head
Deprat	Dependency ratio
Dtaa	Dummy for Tabia Araasegda
Dtaf	Dummy for Tabia fekre alem
Dtef	Dummy for Tabia Felegeselam
Dtem	Dummy for Tabia Mytsedo
Dyear	Year dummy (1996=1, 1997=0)
Educm	Education dummy (1 if the household head has modern education and 0 otherwise)
Educt	Education dummy (1 if household has traditional education and 0 otherwise
Lsubrat	Log of subsistence ratio
Texpbirr	Total consumption expenditure
Ylny	Total expenditure times the natural log of total consumption expenditure

Table A9.2 Estimation result of Engel function for total food consumption (Expfood)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T RATIO	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	-1.386	0.501	-2.768	0.006	8.592	3.425	2.509	0.013
Ylny	0.231	0.054	4.294	0.000	-0.836	0.363	-2.302	0.022
Deprat	102.673	118.68	0.865	0.388	-291.173	270.638	-1.076	0.283
Adeqfs	-9.146	19.539	-0.468	0.640	-44.283	99.955	-0.443	0.658
Age	-1.327	2.030	-0.654	0.514	6.263	5.302	1.181	0.238
Dyear	-254.446	34.097	-7.462	0.000	672.927	137.762	4.885	0.000
Educt	1.058	50.986	0.021	0.983	-163.090	146.138	-1.116	0.265
Educm	-68.612	66.834	-1.027	0.305	163.046	158.373	1.030	0.304
Dtaa	-468.613	68.105	-6.881	0.000	-242.835	331.929	-0.732	0.465
Dtaf	-290.121	48.863	-5.937	0.000	-82.130	365.409	-0.225	0.822
Dtef	-51.294	53.153	-0.965	0.335	-499.612	344.050	-1.452	0.147
Dtem	-44.011	51.954	-0.847	0.397	-616.266	340.075	-1.812	0.071
Lsubrat	226.551	62.332	3.635	0.000	715.978	228.959	3.127	0.002
_cons	1466.942	223.63	6.560	0.000	-3064.752	1435.83	-2.134	0.033
R^2	0.94				0.29			

Table A9.3 Estimation result of Engel function for total non-food consumption (Expother)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T RATIO	P>|t|	Coef.	Std. Err.	T RATIO	P>|t|
Texpbirr	2.386	0.501	4.766	0.000	2.770	1.643	1.686	0.093
Ylny	-0.231	0.054	-4.294	0.000	-0.264	0.175	-1.507	0.133
Deprat	-102.673	118.679	-0.865	0.388	-255.187	142.280	-1.794	0.074
Adeqfs	9.146	19.539	0.468	0.640	-10.485	36.638	-0.286	0.775
Age	1.327	2.030	0.654	0.514	2.782	2.482	1.121	0.263
Dyear	254.446	34.097	7.462	0.000	512.936	43.975	11.664	0.000
Educt	-1.058	50.986	-0.021	0.983	0.534	65.315	0.008	0.993
Educm	68.612	66.834	1.027	0.305	117.331	88.419	1.327	0.185
Dtaa	468.613	68.105	6.881	0.000	622.603	75.711	8.223	0.000
Dtaf	290.121	48.863	5.937	0.000	469.818	56.475	8.319	0.000
Dtef	51.294	53.153	0.965	0.335	-4.116	65.322	-0.063	0.950
Dtem	44.011	51.954	0.847	0.397	-13.423	59.811	-0.224	0.823
Lsubrat	-226.551	62.332	-3.635	0.000	-136.245	66.118	-2.061	0.040
_cons	-1466.942	223.627	-6.560	0.000	-1998.771	717.106	-2.787	0.006
R^2	0.64				0.49			

