TECHNICAL EFFICIENCY OF CEREAL PRODUCING FARMERS: A COMPARATIVE ANALYSIS OF OWN-OPERATORS AND TENANTS

(THE CASE OF ETHIOPIA)

BY
WORKU GEBEYEHU

ADDIS ABABA UNIVERSITY
JUNE 1999

TECHNICAL EFFICIENCY OF CEREAL PRODUCING FARMERS: A COMPARATIVE ANALYSIS OF OWN-OPERATORS AND TENANTS

(THE CASE OF ETHIOPIA)

BY

WORKU GEBEYEHU ALEMAYEHU

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulifilement of the Requirement for the Degree of Master of Science in Economic Policy Analysis

ADDIS ABABA UNIVERSITY

JUNE 1999

184

ADDIS ABABA UNIVERSITY
School of Graduate Studies

Technical Efficiency of Cereal Producing Farmers: A Comparative Analysis of Own-Operators and Tenants (The Case of Ethiopia)

By
Worku Gebeyehu Alemayehu
Faculty of Business and Economics

Approval by Board of Examiners:

Dr. Abdulhamid Bedri K. — Signature
Advisor

Dr. Mulat Demeke — Signature
Examiner

Dr. Alemayehu Seyoum — Signature
Examiner

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACKNOWLEDGEMENT

This thesis has been done under a very intense environment due to some personal problems. In such circumstances, I have been indebted to many people without whose support the study could not have been a reality. First, I would like to express my gratitude to my advisor, Dr. Abdulhamid Bedri Kello, for his intimacy, guidance, and advice throught the project.

The Department of Economics of Addis Ababa University not only provided me access for the 1993/94 Ethiopian Rural Household Survey but also helped me to cope with my personal problems by allowing extra time to work on my thesis. I would like to extend my heartfelt thanks for Dr. Alemu Mekonnen, Dr. Andre Croppenstedt, Dr. Assefa Admassie, W/ro Yirgedu Begashaw, and other members of the Department.

My special appereciation goes to my friends and colleagues, Abebe, Admit, Demirew, Fisha, Getnet, Jember, Tilahun, Minyashal and Wondwoson for their valuable comments on the draft document and moral support. I do not have words to express the way I am indebted particularly to Abebe Alebachew.

I would like to thank also my sponsors, the Ministry of Economic Development and Co-operation (MEDaC) and the African Economic Research Consortium (AERC) for granting me the necessary resoures. Specially, I need to provide a special apperiaciation to Ato Girma Wubbie and Ato Nigatu Mereke.

Last but not least, I am very much grateful to my fiancée, Tigist Desalegn, my other relatives, Zinash Tefera, Sintayehu W/ Michael and W/zo Desta Fantaw and family. They have been with me all the time.

ABSTRACT

Studies on the efficiency of peasant farms are very important sources of policy advise in agriculture dominated economies such as that of Ethiopia. The importance extends to the economy at large beyond directly affecting peasants. An important factor that is central to these studies is land use arrangements' role in determining efficiency levels. Volumes of theoretical controversies and empirical evidences are documented in the literature on the impact of land use arrangements on efficiency of farmers. This study tried to investigate and analyze technical efficiency of farmers and its difference between groups of households working under different mode of land use arrangements. It also attempted to indicate some of the factors that might affect the efficiency of tenant farmers. To this effect, Cobb-Douglas stochastic frontier production function and other econometric tools are employed on a cross-sectional data of 340 households operating with similar farming practices. The mean technical efficiency of sample households is found to be around 62.8 percent indicating the existence of inefficiency and considerable potential for efficiency improvement under the given state of technology. Efficiency is found to be higher for smaller farms and households with literate household heads. Wealth of the household, level of credit, amount of fertilizer used and rainfall are found to contribute significantly to production. Regardless of differences in the mode of landholding and tenancy associated problems, no significant efficiency gap is observed between owner-operators and tenants. On the other hand, in line with the hypothesis of the Marshallian and others, there is an indication that non-sharecroppers perform better than sharecroppers are. The way inputs are financed and decisions are made on activities has some influence on efficiency of tenants. To enhance efficiency of farmers, efforts towards providing training and extension services, forming and expanding the coverage of credit and small-scale irrigation schemes should be strengthened. Indeed, given the land use policy which provides room for land renting, the formation and functioning of land rent-lease arrangements among farmers would enable better use of resources and enhance the overall efficiency of the sector.

1. INTRODUCTION

1.1. BACKGROUND AND STATEMENT OF THE PROBLEM

Ethiopia is among the poorest countries in the world where agriculture is almost the only source of living for the majority of its people. The sector provides employment for about 85 % of the population, contributes about 50 % of GDP, generates more than 85 % of export earnings and supplies 70% of the raw material requirements of agro-based industries [MEDaC, 1998].

Given the existing structure of employment and the economy at large as well as the potential opportunity for growth and reform in the structure of the economy during the coming few years, agriculture has been and remains to be the basis for the Ethiopian economy.

Despite its importance, agriculture in Ethiopia has remained stagnant with low productivity. Not only the rate of growth of the sector has been very low but also the trend was very alarming, until very recently. It was growing at a rate of 2.2% during 1960-1970, 0.7% over 1970-1980 and 0.4 over the period of 1980-1992 [World Bank 1982, 1986 and 1993]. Particularly, during 1987-1991 per capita agricultural production was declining at a rate of 2.7% per annum [MEDaC, 1998].

The high rate of population growth and unfavourable natural and policy environment led to a deteriorating food security position of the majority of the population. During the early 1980s, domestic production met only about 70% of the recommended minimum caloric intake [FAO, 1996]. As a result of the declining tendency in food production per capita, the country's food self-sufficiency rate reached as low as 58% in 1991/92 [Mulat et al., 1997].

In the 1960s, Ethiopia was food secure but since 1970s the failure of domestic production to satisfy the growing demand forced the country to look for imports through purchases and food aid from other countries [FAO, 1996]. The amount of purchased food imports and food aid fluctuates over the years depending on the level of domestic production. Nevertheless, the trend could be viewed as increasing dependency on external sources. For instance, cereal food aid was about 200,000 metric tons in 1985 whereas in 1996 this amount increased to as much as 1.2 million metric tones [Clay, et al., 1998 and Croppenstedt and Mulat, 1997].

Regardless of efforts made to meet the demand for food through domestic production, foreign purchases and aid, the available per capita supply from all these sources has been far below the biological minimum requirements. According to the National Nutrition Survey of 1993, about 60% of the population in Ethiopia live below the poverty line. Of the children below the age of five years, 64 % and 8 % are stunted and wasted respectively and about 47 % are under-weight. These figures are alarming by every standard [Croppenstedt and Mulat, 1997]. The frequent occurrence of famine that claim the lives of many thousands of people is also one of the basic indication of the inability of the country to feed itself.

Recurrent drought and famine, ill-designed agricultural policies, loss of priority for the growth of the peasant sub-sector and protracted civil war were often mentioned as main factors for stagnant nature of the agricultural sector in the previous two decades.

Given the above state of the Ethiopian agriculture, improving its efficiency is, therefore, not only necessary as an engine for growth and transforming employment structure in the economy, but also a necessity for survival of the population at large. This calls for a close examination of factors that inhibited productivity and production growth in the sector.

Currently relative peace and stability prevail in the country. Enhancing agricultural productivity became the main concern of the current government and to this effect measures in the macro- economic environment to increase production and productivity are put in place. Among others, these measures include, liberalisation of factors of production and output markets, curbing forceful collectivisation and villagization, and formulation and subsequent implementation of Agriculture Development-Led-Industrialisation Policy, (ADLI).

As a result of these policy changes agricultural production has shown improvements in recent years. Besides the exceptional record of the 1995/1996 harvest of 103.3 million quintals of cereals, 73 million and 75 million quintals of cereals were recorded in 1993/94 and 1994/1995 respectively compared to 56.9 million in 1991/92 and 68.3 million quintals of cereals in 1992/93 [C.S.A., 1992-1996]. Along with favourable policy environment, stable weather conditions have also contributed for the harvest in these years.[1]

As we have witnessed from the 1996 domestic production shortfall that resulted in a substantial food aid, the above positive trend may not necessarily continue. Thus, efforts towards increasing agricultural productivity further and making it sustainable should be strengthened both at the national and every farm level as a means of alleviating frequent occurrence of famine in the country and contributing a share in the growth of the economy at large.

Direct ways of enhancing agricultural production include expansion of cultivated land, intensive use of land through more and efficient use of cultural practices, application of modern inputs and minimising post harvest losses [Mulat et al., 1997, and Wendwosen, 1998].

It is estimated that around 38 percent of the total land area of Ethiopia is potentially cultivable. Of this area, around 11 per cent require special management through good drainage facility or intensive conservation measures. 27% of the total area of Ethiopia is suitable for rain-fed agriculture, of which only around 50% have been under crops. With the given technology and farming practice, potentially expandable land of 13 million hectares could have produced 16.7 million quintals of grains and 2.9 million quintals of oilseeds. Under the country's prevailing land holding of 0.8 hectares per farmer, this size of virgin land could have employed around 16 million additional farmers [C.S.A., 1988, FAO/UNDP, 1988 and Tegegn 1995].