Table A9.4 Estimation result of Engel function for purchased non-local food consumption (other2) (coffee, sugar, salt and spices)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T RATIO	P>|t|	Coef.	Std. Err.	T RATIO	P>|t|
Texpbirr	1.450	0.186	7.817	0.000	1.018	0.816	1.248	0.213
Ylny	-0.141	0.020	-7.215	0.000	-0.086	0.087	-0.994	0.321
Deprat	134.036	54.099	2.478	0.014	47.607	69.741	0.683	0.495
Adeqfs	-34.383	9.675	-3.554	0.000	-59.664	17.232	-3.462	0.001
Age	1.517	0.919	1.650	0.100	2.262	1.169	1.935	0.054
Dyear	96.013	18.929	5.072	0.000	238.690	22.002	10.848	0.000
Educt	-15.761	27.097	-0.582	0.561	-8.727	33.431	-0.261	0.794
Educm	67.011	26.079	2.570	0.011	84.947	32.527	2.612	0.009
Dtaa	228.706	28.570	8.005	0.000	323.196	34.576	9.347	0.000
Dtaf	257.206	27.751	9.268	0.000	372.766	33.494	11.129	0.000
Dtef	107.275	27.008	3.972	0.000	71.076	36.264	1.960	0.051
Dtem	40.629	25.492	1.594	0.112	7.785	29.469	0.264	0.792
Lsubrat	-109.633	29.818	-3.677	0.000	-64.85	33.964	-1.909	0.057
_cons	-759.135	95.573	-7.943	0.000	-853.64	357.279	-2.389	0.017
R^2	0.68				0.52			

Table A9.5 Estimation result of Engel function for service, ceremonial and other social expenses (Expsoc) (ceremonial expenditure, taxes, contribution to churches, local institutions and organisation)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	0.460	0.369	1.244	0.214	0.630	0.963	0.655	0.513
Ylny	-0.041	0.040	-1.021	0.308	-0.064	0.101	-0.630	0.529
Deprat	-50.560	68.091	-0.743	0.458	-72.742	76.197	-0.955	0.340
Adeqfs	-6.995	14.258	-0.491	0.624	14.043	27.722	0.507	0.613
Age	1.822	1.320	1.380	0.168	2.609	1.588	1.643	0.101
Dyear	135.280	22.214	6.090	0.000	234.019	27.843	8.405	0.000
Educt	49.805	35.926	1.386	0.166	42.145	42.028	1.003	0.317
Educm	59.833	50.703	1.180	0.239	97.135	64.895	1.497	0.135
Dtaa	269.418	54.328	4.959	0.000	305.457	53.001	5.763	0.000
Dtaf	177.596	24.891	7.135	0.000	209.174	25.862	8.088	0.000
Dtef	62.541	30.975	2.019	0.044	37.306	32.338	1.154	0.249
Dtem	33.907	18.307	1.852	0.065	5.235	22.550	0.232	0.817
Lsubrat	-126.398	47.460	-2.663	0.008	-76.171	43.623	-1.746	0.082
_cons	-574.106	150.491	-3.815	0.000	-660.533	428.184	-1.543	0.124
R^2	0.42				0.32			

Table A9.6 Estimation result of Engel function for purchased industrial products (Indus) (household goods, building materials, clothes shoes and cosmetics)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T RATIO	P>|t|	Coef.	Std. Err.	T RATIO	P>|t|
Texpbirr	1.926	0.236	8.154	0.000	2.139	1.142	1.874	0.062
Ylny	-0.190	0.025	-7.637	0.000	-0.200	0.122	-1.638	0.102
Deprat	-52.113	86.022	-0.606	0.545	-182.445	94.200	-1.937	0.053
Adeqfs	16.142	14.028	1.151	0.251	-24.527	22.399	-1.095	0.274
Age	-0.495	1.250	-0.396	0.692	0.173	1.363	0.127	0.899
Dyear	119.166	25.280	4.714	0.000	278.918	29.032	9.607	0.000
Educt	-50.863	40.216	-1.265	0.207	-41.611	43.939	-0.947	0.344
Educm	8.779	36.839	0.238	0.812	20.196	43.636	0.463	0.644
Dtaa	199.195	41.321	4.821	0.000	317.146	45.154	7.024	0.000
Dtaf	112.525	37.729	2.982	0.003	260.645	40.760	6.395	0.000
Dtef	-11.247	40.716	-0.276	0.783	-41.422	46.473	-0.891	0.373
Dtem	10.104	46.598	0.217	0.828	-18.659	49.229	-0.379	0.705
Lsubrat	-100.152	26.948	-3.716	0.000	-60.074	33.864	-1.774	0.077
_cons	-892.836	120.012	-7.440	0.000	-1338.238	475.573	-2.814	0.005
R^2	0.57				0.46			