---

[1] The increase in production in the latter years are attributed not only due to the mentioned factors but also the inclusion of some areas into the survey which were not considered before because of peace problems.

Regardless of the mentioned potential and increasing demand for land due to population growth, the size of cultivated land has not shown significant change over the years. The mean cultivated land for cereals and all major crops over 1980/81-1997/98 were 4.84 million hectares and 5.76 million hectares respectively and the maximum size of land areas cultivated for both purposes were 6.59 million hectares and 8.1 million hectares respectively. Using simple arithmetic growth rate formulae, we have found that area cultivated for cereals was growing at a rate of 1.33 percent while the respective figure for all major crops was 1.57 percent per annum. These figures indicate that rate of land expansion over the mentioned period was lagging behind the rate of population growth in the country for the last 17 years [Appendix 7 and 8].

For the limited level of land utilisation two main factors could be mentioned: environment and demography. The highlands above 1500 meters cover around 43 % of the total land area of the country but account for about 95% of the total cultivated land and 85% of the population. Therefore, the potential for expansion in these areas is very minimal [EHRS, 1984 and Wendwosen, 1998].

The greater proportion of the unrealised potential for rain-fed agriculture exists in Western and South-western parts of the country but the prevalence of Tse Tse fly, malaria and other similar vectors could make it difficult to exploit these areas given the technology available [MEDaC, 1998].

Land degradation is a critical problem in rural Ethiopia in its effect of reducing the size of cultivable land. Even though highlands are relatively suitable for habitation, they are sloppy and populous. The effort to over tax the land in these densely populated areas intensified land degradation. About 50% of the area of the highlands is significantly eroded and 25% is seriously eroded. More than 2 million hectares of formerly cultivated land reached to a point of no return [EHRS, 1986]. Thus, under the given technology, land degradation intensity, unfavourable environment of virgin lands and the country's limited resource capacity, the hope for increasing agricultural production through expanding cultivated land is very limited.

The second option for enhancing agricultural production is improving productivity through the use of modern technology and inputs such as chemical fertilisers, improved seeds, pesticides and other efficient pest management techniques etc. According to Mulat et al., (1997), additional 3.4 to 7.44 quintals of cereals output per hectares could be acquired through 100 kg of DAP (one type of chemical fertiliser). Similarly, the use of improved seeds on certain demonstration sites was found to provide a yield level, which was two-to-three time over the national average.[2]

The Ethiopian experience in the use of modern inputs has been very weak. Recent figures indicated that the maximum share of area covered by improved seeds, pesticides, and fertilisers was about 1.9%, 7.1% and 32.2% of the total cultivated land in 1996/97. If one examines the use of such modern farm management practices across regions, Oromia and Southern Peoples Administrative Regional states have been relatively better compared to the others [Appendix 9]. Low level of modern inputs application to date and disparities amongst regions indicate that there would be a good potential for efficiency gain yet untapped.

Realising this potential requires both resources and intensive demonstration and extension services. But, the number of farmers benefited from a program run by the government, Sasakawa-Global (SG) 2000 and Participatory Demonstration and Training Extension System (PADETES), for instance, are very small: only 350,000 farmers got this advantage in 1995/96 [Croppenstedt and Mulat 1997].

The room for widespread use of cultural practices to improve agricultural productivity seems nearly closed. Ever increasing demand for land and energy resulted from population growth force farmers to shorten the fallowing period and use animal dung and forest residues to satisfy their fire wood requirements instead of using them as manure.

In densely populated areas, farmers try to maximise their output through extensive farming. This is against the traditional soil-fertility restoring techniques such as fallowing. Planting cereals continuously as a short run means of increasing production may result in a disaster in

---

[2] Such increase has been achieved through SG 2000 project, which uses improved seeds; fertiliser and intensive management based on 1/2-hectare demonstration plots.

the long run. In such farms, even the chemical fertilisers farmers use may not compensate the loss of soil nutrients [Mulat and et al., 1998][3].

Structural transformation and sustainable agricultural growth need huge investment injection into the sector both for the application of modern inputs and converting virgin lands into use. Nevertheless, this is beyond the capacity of the country in the short run. The government has made efforts to increase agricultural productivity through extension programs involving the use of modern inputs and expanding the range of modern farm management practices across areas. Given resource limitations on the side of the government, attempts have also be made to examine whether there is a room for improvements in the efficiency of available resources as a means of increasing production.

Efficiency of available resources may be affected by several factors. For instance, not only scarcity of land but also its distribution to users may have an impact on the level of efficiency and agricultural production. Evidence on access to land and the degree of equity in the size of land holdings in Ethiopia reflects the existence of skewed distribution.

In the early 1970s, around 58% of the Ethiopian farmers held only about 18% of the total rural land with holding size of one hectare or less. On the other extreme, the share of 19% privileged farmers was 59% of the total with a per capita holding of more than two hectares [Dessalegn, 1984].

In recent years such extreme uneven distribution has been relatively changed. As it could be observed from the Agricultural Sample Survey 1995/96, of the total number of landowners, around 87% of households owned equal or less than two hectares while the rest 13% held as much as ten hectares [C.S.A., 1996].

On the other hand, there are many farmers who do not have direct access to land. We find recently married youngsters, individuals settled in a particular area after land has been

---

[3] This does not necessarily imply that the use of chemical fertilisers has no role for improving land quality. Rather it indicates that excessive usage of fertilisers and allowing the land no period for fallowing year after year would likely to minimise the benefit farmers may anticipate from the use of chemical fertilisers.

distributed, ex-soldiers, returnees from resettlement areas and other displaced individuals in the group of landless persons.

According to Dessalegn (1994), around 1.2 million demobilised soldiers of the military regime, returnees and displaced persons were flocking into the different parts of the country for new life. Of this number, rural areas were forced to accommodate nearly 50%. Highly skewed age distribution towards youngsters and children in the Ethiopian population also indicates that there exists a pressing demand for land at the moment and a growing trend for potential claimants in the future.

On the other hand, in rural Ethiopia other indispensable farm inputs are also lacking. Even though oxen are principal vehicles for farming in many parts of the country as many as 30% of all holdings in the country had no oxen at all and only 8% of farm households had more than one pair of oxen in 1974 [Daniel, et al., 1997]. A similar study on some parts of the Ethiopian highland indicated that 14% of the sample households were female headed, 21.1% had no oxen and 31.4 % had only one oxen [Wendwosen, 1998].

Absence of male member has also been seen as a critical problem in many households in other surveys too. As much as 25% households are headed by women and almost all of them are either widows or divorced [Dessalegn, 1994]. This has a direct implication on how they should utilise their available land.

Viewing a rural household as a small but complete production unit with all the necessary inputs under its disposal is no longer tenable. Due to the above constraints households lack completeness. On the one hand, there are many farmers suffering from either relative or absolute shortage of land with other complimentary inputs in their hands and on the other those who own land might not be endowed with sufficient amount of other factors of production. This disproportionate resource endowment calls for a certain form of arrangement that would enable all parties to use their inputs for better economic return.

As Ege (1994) indicated due to reasons including lack of male labour, illness, old age, death or complete absence of the family head and lack of oxen, many landholders in Ethiopia require to working with landless peasants. Whereas, those who lack land try to get access to land through a contractual agreement with landowners.

There were three forms of land use structures before the major 1975 land reform. In the northern part of the country, ownership of land was led by community-based *REST* [4]system while in the south few absentee landlords were controlling the ownership status with many tenants under their rule. Some commercial farms were also flourishing in the south, north and eastern parts of the country.

Undoubtedly, land reform of the previous government has brought about a significant institutional transformation in the owner-tenant relationship and provided tillers the right to use the land. But as a result of dynamic population growth, low level of changes in the overall structure of the economy, absence of frequent redistribution of land compatible to the pressing demand and non-expandable and immobile nature of land itself, land scarcity has become an acute problem.

Under the ruling government, land is a state property with farmers only having use right. But landholders are allowed to either lease or bequeath 'their' land for a short and legally recognised period of time [Daniel et al, 1997]. This rule further facilitated the legal operation of tenancy that exists in different parts of Ethiopia nowadays.

Studies indicated that lack of oxen and male labour are major factors contributing for land leasing. In Mafud district of North Shewa, of the total number of households who have given land to tenants, 47% did not have a male worker; another 40% had only one worker. Among the owners of tenancy land around 65% were without oxen [Ege, 1994].

Tenants rent land for two reasons. Some of them rent land because the land they own is not sufficient enough to enable them efficiently utilise their complimentary inputs while others rent because they do not have direct access to any land.

---

[4] It was a system of land use whereby only those who had descent kinship ties with the original founder of the community could have a right to use " communal land".

A study conducted in six peasant associations of Selale *Awraja (*in the previous administration level) found that around 80% of sharecropped land (one form of tenancy arrangement) was controlled by older, well established farmers with better oxen and labour factor endowments. The rest 20% were landless peasants [Yohannes Habtu, 1994].

Scarcity of land and its unequal distribution on the one hand and availability of under utilised complimentary inputs on the other have resulted in tenancy. The question then arises how efficiently resources are employed in this land use arrangement compared to farms run by own operators.

There are different views about the economic validity of tenancy. Some consider the system as reducing incentives of tenant farmers to work, invest on the land and improve efficiency. The arguments forwarded include that tenants lack security to invest on assets whose fruits would be harvested only in the long-run and they hesitate to maximise their output as the landlords take part of the produce. Thus, producing with utmost efficiency presupposes holding ownership status of the land and working ones own land.