Table A9.7 Estimation result of Engel function for clothes, shoes and cosmetics (Expcloth)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	1.852	0.230	8.057	0.000	1.906	1.113	1.712	0.088
Ylny	-0.183	0.024	-7.551	0.000	-0.176	0.119	-1.477	0.141
Deprat	-61.606	86.086	-0.716	0.475	-184.425	92.720	-1.989	0.047
Adeqfs	18.832	14.030	1.342	0.180	-21.466	22.077	-0.972	0.331
Age	-0.279	1.224	-0.228	0.820	0.354	1.319	0.268	0.788
Dyear	100.369	24.933	4.026	0.000	252.517	28.326	8.915	0.000
Educt	-56.648	38.911	-1.456	0.146	-46.740	42.142	-1.109	0.268
Educm	2.352	36.456	0.065	0.949	12.263	42.639	0.288	0.774
Dtaa	178.742	40.661	4.396	0.000	292.302	43.974	6.647	0.000
Dtaf	92.472	37.084	2.494	0.013	235.600	39.392	5.981	0.000
Dtef	-19.659	39.824	-0.494	0.622	-49.486	44.873	-1.103	0.271
Dtem	-3.178	46.030	-0.069	0.945	-30.687	48.345	-0.635	0.526
Lsubrat	-85.504	26.014	-3.287	0.001	-47.775	32.390	-1.475	0.141
_cons	-841.355	118.422	-7.105	0.000	-1212.733	462.527	-2.622	0.009
R^2	0.55				0.44			

Table A9.8 Estimation result of Engel function for cereal consumption (p7v17)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T RATIO	P>|t|
Texpbirr	-5.620	0.942	-5.967	0.000	2.338	2.533	0.923	0.357
Ylny	0.643	0.101	6.357	0.000	-0.237	0.268	-0.883	0.378
Deprat	-120.218	161.981	-0.742	0.458	-171.704	182.579	-0.940	0.348
Adeqfs	92.793	25.539	3.633	0.000	160.304	86.756	1.848	0.065
Age	-2.347	2.719	-0.863	0.389	3.397	3.624	0.938	0.349
Dyear	-147.507	56.738	-2.600	0.010	368.350	120.165	3.065	0.002
Educt	58.814	60.245	0.976	0.330	-112.575	107.497	-1.047	0.296
Educm	-156.444	83.764	-1.868	0.063	42.113	126.473	0.333	0.739
Dtaa	-739.690	77.299	-9.569	0.000	-792.834	314.955	-2.517	0.012
Dtaf	-729.178	74.418	-9.798	0.000	-869.247	349.149	-2.490	0.013
Dtef	-277.005	86.101	-3.217	0.001	-635.244	323.361	-1.965	0.050
Dtem	-112.116	68.699	-1.632	0.103	-584.375	320.859	-1.821	0.069
Lsubrat	242.114	67.887	3.566	0.000	617.986	217.972	2.835	0.005
_cons	3260.887	392.153	8.315	0.000	405.507	1083.290	0.374	0.708
R^2	0.84				0.21			

Table A9.9 Estimation result of Engel function for pulses consumption (p7v25)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	0.561	0.127	4.426	0.000	0.310	0.436	0.711	0.478
Ylny	-0.055	0.012	-4.384	0.000	-0.025	0.046	-0.529	0.597
Deprat	12.840	25.307	0.507	0.612	-18.367	25.606	-0.717	0.474
Adeqfs	-6.745	8.850	-0.762	0.446	-15.351	8.043	-1.909	0.057
Age	0.079	0.689	0.114	0.909	0.393	0.697	0.565	0.572
Dyear	8.718	23.089	0.378	0.706	65.983	12.284	5.372	0.000
Educt	-5.493	12.035	-0.456	0.648	-2.673	14.090	-0.190	0.850
Educm	-27.531	20.437	-1.347	0.179	-19.319	17.933	-1.077	0.282
Dtaa	-7.557	13.801	-0.548	0.584	29.361	12.479	2.353	0.019
Dtaf	-2.249	13.458	-0.167	0.867	42.454	12.925	3.285	0.001
Dtef	21.241	14.163	1.500	0.134	6.041	14.684	0.411	0.681
Dtem	55.414	33.095	1.674	0.095	41.914	34.968	1.199	0.231
Lsubrat	1.507	10.253	0.147	0.883	20.421	15.850	1.288	0.198
_cons	-202.144	33.028	-6.120	0.000	-202.380	155.060	-1.305	0.193
R^2	0.35				0.22			