Others argue that tenancy arrangement is a mechanism through which resources would be used more efficiently than otherwise. Particularly, in countries like Ethiopia where there are cases of disproportionate holding of complimentary inputs in the hands of different individuals, the system would help to maximise agricultural output.

The validity of one of the two polar arguments could only be confirmed through empirical findings. If at all, tenure system is taken to be the viable option of using resources productively, a question may arise on the kind of contractual agreement that maximises the level of efficiency.

Basically, there are two forms of contracts: fixed rent and sharecropping. A fixed rent contract is an arrangement whereby a tenant is supposed to pay the landlord a fixed amount of crop or cash for the services of the land. On the other hand, in a sharecropping contract, a tenant pays a certain percentage of his crop or its equivalent as rent to the landowner.

It is believed that tenant farmers involved in fixed rent system are presumed to maximise the residual of their variable level of output regardless of the amount of rent they are supposed to pay. But in the case of sharecropping, the rent is an increasing function of the level of output with a likely effect of discouraging tenant farmers to put their maximum effort.

There are diverse views on the functioning of sharecropping itself. Some consider it as efficient as other forms of land-ownership and user arrangements that enable sharing of possible production risks. Others contend that regardless of its advantage in situations of risks and uncertainties, sharecropping is inefficient and should either be discouraged or prohibited. For instance, Jabbar (1977) in Bangladesh and Junakar (1976) in India found owner operators to be more productive than tenants. After reviewing empirical works on the issue, Lipton (1985) held a different view: owner operators and tenants function on similar efficiency boundaries. In comparing fixed rent and sharecropping, a study by Hossain (1977) in Sudanese irrigated cotton farms indicated that both forms of arrangement were equally economically efficient.

Empirical findings on the level of efficiency on tenancy arrangement are very few in the Ethiopian case. Gavian and Ehui (1996) tested the relative efficiency of three informal land contracts, (fixed rent, share cropped and borrowed) relative to land held under formal contracts with the government. Based on data collected on 477 plots in Arsi Zone they found that informally contracted lands were less efficient compared to the land directly acquired from the state.

On the other hand, Bereket and Croppenstedt (1995) conducted a comparative analysis of own-land operators and sharecropper farmers using the Ethiopian Household Survey Data collected by Addis Ababa University and Oxford University. They did not directly estimate and analyse the level of production efficiency. Based on 695 sample farmers, they simply implied through some statistical techniques that sharecropping is an instrument to use idle resources in both the landless with other complimentary inputs and landowners with inadequate endowment of other factors of production.

The available empirical evidences in Ethiopia do not lead to a conclusion on the possible efficiency gap between own operators and tenants. This may be attributed to two main factors. Firstly, 'Peasants are poor but efficient.' hypothesis of Schultz (1964) which was widely accepted as the 'Bible' for a long time have influenced researchers to look only for exogenous factors that may bring about agricultural productivity. But using more appropriate models recent studies in different developing counties found that the degree of efficiency varies among the different farmers with similar resource endowments and proper utilisation of available resources could bring growth in production.

Secondly, until recently rural household data were virtually non existent. Indeed, conducting surveys on rural areas by an individual is both expensive and time consuming. Though few in number and relatively narrow in their coverage, rural household surveys have been conducted at the national level recently.

Changes in these two inhibiting factors have been the motivation for conducting this research. It is hoped that this study will help to fill the gap both in its wider area coverage and better model usage particularly to the specific area under consideration.

1.2. OBJECTIVES OF THE STUDY

The livelihood of every Ethiopian depends on the performance of the agriculture sector. But production has been lagging behind the growing population. On the other hand, the impact of land distribution and the associated tenancy system on the growth of agricultural sector in Ethiopia has been an issue not yet well addressed and resolved. Under such environment, some questions may be raised. Do farmers operate at the boundary of the frontier production function as Schultz's hypothesis indicated? Are there any efficiency differentials between owner-operators and tenant farmers, and does the form of contractual agreement have any influence on the level of efficiency? This paper tries to address these issues.

Thus, the main objectives of the paper would be:

- to examining the degree of technical efficiency of farmers in the sample
- to investigate and analyse whether there are technical efficiency differentials between own operators and tenants, and between sharecroppers and non-sharecroppers
- to assess factors that may influence the level of technical efficiency of tenants.

1.3. SIGNIFICANCE OF THE STUDY

Under the existing structure of the overall economy, introducing dynamism in the agricultural sector is critical for alleviating food shortages and economic stagnation in Ethiopia.

Given the farmers' resource endowments and the poor prospect for external injection comparable to the country's demand for growth, the feasible and immediate means of promoting agricultural production is to formulate and pursue policies and strategies that would enhance efficiency of inputs at hand. This requires estimation of different forms of efficiency indices, one of which may be technical efficiency.

Variations in technical efficiency among peasants may influence what form of development strategies and policies governments need to design. As Shapiro indicated;

> If most farmers obtain the best output/input ratios possible with the available inputs and technologies, then new investment streams may be critical for any development. However, if some farmers perform much better than most of their neighbours with the same inputs and technologies, there may be considerable scope for increasing output without major new investments [Shapiro, 1983: p-1983].

Providing empirical evidences on the degree of farmers' technical efficiency and factors contributing to it would, therefore, help to guide policy makers to shape their conceptions of farmers operation.

One possible factor that affects the level of farm efficiency may be scarcity of land, its unequal distribution and the resulting institutional land use arrangement. Operating on own land and rented land may not provide equal incentive to work with utmost efficiency.

Prior to this study, attempts were made to empirically examine the impact of tenure arrangements on farmers' efficiency. But these works were limited either in terms of area coverage or the methodology they used.

Unlike Bereket and Croppenstedt (1995), and Gavian and Ehui (1996), who used simple statistical methods and total factor productivity measures, this paper would employ a stochastic production function approach. A stochastic production function would help to examine the relative magnitude of technical efficiency each individual farmer attained compared to the frontier production levels with given inputs whilst the conventional models and simple statistical measures do not have this quality.

Thus, it is worthwhile to conduct such a research to provide possible ideas for policy makers to revitalise their policy package particularly towards improving land utilisation at the moment when the efforts of the government and the farmers at large are directed to enhancing agricultural production

1.4. LIMITATIONS OF THE STUDY

1. The survey provides the size of rented-in land. But it fails to show how much cereal production was obtained from the rented-in land alone. Thus, output from and input levels on tenant farms include both own and the rented-in lands.

2. The study may not indicate the pattern of efficiency of farmers over time since it is cross-sectional in nature and its scope is limited to addressing efficiency differentials of groups of farmers at a point in time.

1.5. METHODOLOGY AND SOURCE OF DATA

This study basically uses a quantitative approach employing statistical and econometric tools. To examine the nature of the data, simple measures of central tendency and scatter variability and other techniques of descriptive statistics are applied. Regarding estimation and analysis, the basic econometric tool would be stochastic frontier production function regression. Stochastic frontier production function would help to estimate farm level efficiency.

The basic source of data for this study is the first round of the 1993/1994 Ethiopian Rural Household Survey collected by Economics Department of Addis Ababa University in collaboration with Centre for the Study of African Economies, Oxford University; United Kingdom.

2. SURVEY OF LITERATURE

2. 1. THEORETICAL BACKGROUND

Due to some economic, political or institutional constraints, households may fail to be complete production units. Some factors of production may be in excess supply while other critical inputs are lacking. Combining compatible resources available in excess in two or more households would maximise output as compared to the alternative of leaving them idle. Thus, households seek to find ways and means to engage their available resources in the production process. Some argue that one of the many institutional arrangements that makes it possible for such optimisation is tenancy system. But others consider tenancy as a source of misutilization of resources.

Land tenancy is a system where by land is utilised not by the owner of the land but by another farmer who pays some kind of rent to the former. The farmer who uses another individual's land by paying a rent for the service is called a tenant. Different views exist about the economic impact of tenancy of which theories revolving around efficiency possess a pivotal position. This chapter tries to review some of the fundamental theories and empirical findings on tenancy efficiency. It also attempts to provide salient features of tenancy in Ethiopia.

2.1.1. Economic Implication of Tenancy System: General

Most scholars argue that tenancy reduces farm efficiency and retards the overall growth of the agricultural sector. Since tenancy does not imply control over the land, a tenant "... will not make long-term investments in his holding unless he is secure in his expectation of reaping the benefits of his investments " [Bruce, 1986: p-28].

Others also argued that the increase in the rate of discount (r) due to tenurial uncertainty (on future benefits) results in an increase in short-run investments as opposed to permanent improvements such as contour bundling or erosion control. This implies that instead of putting their resource on growth generating activities, tenant farmers are likely to invest on marketable assets and/or on goods which have shorter gestation [Barrows, 1973 and Junakar, 1976].

According to this view, tenants are likely to under supply their resources on rented-in land due to fear of insecurity and this would cause differences in the level and quality of resources between owner-operated and tenant-operated farms. This in turn implies that own-operators and tenants lay on different production functions, and the latter is expected to hold an inferior one. Thus, tenancy increases social inequality and leads to sub-optimal input use practices.