Table A9.10 Estimation result of Engel function for oil crops consumption (p7v33)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T RATIO	P>|t|
Texpbirr	0.087	0.016	5.542	0.000	0.196	0.074	2.659	0.008
Ylny	-0.009	0.002	-5.462	0.000	-0.021	0.008	-2.648	0.008
Deprat	-5.154	8.680	-0.594	0.553	-10.842	9.269	-1.170	0.243
Adeqfs	-2.836	1.182	-2.399	0.017	-2.098	1.586	-1.323	0.187
Age	0.359	0.138	2.592	0.010	0.386	0.144	2.672	0.008
Dyear	9.639	2.204	4.374	0.000	15.930	2.698	5.904	0.000
Educt	-6.715	3.428	-1.959	0.051	-6.926	3.438	-2.014	0.045
Educm	-6.173	3.205	-1.926	0.055	-4.396	3.324	-1.322	0.187
Dtaa	21.216	3.530	6.010	0.000	25.320	3.763	6.729	0.000
Dtaf	25.559	3.884	6.581	0.000	30.035	4.192	7.166	0.000
Dtef	-0.576	2.143	-0.269	0.788	0.179	2.211	0.081	0.935
Dtem	-3.229	1.957	-1.650	0.100	-2.905	1.973	-1.472	0.142
Lsubrat	-0.643	3.647	-0.176	0.860	1.198	3.701	0.324	0.746
_cons	-56.802	10.416	-5.454	0.000	-107.422	35.358	-3.038	0.003
R^2	0.33				0.29			

Table A9.11 Estimation result of Engel function for animal product consumption (p7v41)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	2.142	0.371	5.774	0.000	4.711	1.491	3.160	0.002
Ylny	-0.209	0.038	-5.429	0.000	-0.465	0.159	-2.922	0.004
Deprat	80.360	98.651	0.815	0.416	-138.023	104.587	-1.320	0.188
Adeqfs	-58.062	17.495	-3.319	0.001	-127.233	24.845	-5.121	0.000
Age	-0.951	1.843	-0.516	0.606	-0.193	2.043	-0.094	0.925
Dyear	-223.141	52.178	-4.277	0.000	-18.049	38.470	-0.469	0.639
Educt	-29.050	49.576	-0.586	0.558	-31.270	56.588	-0.553	0.581
Educm	52.750	57.145	0.923	0.357	58.054	59.564	0.975	0.330
Dtaa	32.227	46.914	0.687	0.493	175.677	47.847	3.672	0.000
Dtaf	161.179	45.792	3.520	0.000	344.495	50.469	6.826	0.000
Dtef	98.738	68.226	1.447	0.149	59.514	72.539	0.820	0.412
Dtem	-28.793	45.367	-0.635	0.526	-82.356	47.365	-1.739	0.083
Lsubrat	94.215	37.830	2.490	0.013	142.179	38.327	3.710	0.000
_cons	-778.889	169.823	-4.586	0.000	-2299.124	591.273	-3.888	0.000
R^2	0.42				0.28			

Table A9.12 Estimation result of Engel function for vegetables consumption (p7v81)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T RATIO	P>|t|
Texpbirr	-0.005	0.005	-1.018	0.309	0.019	0.025	0.766	0.444
Ylny	0.001	0.001	1.070	0.285	-0.002	0.003	-0.750	0.454
Deprat	0.808	2.172	0.372	0.710	0.156	2.052	0.076	0.940
Adeqfs	0.086	0.345	0.250	0.803	-0.240	0.633	-0.379	0.705
Age	0.016	0.039	0.403	0.687	0.016	0.037	0.437	0.662
Dyear	1.833	0.774	2.369	0.018	2.024	0.701	2.887	0.004
Educt	-0.736	0.612	-1.203	0.230	-0.919	0.616	-1.492	0.136
Educm	1.774	1.194	1.486	0.138	1.646	1.234	1.335	0.183
Dtaa	-3.515	1.180	-2.978	0.003	-3.556	1.239	-2.871	0.004
Dtaf	-2.638	1.151	-2.291	0.022	-2.633	1.206	-2.184	0.030
Dtef	-0.967	1.166	-0.829	0.407	-1.179	1.199	-0.983	0.326
Dtem	4.083	1.832	2.228	0.026	3.672	1.827	2.010	0.045
Lsubrat	-1.010	1.647	-0.613	0.540	-0.954	1.678	-0.569	0.570
_cons	3.026	4.196	0.721	0.471	-7.693	12.601	-0.610	0.542
R^2	0.153				0.148			

Table A9.13 Estimation result of Engel function for the consumption of household durable goods (p7v94)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	0.074	0.018	4.062	0.000	0.233	0.091	2.572	0.01
Ylny	-0.007	0.002	-3.887	0.000	-0.024	0.010	-2.516	0.012
Deprat	9.493	7.829	1.213	0.226	1.980	8.599	0.230	0.818
Adeqfs	-2.690	1.441	-1.867	0.063	-3.061	2.232	-1.371	0.171
Age	-0.216	0.133	-1.631	0.104	-0.182	0.139	-1.305	0.193
Dyear	18.797	3.120	6.025	0.000	26.401	3.194	8.265	0
Educt	5.785	4.816	1.201	0.230	5.129	4.933	1.040	0.299
Educm	6.428	5.069	1.268	0.206	7.934	5.419	1.464	0.144
Dtaa	20.452	4.079	5.014	0.000	24.844	4.252	5.844	0
Dtaf	20.053	4.291	4.673	0.000	25.045	4.612	5.430	0
Dtef	8.412	3.831	2.196	0.029	8.063	4.129	1.953	0.052
Dtem	13.283	4.682	2.837	0.005	12.028	4.680	2.570	0.011
Lsubrat	-14.648	4.251	-3.446	0.001	-12.299	4.413	-2.787	0.006
_cons	-51.481	11.072	-4.650	0.000	-125.505	39.204	-3.201	0.001
R^2	0.31				0.28			

Table A9.14 Estimation result of Engel function for own produced food consumption (Ownfood)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	-3.464	0.595	-5.820	0.000	3.378	3.030	1.115	0.266
Ylny	0.429	0.064	6.706	0.000	-0.309	0.322	-0.957	0.339
Deprat	-54.990	150.257	-0.366	0.715	-244.596	218.811	-1.118	0.264
Adeqfs	8.034	21.659	0.371	0.711	-1.474	85.272	-0.017	0.986
Age	-4.182	2.359	-1.773	0.077	2.071	4.202	0.493	0.622
Dyear	-279.127	42.503	-6.567	0.000	393.339	121.806	3.229	0.001
Educt	37.257	57.327	0.650	0.516	-111.820	124.284	-0.900	0.369
Educm	-72.018	74.244	-0.970	0.333	114.913	135.988	0.845	0.399
Dtaa	-388.861	77.183	-5.038	0.000	-304.709	302.472	-1.007	0.314
Dtaf	-241.277	68.417	-3.527	0.000	-197.736	335.514	-0.589	0.556
Dtef	-60.202	64.710	-0.930	0.353	-462.519	313.043	-1.477	0.14
Dtem	-20.760	62.426	-0.333	0.740	-526.679	310.713	-1.695	0.091
Lsubrat	1109.093	135.561	8.182	0.000	1511.880	256.446	5.896	0
_cons	2621.661	256.062	10.238	0.000	-285.106	1226.495	-0.232	0.816
R^2	0.91				0.33			