Land is under state control in Ethiopia. However, every farmer does not have the opportunity of possessing land from the state and tenancy is an institutional land use arrangement that has been practised in the country.[5] On the other hand, there is high population growth, stagnant economic transformation and increasing number of land claimants. Due to these factors, the government redistributes land for those who do not have access on occasional basis. This situation makes 'landholders' suspicious of land redistribution every time. The ultimate result of this fear makes insecure not only tenants whose access to land solely depend on the will of land-holders but also the land-holders themselves. Given such circumstances, insecurity of land is more severe for tenant farmers in Ethiopia and the impact of insecurity on efficiency seems relevant in this respect.

Other scholars hold a different view. Tenancy promotes efficiency by allowing better use of resources that would otherwise be idle. It is argued that:

> "... if a person does not own some types of assets, especially types with imperfect or expensively-accessed markets, that person's net yield from combining his labour with other assets may be substantially reduced. ... lack of owned oxen, in conjunction with imperfect markets in draught-power, may so reduce the return to own-operated farmland as to induce the land owner to rent out." [Lipton, 1985: p-3].

[5] We have detail discussion in part 2.2 of this chapter.

Stagnant nature of the economies and lack of job opportunities as well as limited capacity of individuals to move from farming to other professions force landless peasants to work with landowners under certain conditions. Thus, in response to this disproportionate resource endowment, households try to involve themselves to various forms of institutional arrangements that would enable them to use idle resources in a more efficient way.

Lipton (1985) also argued that tenancy acts as a means of adjusting different ownership holding sizes towards an operationally optimum land size. Holding an optimum size in turn enables tenants to operate near the bottom of the average cost curve.

Furthermore, being a tenant may provide a better incentive to strengthen ones effort for own benefit and thereby promoting efficiency compared to opting for wage-labour employment. In this sense, the net effect of tenancy market operation is to provide increased social welfare given non-egalitarian land distribution.

The debate on the efficiency impact of institutional arrangements is not limited to the tenancy and own land operation. It is extended to different forms of tenancy. It is stated in the literature that different forms of tenancy arrangement (fixed-rental or sharecropping) have different efficiency implications.

Fixed rent and share cropping contracts have existed for centuries under different objective circumstances. Detail contractual agreements and the environment under which they operate widely varied overtime and space. The controversy on what form of contractual agreements is preferable led most of the scholars to deal with the study of fixed rent vis-à-vis sharecropping. Though both fixed rent and sharecropping contracts have been attacked on the ground of efficiency, much theoretical explanations are provided for the latter.

2.1.2. Sharecropping

There are many theoretical models that tried to explain the efficacy of sharecropping on the basis of efficiency: some argue in favour of it while others condemn its existence. These theoretical models raise and discuss issues related to how efficient is sharecropping as compared to other alternative land tenure arrangements, the impact of rental share on tenants' efficiency, the need, extent and impact of land-owners intervention on efficiency of tenants.

One can broadly classify these models into four as they are related to sharecropping efficiency: the Marshallian Hypothesis, Cheung and others, General equilibrium model and non-competitive markets and the role of sharecropping. A brief description of these models is provided below.

A. The Marshallian Model

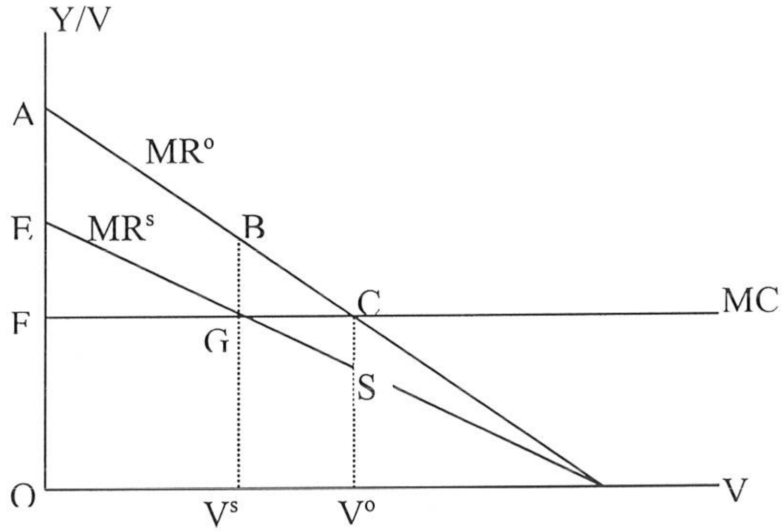
Until the pioneering work of Alfred Marshall in 1920, no tangible economic analysis was provided on sharecropping. Almost all pre-Marshall scholars considered sharecropping as inefficient system of operation and the Marshallian model used as a basis for analytical explanation as to why sharecropping is an inefficient system [Bell, 1977].

This model assumes that markets for inputs including land, tenants and hired labour and outputs are purely competitive, there is perfect certainty and smooth enforceability of contracts.

Assume that we have two farmers; one is owner-operator or fixed rent tenant and the other is a sharecropper paying a certain fraction of his gross output as a rent for the use of land (r). Assume also that both farmers use homogeneous fixed input, land (H) with a similar area and soil fertility. They use variable inputs (weighted in monetary terms as one factor endowment V, for the sake of convenience) and produce Y amount of output.

Given a competitive market, the two farmers commonly encounter horizontal marginal cost curve (MC). To simplify the analysis, the two farmers are assumed to have downward slopping marginal revenue curves. While the marginal revenue curve of owner operator is MR^o, the respective curve for the sharecropper would be $MR^s = (1-r)MR^o$, since the latter is supposed to pay rMR^o as a rent to the landowner. Ceteris paribus, as a rational economic agent, the two farmers are supposed to maximise their respective revenues by equating MR_i and MC.

Fig. 1 The Foundation of Marshallian Hypothesis



Source: Bell, 1977, PP. 319-320

A tenant paying a fixed rent or owner operator employs v^o units of variable inputs with an optimal position at point C. The share cropper's variable inputs supply would be v^s. To satisfy the marginal condition, the sharecropper would under supply the variable inputs by $v^o - v^s$ amount.

If the share parameter (r) is allowed to have higher values, the slope of MR^s would further decline with an ultimate result of widening the difference in variable input supply of the two farmers.

As it is observed from the above figure, the gross outputs of own land operator and sharecropper are $OACV^o$ and $OABV^s$ respectively. Output $OFGV^s$ is the opportunity cost of the variable inputs or payment to the services of variable inputs and EABG is a rent paid to the landlord. Only the remaining output would be left for the sharecropper over and above his cost of production. Given this level of operation, the sharecropper's gross output lags behind the own land farmer by the amount of BGC, which could be taken as a welfare loss.

If r grows further to a level that would force the MR^s curve to pass through point F, no sharecropper would be willing to work in this form of arrangement. Considering the rental share paid to the landlord as 'excise-tax' imposed on the sharecropper, this model is sometimes called 'tax' equivalent approach.

The argument against sharecropping goes as flows:

> " ... a tenant whose contract stipulates solely the fraction of gross output to be paid as rent will have an incentive to use variable inputs less intensively than an owner operator or a tenant leasing in land on a fixed rent basis. Under competitive conditions, fixed rent contracts will lead to a pattern of resource allocation which is Pareto- optimal, so that production under sharecropping will not be efficient" [Bell, 1977: p-318].

Based on the above analysis, this school concludes that sharecropping is inefficient compared to wage-labour, own-land operators or fixed rent land lease. The Marshallian school, therefore, advises that some sort of government intervention is required either to reduce rent or prohibit totally this form of arrangement as a means to improve social welfare.

The Marshallian view of inefficiency is criticised in its failure of taking into account the merits of sharecropping. Sharecropping has advantages. These include" ... the reduction of supervision costs for landowners who sharecrop out instead of employing; reduction of research-costs for those who choose to share crop rather than to work on land operated by others; risk-sharing effects; ... " [Lipton, 1985: p, 25].

B. Cheung and Others

Challenging the Marshallian view, Cheung (1968, 1969) argued that ".... a sharecropper will under supply effort to the share tenancy is incompatible with pure competition ... the competitive mechanism will not permit inefficiency models of production/ exchange to survive" [Rao, 1987: p-1164]. This school further states that the landowner would induce efficiency in the sharecropper by supervising the use of desired level of inputs and efforts.

Against the Marshallian tradition which implicitly assumed only one variable, rental share, Cheung argued that many real world contracts accommodate items such as the amount of land to be cultivated, non-labour inputs to be supplied, etc. [Quibria and Rashid, 1984: p-105].

Johnson (1950) indicated three ways in which the land owner will seek to enforce the application of inputs that would generate optimal levels of output;

i. specify guideline what the tenant must do
ii. guarantee the land on a short-term lease and renew the contract based on periodic assessment of the tenants' performance
iii. sharing the cost of production in the same proportion as the shares in gross output [Johnson, 1950: p-118,].

Cheung (1968) approached the problem from the side of the landlord (taking into account Johnson's proposal of enforcing input application) and tried to show how Pareto-efficient sharecropping system is.

Bell (1977) tried to illustrate the hypothesis of Cheung in the following way. Assume that the landowner is able to take measures to enforce the contract on the share croppers application of the desired level of variable inputs and the magnitude of rental share. If a perfectly elastic labour supply, which enables labourers engage either as a tenant or in other alternative employment, exists, there will be a competitive equilibrium. At the equilibrium, both the rent per hectare of land will be equal to its marginal product and the marginal product of the tenant will be equal to the wage rate. These marginal conditions would be achieved through the landlords' effort to set appropriate control levels.

Thus, the unlimited labour supply resulted from the competition among sharecroppers will lead the existing sharecropper to supply V^o and earn a fee $OFCV^o$ for his effort equivalent to the alternative earnings in the labour market as shown in Fig. 1 whilst the land owner is able to tax EFG.

Cheung's analysis is based on some superfluous assumptions, too. For instance, tenants are not allowed to choose among landlords and they are assumed to freely and smoothly move from one activity to the other. In practice, as there are many tenants, there are several landlords with whom such arrangement is possible.

The inefficiency argument of Marshall was also attacked on the basis of the Coase- theorem. According to this analysis, both the landlord and the sharecropper would negotiate and reach at a contract that would exhaust all gains from trade. " Since the maximum the landlord is willing to pay is in excess of the minimum the tenant is willing to accept, obviously there is a room for trade" [Quibria and Rashid, 1984: p-105]. Thus, the two parties could agree on point C in Fig.1. Because the landlord may regain BGCS level of output at V^{o}, and the tenant would be willing to accept any amount greater or equal to his labour cost GCS. The implication behind this theorem is that share-rate is a function of the tenants' output unlike the previous cases where an agreement is reached on the rate prior to production. This is hardly possible to make it practical.

C. General Equilibrium Model

Bardhan and Srinivasan (1971) formulated a general equilibrium approach allowing both the landlord and tenants to influence rental share determination unlike Marshallian and Cheung who viewed the process on the side of one of the parties.

In this model, the tenant is assumed to lease in land to cultivate with his labour or engaging himself as a wage labourer. On the other hand, the landlord is provided an option of renting his land for tenants and collects a share or hired labour and pay wages. The labour market is assumed to be competitive. We have the demand for land as an inverse function of the rental share (r) and the wage rate. Similarly, there is a supply function for land with positive relations with rental share and wage rate variables. Both parties strive to maximise their utilities that could be expressed in terms of income and leisure.

Assuming both the landowner and sharecropper could play a role in enforcing contracts in this model, the equilibrium share-rental rate is determined by equating demand and supply.

Bardhan and Srinivasan (1971) end up with a similar result to the Marshallian Paradigm: sharecropping is inefficient.

In their model, Bardhan and Srinivasan assumed that the marginal product of land could go to zero values. But as Newbery (1977) argued, this is highly implausible in land-scarce countries and most production functions including Cobb-Douglas could not provide this result. Newbery further criticised Cheung's labour intensity stipulation considered as it could easily be enforced in the general equilibrium model. For the landlord to constantly enforce the intensity of labour by the sharecropper, he might employ a labourer that requires additional cost.

Lucas (1979) took wage-labour as it requires monitoring in order to extract full effort. Then, he concluded that:

> two distortions seem to emerge in this world: monitoring costs for the landlord and a share tax on the tenant. ... (Thus), the mixed wage /share tenancy economy is technically more efficient ... than a wage-only economy [Quibria and Rashid, 1984: p-107].

D. Non- Competitive Markets and the Role of Sharecropping

On the basis of the agrarian economies, Raquibbuzaman (1973) examined sharecropping under dual labour market conditions with the assumption that the cost of wage-labour is strictly positive and family labour being zero. If such duality exists then sharecropping is not likely to be inefficient. Because the sharecropper with his family would supply labour input as its marginal product less rental share [MP(1-r)] equals zero while that would not be the case for hired labour [Quibria and Rashid, 1984: p-105]. Raquibbuzaman's assumption of zero opportunity cost for family labour implies that there is no other alternative employment for such labour. This is a stringent assumption.

Jaynes (1982) argued that in conditions of capital market imperfections, both capital-constrained landlord and a tenant with adequate amount of capital would benefit if both agreed on a point where both parties receive a share of output equivalent to their share of capital costs. This point of agreement allows a fair share for the tenant too [Quibria and

Rashid, 1984: p-105]. The terms of trade involving the two parties under less developed capital market conditions would, therefore, lead to Pareto-optimality.

A number of authors on cropsharing indicated that in agrarian countries land lease markets tend to be interlocked with other markets. As small tenants rent land they would be required to buy or sell goods from, borrow credits, or work for the landlords.

Interlocked markets may have their own impact on tenants' efficiency. There are two counter arguments regarding such markets [See Taslim, 1988 for further discussion].

Some argue that landlords interlock land lease to other markets including credits:

- to provide cheap credits to improve allocative efficiency in the presence of costly monitoring and moral hazard problems in less developed countries,
- to facilitate production since access to other credit facilities on sharecropped land is limited,
- to tie up land, credit and labour markets to avail inputs at the right time and quality.

The effects of interlocked markets are not welcome by other scholars. According to them, markets are interlocked by landowners to extract maximum surplus from their tenants and keep them in perpetual bondage of indebtedness. These markets discouraged technological innovations on behalf of the landlords so long as improvements from such investments may be compensated by the loss of interests on loans that could otherwise be gained from tenants if the money was lent to them. Indeed, such contracts reduce the freedom of poor tenants to compete and bargain in free markets. Constraints resulting from interlocked markets would, therefore, tend to discourage tenants to operate on optimal production frontier.

From the two polar arguments one may conclude that the net effect of interlocked markets depends on the availability of a more viable option in the system and the kind of contracts agreed upon by the two parties.

Even if sharecropping could be taken as inefficient system on the basis of different arguments, uncertainty and risk reduction may also be viewed as an alternative objective to efficiency maximisation. Different contracts entertain different degrees of risk for the two parties involved.

> Under a fixed rental system, the entire risk burden falls on the tenant, while under a hired-labour wage contract, it falls on the landlord. Regardless of crop failure, the landlord sets a fixed amount in the former case, while in the latter the hired workers are guaranteed a fixed amount [Huang, 1975: p-706].

Sharecropping, on the other hand, is considered as a dispersion mechanism through which risks on agricultural activities could be shared between the landlord and the tenant.

Newbery and Stiglitz (1979) have provided additional rationale for the role of sharecropping in uncertain situations and imperfect market conditions. Sharecropping is a risk-sharing device, provides incentives to the tenant compared to wage workers, economises on information and is a means of screening workers of different capabilities.

According to some economists,

> Agriculture typically consists of a sequence of production decisions, which will be affected to various degrees by the weather and other unforeseen events. These events will thus affect the demand for labour over the years in a random way and make it impossible for the labour markets to guarantee full employment at a constant, or even predictable wage [Newbery, 1977].

Not only the sequence of activities that matters, but also the possibility that every farmer becomes simultaneously busy during the main agricultural season and wage employment may fail short of the own-operators' demand.

Lack of timely supply of adequate variable input also applies to oxen and bulls. In the Ethiopian situation, it is a more acute constraint compared to problems of labour supply for many landholders.

Sharecropping is not inefficient compared to other means of labour use if it is also seen from another perspectives. Not only sharecropping, but also the use of hired labour on own-land need supervision. If the owner-operator lacks adequate family labour, and opts for hired farm workers, his operation would not be efficient unless he has an experienced family member who could work with and make hired workers put their maximum effort on the field.

Many tenants own inputs for some of which (like knowledge or husbandry skills and other physical factors of production including land and animal draught power) the market is either incomplete or non-existent. Under imperfect factor market conditions, tenants may be forced to take into account resources they left idle when ever they bargain on the level of wages: higher wages vis-à-vis tenancy operation [Toutique, 1988: pp. 91-94]. In this regard, renting land to tenant farmers would maximise the benefit of the landowner better than hiring a labourer.

According to this view, even if there might exist " tax equivalent" output loss due to sharecropping, the system might be preferred to fixed rentals or hired labour contracts by either of the two parties if risks are significant enough to merit the disadvantage described in the Marshallian model.

2.2. TENURE SYSTEM IN ETHIOPIA: SOME BASIC FEATURES

Land tenure system is as old as recorded history. " The manner of its first appearance and its precise early origins ...can only be the subject of speculation based on the most fragmentary of information [Byres, 1983: p-7].

Whatever its precise origins in time, land tenure system was formed in a variety of places. It

> "...has spread ... survived continuously often for a millennium or more, ... diminished in others ... and finally disappeared else where, driven out in some areas by the relentless advances of capitalism and spread of capitalistic relations in the country side or exaceberated by land reform and collectivisation in socialist countries" [Byres, 1983: p-11 &12].

Land tenure system has been prevailing in Ethiopia for many years with different forms in the various regimes[6]. During the emperor's era not only land ownership was too much skewed but also tenure system was existing in various forms over the different parts of the country with legal covers favouring landlords.

In the northern part, peasant ownership of land was claimed through the community -based *REST* system and the associated land tenure arrangement was not as vivid as the south. The *REST* system provided individuals lifetime use-right over their share that could be acquired from the 'communal' land. In this system, only those individuals who had descent kinship ties to the original founder of the community were entitled to gain a share. Periodic redistribution was made to fulfil the demands of new claimants arose from the system [Dessalegn, 1994].