Table A9.15 Estimation result of Engel function for purchased locally produced food consumption (Purfloc)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	0.628	0.235	2.671	0.008	4.196	1.101	3.812	0
Ylny	-0.057	0.025	-2.308	0.022	-0.441	0.117	-3.759	0
Deprat	23.627	84.448	0.280	0.780	-94.185	87.309	-1.079	0.281
Adeqfs	17.203	13.887	1.239	0.216	16.855	20.951	0.805	0.422
Age	1.338	1.196	1.118	0.264	1.929	1.283	1.504	0.133
Dyear	-71.331	28.803	-2.477	0.014	40.898	27.430	1.491	0.137
Educt	-20.437	38.893	-0.525	0.600	-42.543	39.814	-1.069	0.286
Educm	-63.606	34.601	-1.838	0.067	-36.815	36.440	-1.010	0.313
Dtaa	-308.458	46.987	-6.565	0.000	-261.322	51.958	-5.029	0
Dtaf	-306.050	46.053	-6.646	0.000	-257.160	50.997	-5.043	0
Dtef	-98.368	43.223	-2.276	0.023	-108.169	47.788	-2.264	0.024
Dtem	-63.880	47.458	-1.346	0.179	-97.372	51.437	-1.893	0.059
Lsubrat	-772.910	94.846	-8.149	0.000	-731.050	90.613	-8.068	0
_cons	-395.584	116.090	-3.408	0.001	-1926.006	450.424	-4.276	0
R^2	0.64				0.57			

Table A9.16 Estimation result of Engel function for public good consumption (Hhgood) (household goods and building materials)

	Ordinary least square				Instrumental variable estimation			
	Coef.	Std. Err.	T ratio	P>|t|	Coef.	Std. Err.	T ratio	P>|t|
Texpbirr	0.272	0.085	3.214	0.001	0.609	0.357	1.708	0.088
Ylny	-0.027	0.008	-3.163	0.002	-0.064	0.037	-1.701	0.09
Deprat	10.024	21.436	0.468	0.640	-7.907	19.464	-0.406	0.685
Adeqfs	-9.525	5.623	-1.694	0.091	-5.629	6.840	-0.823	0.411
Age	-0.592	0.373	-1.586	0.113	-0.443	0.379	-1.170	0.243
Dyear	25.708	13.722	1.873	0.062	52.199	9.290	5.619	0
Educt	37.953	25.418	1.493	0.136	36.449	26.297	1.386	0.167
Educm	13.684	11.414	1.199	0.231	22.019	11.888	1.852	0.065
Dtaa	45.921	11.559	3.973	0.000	60.279	10.458	5.764	0
Dtaf	46.621	9.840	4.738	0.000	61.518	9.843	6.250	0
Dtef	29.342	18.503	1.586	0.114	28.888	19.956	1.448	0.149
Dtem	19.654	7.683	2.558	0.011	17.504	7.466	2.345	0.02
Lsubrat	-32.277	9.758	-3.308	0.001	-22.443	10.359	-2.167	0.031
_cons	-153.083	29.268	-5.230	0.000	-308.333	151.088	-2.041	0.042
R^2	0.25				0.19			

CURRICULUM VITAE

Tassew was born on June 5, 1964 at a village called *Sesela*, which is located near the town of *Korem*, Ethiopia. His parents sent him to school at the age of six. After finishing primary and secondary education at *Korem*, he studied General Agriculture at Ambo Institute of Agriculture and was awarded a diploma with the grade 'great distinction'. He worked for seven years in the Ministry of Agriculture as an Agronomist. In 1988, he joined Alemaya University of Agriculture (AUA) and obtained a BSc degree in Agricultural Economics with 'great distinction'. He obtained the Chancellor's medal for that academic year. Immediately afterwards he was employed by AUA as a Graduate Assistant, which is a rare chance given to outstanding students. From September 1993 to January 1995, he studied Agricultural and Environmental Economics and Policy at Wageningen Agricultural University, the Netherlands and obtained an MSc degree in Agricultural Economics and Marketing with distinction. In February 1995, he joined the Agricultural Economics and Rural Policy Group of Wageningen University as a PhD student to study Farm Household Economics and obtained a WOTRO research grant. During his PhD period he obtained the diploma the Netherlands Network of Economics (NAKE). Moreover, he stayed two years at Mekelle University College – where he combined research and teaching - and three months at Michigan State University. After finishing his work on the thesis he spends three months at the Centre for the Study of African Economies, Oxford University, UK.