In the south, land ownership was highly concentrated in the hands of few landlords who let a large portion of their land being farmed by tenants with an obligation of paying a larger share of their output (up to 75% in some areas) for the former. In some parts of the south, the development of mechanised farming during the late 1960s even led to the evictions of many hand-to-mouth tenants from their rented holdings [World Bank, 1977].

Dejene and Teferri (1995) noted that the Orthodox Church was also a big landowner controlling the right of using a large share of the land in many parts of the country. The church provided the land under its disposal (which was known as *SEMON* land) for clergymen as a privilege for serving the church and allowed to charging certain peasants a tribute from which government would not collect taxes. This could be taken as one form of tenancy relationship.

There was also land under privates. This land was either expropriated from peasants and local chieftains or unoccupied land given to loyal servants of the ruling class [Daniel et al, 1997].

The views of many scholars towards the tenure system in Ethiopia during the Imperial era were negative. Some argued that "Ethiopia is one of those rare countries so richly endowed

---

[6] For further discussion of tenure system in Ethiopia refer authors like Dessalegn (1984), Dejene and Teferri (1995), Mesfin (1991).

by nature that the agrarian structure, feudal in every sense of the term, does appear to be the only constraint on development" [Warriner, 1973].

The prevailed tenure system, particularly in the southern part of the country, was blamed for killing development initiatives. In these areas," ... landlords did not take an interest in the development of their lands, did not share in investing in new inputs and because of the skewed distribution of income resulting from the tenure patterns, it was felt that growth was slowed" [Ellis, 1980: pp. 526&527].

Ellis (1980) further argued that the tenure system was retarding growth as it stifled incentives to innovate, evicted peasants and intensified urban migration, aggravated income inequality and there by enhanced the demand for imported items while capacity under utilisation of domestic industries might prevail due to lack of demand.

On the basis of land tenure failures, land reform proclamation of 1975 which was carried out with the intention of abolishing without compensation all private ownership and let all land to be " the collective property of the Ethiopian people", prohibited tenure system all over the country [Ethiopian Government, 1975].

In Ethiopia land is a means where by the actual existence of the majority of the people, the peasants and the hope of their children rely heavily. A policy shift on land ownership is likely to affect all aspects of peasant life: economic well being, land use decisions, social equity, and social relations [Ege, 1994: p-3].

The immediate effect of the land reform was reflected, among other things, in equity: in terms of both land and income distribution. A study undertaken in Wayu of North Shewa, for instance, indicated that the proportion of households owing less than 7 *timad* (1 timad=0.22 hectares) increased from 42 percent during the pre-reform period to 91 percent after the reform. Indeed, 7 percent of the households were landless during the pre-reform period. But all of them got access to land as a result of the reform [Teferi, 1994 and Dejene and Teferri, 1995].

A similar study conducted in Arsi administrative region has revealed that the average incomes of sampled households increased by 91 percent during the post-reform period compared to the pre-reform times. This might be attributed to the abolition of tenancy rents [Dejene and Teferri, 1995].

The Mixed Economy Policy of the Military Government in March 1990 strengthened the " ownership" rights of peasants by providing provision for either renting or transferring their land to children. But the policy still prevented selling and mortgaging land [Ege, 1994].

The basic modality for creating an equitable land ownership since 1975 land reform is through redistribution of land. But " experiences differ from one part of the country to another with regard to land distribution after the *Derg*. Rare have been the cases where full-scale redistribution has occurred; the common practice has been to try and accommodate new claims through small allotments or to freeze all new allocations" [Dessalegn, 1994: p-3].

Thus, given the existing technology and the structure of the over all economy, the problem of absolute or relative shortage of land is and would continue to be a crucial problem. Nowadays, landless and land deficit population coexist with small holders all of whom might not be endowed with the required amount of other inputs like draft oxen and farm labour.

A study conducted by Ege (1994) on 13 Peasant Associations of Mafud district in Amhara region as of 1992/93 indicated that 20 % of the households were tenants while 4 % were landless (who did not even rent-in land) and involved in other ways of living. A similar study on Ayne PA of the same district indicated that from age group of 20 and more, 27 % and 78 % male and female peasants respectively were landless. The problem would be further intensified when the population below 20, who constituted 58 % of the population in the area as of the study, come to age and demand their share of land or want to enter into tenancy market in the years that follow [Ege, 1990: p.232]. Thus, land owner-tenant relationship in various arrangements has been becoming not only a common phenomenon but will also grow with an increase in the agrarian population.

Specific socio-economic groups have less access to land compared to others. The study conducted in 1994 on different parts of Ethiopia for example indicated that recently married youngsters, non-married women, households lacking the necessary inputs, and peasants failing to pay government taxes are disadvantaged in terms of access to land. Furthermore, individuals who have settled in the communities after land has been distributed, ex-soldiers, peasants who had taken refuge in the nearby countries, returnees from resettlement, and persons displaced by the civil war are less favoured in terms of access to farming plots [Dessalegn, 1994 and Teferi, 1994]. From this stock of landless or land scarce farmers, those who have relatively adequate complimentary inputs demand to enter into tenancy market.

On the other hand, there are peculiar features that force farmers to be tenancy landowners. Most often, female-headed households, households with no oxen, households whose male labour is declining or completely absent (including widows, disabled people, or orphaned children) and households who have no adequate complimentary inputs to use all of their holdings usually lease their land [Ege, 1994: PP.17 &18].

A study on six peasant associations of North Shewa in Oromia regional states demonstrated the feature of land use as:

> " ... less than 50% of the households ... in the study area farm the *only* land legally bestowed on them; more than one in five farmers who already have land ... access other farmers' land to prevail over their land constraints. On the supply side ... 15% of the households in the study PAs (Peasant Associations) ... rely on sharing their land resource to overcome other production constraints. Over 10% of the households ... were found to be landless ... i.e., without accesses to shared or cash rented land. ... Sharecropping was found to be the most significant way for indirect access to land by the landless ..." [Yohannes, 1994: p-10].

Various forms of rental contracts exist among the owners of the land not only over the different parts of the country but also in a given locality. These rental agreements could either be expressed in fixed rent, sharecropped, or in other forms.

Ege's study on 13 PAs of Mafud district in Amhara region showed that in the highlands which constitutes 10 PAs, the tenancy land is described as <u>Ma¨ gazo</u>. In this system, the rent varies from 1/4 to 2/5 of the harvest. The agreements commonly witnessed in this category are *Erbo* and *Siso* where by owner farmers are entitled to get 1/4 or 1/3 respectively. In some cases, the share may be as high as 1/2. In the low lands, the tenancy land is described as *Ye-gamis* or *Ya-gamash.* This is to specify the amount of share which is 1/2. In the low lands, the common share is 1/2:1/2. But, there are cases where tenants may be required to pay 1/3 or other rates. According to Ege, Even though peasants claim that there are differences between *Magazo* and *Ya-gamash*, there is no clear variation except the rate [Ege, 1994: p-6].

On the other hand, a study on Wayu and Anget Mewgiya PA of Northern Shewa showed that in all forms of *Magazo*, both the land owners and the tenants are expected to contribute seed proportional to their respective output shares. If one of them failed, the person who let the seed would be entitled to take the amount from the produce before distribution [Teferi, 1994: p-14].

In many of the studies, the prevailing rental system is sharecropping. The role of sharecropping varies over the different parts of the country. Bereket and Croppenstedt (1995) found out that no household was reported to share crop any land in Indibir Hayagasha of Gurage zone. In other places, the percentages of households renting-in land in sharecropping ranges from 3.1% in Adele Keke of the East Hararge zone to 41.7 % in Yetmen of the East Gojjam zone. The percentage of sampled households who rent-out land is as small as 0.8 % in Adado of Sidama zone and as large as 31.1 % in Yetmen [Bereket and Croppenstedt, p-342, 1995].

The current tenancy system of the country is not similar to the kind of rich landlord-poor tenant relationship that is prevailing in many countries of the world or the one which was existing during the emperor's regime particularly in the southern part of the country. The factor that leads the owners of the land to tenancy markets is not ' excess holding ' as was the earlier times.

Ege noted that

> The relationship between the landowner and land user is asymmetrical, but in the opposite way of what is normally associated with tenancy situations. When we talk of tenancy, we normally envisage large landowners, or at least well-to-do peasants sucking the labour of others through onerous tenancy arrangements, ... although the

> tenancy arrangements currently in question are not necessarily onerous, ... the tenants are generally much better off than the owners, and not so much below those who only cultivate their own land [Ege, 1994: p-12].

While landlords of some other countries are endowed with large size of land and opt for exploiting the services of many tenant farmers 'under their rule', tenancy landowners in Ethiopia involve themselves to this arrangement usually due to failures of employing other indispensable inputs in terms of adequate magnitude.

On the other extreme, the Cheung's assumption that states the co-existence of unlimited supply of sharecroppers and a monopoly landowner does not seem a realistic assumption in the context of Ethiopia. In Ethiopia, there are many landless peasants. On the other hand, the state as the landowner provides farming plots to farmers and periodic redistribution is also made. Thus, in this country, it is neither possible to assume monopoly of land nor an easy access to it.

Possibly one can hypothesise, therefore, that share cropping is neither as inefficient as the Marshallian model nor as efficient as the Cheung hypothesis has asserted. Both parties have a room to influence contract enforcement. This is the view of Bardhan and Srinivasan (1971). As it was mentioned before, these two scholars assume in their General equilibrium model that marginal productivity of land could go down to zero values. While the overall description of the theory seems to be relevant to the Ethiopian context, 'the zero marginal product of land' proposition is not realistic given sever scarcity of land in the country.

On the basis of the Ethiopian specific conditions, two contradictory views may arise. Some argue that tenancy system promotes efficiency by allowing well-to-do farmers to apply their resources on the land that could otherwise be under utilised.

On the other hand, some have a view that as a result of population explosion and stagnant economic transformation, periodic land redistribution makes tenants more insecure on the use of land. This might reduce incentives to improve land use conditions and enhance efficiency.

There might also be different views on the impact of rental share magnitudes. As population increase potential tenants may involve themselves into scarce land-lease market with a possible effect of pushing the margins of rental share up. Given this condition, some may argue that competition among tenants may increase productivity of farmers regardless of the level of rental share. Others think that extending the proportion of the fruits of labour that goes to the landowner might discourage sharecroppers to spend more effort on the rented-land.

Theoretically, whether tenure arrangement is efficient or not lies on the degree to which the tenant can decide on the use of the land, how input costs and produces are distributed and to what extent the tenant is secured. In reality, however, how tenant farmers perform is an issue that needs to be empirically addressed.

2.3. EMPIRICAL EVIDENCE

Of the accumulated literature, some studies are reviewed here to shade light about the salient features of the empirical findings.

Using evidence from Northeast India, Purnea district, Bell (1977) tested Marshallian and Cheung's hypotheses using simple linear regression models and other statistical techniques for his analysis.

The micro evidence, which took into account landowners, sharecroppers and fixed-rent arrangements seem to stand against Cheung at least in the Indian case. The majority of the households were found to be governed by the hypotheses of the Marshallian model. Thus, in case of Purnea District, share cropping was found to be economically inefficient compared to the alternatives.

Jabbar (1977) conducted a study on one hundred farmers from three districts of Bangladesh using simple descriptive statistics and found that different tenure classes achieved different levels of efficiency but owner-operators were the most efficient. According to him, relative inefficiency of the tenure classes implied that the then pattern of resource ownership and property relation were improper for attaining higher level of efficiency.

Using partial productivity measures, a study on Indian agriculture indicated that owners were more productive than tenants for large farms, but no significant difference was observed between small farmers of the two groups [Junakar, 1976: pp. 42-60]. The study did not account for the quality of land in the production function and therefore there might be a possibility that the leased lands were poorer in quality compared to the owner-operated counter parts.

In contrast, after reviewing different empirical works on the issue, Lipton (1985) concluded that owner-occupiers within a village are neither much more nor much less efficient than sharecroppers. Huang (1975) also noted that yields of tenants were at least as good as owner operators in a number of countries as it was found by himself in Malaysia, Ras and Malone (1965) in India, Ruttan (1966) in Philippines, Bray (1963) in US, Cheung (1968) in China and Hendry (1960) in Vietnam.

The relative efficiency of two-forms of production relations was investigated in the Sudanese irrigated cotton farms: the Joint Account (JA) System and Land-Water-Charge System, where the former was basically a sharecropping arrangement and the latter was a fixed contract. Using Seemingly Unrelated regression methods, a profit function was estimated. According to the study, the two groups were found to be technically, allocativelly and hence economically equally efficient. Thus, the two groups of farmers operated on the same profit function. From his finding the author implied that experiences on Sudanese cotton farms lent no support of the Marshallian theory [Seleem, 1988: pp. 975-984].

A study using data from three different areas in Bangladesh indicated that partial productivity measures (other than labour input) were higher for tenants than owner operators. Relatively higher number of labourers working on tenant farms explained this result [Hossain, 1977: pp. 285-348]. With different resource endowments and farm technologies, comparing partial productivity indices would likely provide misleading results.

Majid (1994) conducted a study on the Punjab and Sind provinces in Pakistan to examine the rational of share cropping by allowing for risk sharing, effective supervision of labour, and reserve stock of family (non-tradable) labour in peak period of labour supply constraints.

The evidence suggested that "while the institution is likely to obtain in environments that are not highly risky, ... labour market constraints of supervision and peak period supply are plausible rationales for sharecropping" [Majid, 1994: p-721]. The implication of their finding is that the need for sharecropping is not for its role in possible risk sharing activities. Rather as Cheung and others argued, it increases efficiency by enabling adequate supply and effective management of labour inputs.

A study in Malaysia, on data from the 1960 Agricultural Census of the country indicated that tenants and owner-tenants (those who own and rent land) have significantly higher yields than owner cultivators do. Neither the type of contract and farm size variations nor the differences in soil conditions explained the differences in yields between tenant and owner cultivators. While 36 % of the owner cultivators used fertiliser, the percentage values of tenants and owner-tenants were 57% and 69% respectively. Within tenants, sharecroppers were found to be more productive than the fixed-rental contracts [Huang 1975: pp-711-713].

According to the Marshallian competitive model, the level of efficiency of share cropping is a decreasing function of the rental share. Using quite a different model, a bargaining theoretic approach, Bell and Zusman (1976) examined whether rental share is set at a point where both involved parties are in a Nash equilibrium[7]. The evidence mainly originated from Northeast India, Bihar indicated that rental share determination does not necessarily go in line with Nash's equilibrium. Thus, sharecropping arrangement does not entail equilibrium level of operation and it is in a state of motion.

Studies that deal with the economic impact of tenancy in Ethiopia are very few in numbers. The study by Bereket and Croppenstedt (1995) provided an indication that landowners and sharecroppers operate in the market for tenancies to adjust land holdings to factor endowments such as family size and the number of oxen owned. Thus, "... if off - farm employment opportunities are limited, share cropping helps increase efficiency".

Thus, those who argue that tenancy system is inefficient do not thoroughly examine the opportunity cost of the system given the existing land ownership structure. Given the land tenure system, tenancy provides an opportunity of earning income for the landless, most of whom are young, and it also helps the land owners to maximise their benefits that would not otherwise.

The study by Bereket and Croppenstedt (1995), however, has its own weaknesses. It did not use any econometric model that would measure the degree of efficiency of farmers and the possible efficiency differential amongst them. Rather it tried to imply from simple average measures that sharecropping is an efficient system through its role of employing resources.

Gavian and Ehui (1996) tried to test the relative efficiency of three different informal and "less" secure land contracts (fixed rent, sharecropping and borrowed) on the basis of data collected from 477 plots in Arsi Zone. According to their finding, although farmers of the informally-contracted lands applied inputs more intensively, lands were found to be cultivated 7% to 16% less efficiently compared to own-operated farmers. From this result they concluded that the widespread insecurity of rural land in Ethiopia suggests the need for more stable, enforceable leases to all rural farmland.

In their study the methodology used was total factor productivity (TFP). This measure could not enable them to compare the observed level of output of each group of farmers against the ' best practice' or the maximum possible outputs.

There are also some other empirical evidences on agricultural efficiency in Ethiopia. Abay (1997) tried to assess the impact of education on allocative and technical efficiency of Ethiopian small holder farmers based on the Ethiopian Rural Household Survey conducted by the department of the Addis Ababa University. Using a profit function approach, he found

[7] Nash equilibrium is a point of agreement reached between bargaining parties through plausible bargaining processes. The agreement payoffs to the parties depend on their "disagreement payoffs" and the feasible set of all payoffs [Bell and Zusman, 1976]. This point of

that the mean level of profit inefficiency observed in the sampled farmers was 46 %. He further noticed that educated farmers were relatively and absolutely more efficient than illiterate farmers.

Assefa (1995) conducted a study to determine the degree of technical inefficiencies of smallholder farmers and explain which factors could contribute for such variations among farmers in Ada and Baso and Worana *Woredas*. By applying a three-stage procedure on Cobb-Douglas production function, he concluded that there exists a room for increasing agricultural production through improving input-use efficiency. And, he identified secondary school education, oxen, time of fertiliser delivery, and extension contact as the most important factors influencing technical efficiency in Ada Sub district.

Alemayehu (1989) conducted a study on two peasant associations of Ada and Holeta *Woredas* to measure technical and allocative efficiencies of farmers. On the basis of a Cobb-Douglas production function specification, he estimated technical and allocative efficiency of farmers. From the results of his work, he concluded that while in the use of land all farmers are allocativelly inefficient, in labour use low-income farmers are more allocativelly efficient.

Croppenstedt and Mulat (1997) based on the Rural Household Survey of Economics Department, Addis Ababa University conducted technical efficiency of private cereal producing farmers. Using a fixed-random coefficient regression model, they found that land size is a major constraint in increasing production. Small changes in cultivated land and its quality bring about high increments to output. Human capital expressed in terms of literacy and experience were found to positively affect productivity. High degree of farm-specific inefficiency was observed. Indeed, sharecropping was found to be correlated positively with technical efficiency and more efficient inputs use except on labour.

Abrar (1996) used a stochastic frontier production function to examine technical efficiency of fertilised farms in three districts: Turufe Kechema, Sirbana Godeti and Kedida Gamela. His findings indicated that among fertilised farms there was a wide difference in terms of technical efficiency. This variation was observed not only between villages but also among

---

agreement is considered to be sustainable as one would not go further to get unfair benefit at the expense of the other.

farmers of a village. The study did not try to address factors contributing for such efficiency differentials.

Using a stochastic frontier Cobb-Douglas production function, Wendwosen (1998) conducted a study on the determinants of food production in Ethiopia. He found that the mean technical efficiency of the households covered in the study was 0.45 and traditional inputs such as land, oxen and family labour are major determinants of food production. The study also indicated that food aid and production are negatively correlated.

3. SPECIFICATION OF MODELS AND DEFINITION OF VARIABLES

3.1. EFFICIENCY MEASURES

3.1.1. Some Approaches of Efficiency Measurement

Efficiency is the degree of achieving the intended result in relation to time, money and effort exerted. In our context, efficiency can be defined as the capacity of producing maximum output with minimum use of inputs. In general terms, efficiency is a comparative result of the outcome to the efforts of the household. Literature provides us three major models to examine farmer's efficiency.

A. Partial-Productivity Measures

Partial productivity of input A is expressed in terms of the ratio of output flows to the flows of that particular factor of production. The basic assumptions behind estimating partial productivity measures include inputs are homogeneous, all farmers face similar output and input prices in the market, and factor proportions are invariant over farms.

Leaving aside the unrealistic nature of the assumptions used, these measures have two other major weaknesses. Firstly, comparing productivity of a single factor input without allowing for differences in technologies and other input combinations may give misleading results. For instance, in farms where the use of modern farm inputs is apparent, labour productivity is higher compared to the alternative. Secondly, these measures do not enable specification of the optimum level of production. On the basis of optimal combination of resources, a certain farmer may perform on utmost efficiency. This may not necessarily lead to having the highest partial productivity measures in terms of all factors of production.

In connection to this Silver argued that

> " ... changes in each partial measures may have their origin in changes in other inputs. ... A given number of employees may produce more, but waste relatively increases and raw material productivity falls. Partial measures do not help us to discern whether the aggregate impact of such changes are in any sense favourable and if so by how much" [Silver, 1984: p-14].

B. Production Functions

Production function is defined as the set of relationships that give the maximum level of output, which could be produced, with a given set of inputs. There are different production function models and estimating procedures. The validity of results and their consistency with the underlying definition is largely affected both by the kind of model and estimation procedures.

Regardless of their specification, conventional production function models have been used to measure farmers' efficiency in terms of average and marginal productivity and/ or total factor productivity. While the first two are partial indices, the latter measures the productivity of all inputs weighted and combined. The sum of all elasticity of factor inputs measures the degree of returns to scale.

Theoretically, the assumptions behind estimating the average production functions are farmers produce identical outputs using identical inputs, face the same input and output prices, and all attempt to maximise profits given the same production functions [Kalirajan, 1981: p-308]. In practice, farmers may produce the same output but with different resource endowments and technologies. They face different fixed factors of production, including land, technical knowledge, and socio-economic environment. Unless controlled, the differences in prices of inputs and outputs and fixed-input endowments may affect the levels of efficiency among farmers.

Even though, production functions are assumed to show the maximum level of output that could be produced with a given set of inputs, the methodology widely applied to estimate conventional production functions has been the ordinary-least squares. By its very nature, OLS provides an average relationship between the dependent and the independent variables. Thus, it fails to show the extent to which a farm operates vis-à-vis the maximum level of output.

Production functions are also estimated through linear programming methods. These methods may help to establish maximum and optimal relationship between inputs and outputs, but they do not rely on econometric tools. Thus, neither in their specifications nor in estimations, production functions estimated through linear programming allow the influences of external forces. They lack error terms and assume that there is an exact relationship between visible efforts and outcomes of farmers.

The frontier production functions have been developed to correct the weaknesses of the above methods. These functions are preferable methods of examining efficiency of farmers. They do not only take into account the influences of external factors but also provide the chance to compare the observed output with the maximum possible level of output employing a given technology.

C. Profit Functions

Based on the assumption that farmers maximise their profits, profit functions are derived from production and respective cost functions. In a competitive environment behaviour of farmers is better explained through profit functions. These functions allow for differences in price levels for homogeneous factors of production and yields, and differences in fixed factors of production. As they incorporate pre-determined variables, and prices as explaining variables, they are likely to be free from simultaneous equation bias. These functions allow "for inter-farm differences in equating the marginal value product of variable inputs with their prices. ... Economic efficiency, incorporating its two components of technical and price efficiency, thus be adequately explained by the profit function approach" [Kalirajan, 1981: pp. 308-309].

Derived from the profit maximisation behaviour of peasants, the economic efficiency measures are " defined in the context of perfect competition (where inefficient firms are thrown out of business or become competitive by improving efficiency).... [Abduelhamid, 1992: p-58]. Perfect competition in turn presupposes perfect input and output markets, free mobility of resources and perfect knowledge for all parties involved in production and marketing.

On the basis of the above assumptions, the major component of the profit function model, allocative efficiency criterion has been applied in different studies to test whether peasants maximise profit or not. The conclusions reached on the different studies were not only different but also contradictory in nature. Two basic criticisms have been forwarded against these kinds of studies: they wrongly assumed perfectly competitive environment under which peasants operated and they used misspecified models.[8]

Even though profit functions are theoretically appealing and analytically fascinating, it is not found worthwhile to apply them in this study due to two basic constraints.

First, the underlying assumptions behind estimating profit functions are not very much relevant to the prevailing socio-economic environment of Ethiopian peasant agriculture.
According to Ellis (1987)

> Peasants are farm households, with access to a piece of land and utilising mainly household labour in farm production. They are located in a larger dominant economic and political system that could affect their production behaviour, but fundamentally they are characterised by partial engagement in markets, which tend to function with a high degree of imperfection.

Operating under the umbrella of the above definition, Ethiopian peasant agriculture is predominantly subsistence in nature where the bulk of labour input and output thereof is from and to the family members of the respective households. Given such working environment, it seems unreasonable to consider Ethiopian farmers as profit maximisers. Even if one may consider Ethiopian peasants as profit maximizers, the nature of the data under consideration does not provide a room for estimating a profit function. The data set only provides two variable input factors: fertiliser and hired labour. The shares of tenant households who use hired labour in ploughing, weeding and harvesting are 5%, 10% and 34% respectively. This

---

[8] For further discussion on misspecified models, see Section 3.1.2 of this paper.

provides us a very small sample to estimate input demand functions with associated profit functions.

Indeed, the cost per kilogram of fertiliser purchased was more or less fixed across sites as the period of the survey. Though it seemed to show some variations across sample peasant associations, it was largely attributed to transportation costs. Thus, it is difficult and misleading to consider such minor variations as price changes due to market conditions.

There are also problems in wage variable determination. Wages of rural labour are paid in different forms. In some cases, sufficient information may not be provided. In other cases aggregating different kinds of payments would be difficult and misleading.

The restricted profits need to be normalised through output price(s). Abay (1995) did not normalise the restricted profits when he estimated the profit function to test the relative efficiencies of literate and illiterate farmers due to multi-prices resulted from multi-crops. The need for normalisation presupposes that profit functions should be estimated for one homogeneous crop. Such kind of homogeneity is not the feature of the data under consideration.

Based on the works of Schultz (1964), Leibenstein (1966), Azar (1991) and Assefa (1995), Abay noted with regard to this that estimation of allocative efficiency is not recommended. This is on the grounds that not only its share from the total economic efficiency is small but also it is inapplicable in cross-sectional studies where the input and output price variations across farms are insignificant [Abay, 1995].

Secondly, alike peasants of other developing countries, Ethiopian farmers produce under high level of risk and uncertainty. They suffer from natural disasters (like variable weather conditions, pests, diseases and similar other natural constraints), distorted marketing environment (for instance government intervention both on prices and access to resources e.g. land tenure), and social unrest (in terms of protracted civil war). Unsustainable agricultural growth, low per capita production and frequent occurrence of famine could be taken as the results of the above factors. Operating under such risky environment, Ethiopian peasants would likely to be geared towards considering risk aversion mechanisms in their decision making process [Ellis, 1987, Abdulhamid, 1992, and Mesfin, 1991]. However, this conclusion should not be interpreted by no means as Ethiopian peasants give no room for the influences of market signals.

3.1.2. The Schultz Hypothesis

There is a hypothesis that states " There are comparatively few significant inefficiencies in the allocation of the factors of production in the traditional agriculture" [Schultz, 1964: p-37]. According to him "farmers are efficient but poor", because they " continue year after year to cultivate the same type of land, sow the same crops, use the same techniques of production and bring the same skills to bear in agriculture production" [Schultz, 1964: p-37].

As a basis for his hypothesis, Schultz assumed that " ... no productive factor remains unemployed. Each parcel of land is used that can make a net contribution to production, ... Also, each labourer who wishes and who is capable of doing some useful work is employed" [Schultz, 1964: p-38].

Such generalisation is not valid in so far as all complementary inputs are not available in every household and differences in quality of factors of production including labour can easily be observed among farmers. On the basis of 'full employment assumption' while Schultz tried to justify his hypothesis through empirical results on different places, many recent works are found to stand against it.

According to Shapiro (1983) many researchers confirmed the Schultz hypothesis but most of the studies were done on the basis of the conventional Cobb-Douglas production functions. By the very nature of average production functions, the calculation of marginal revenue products are influenced by the coefficients of input variables, which are taken to be constant over the different farmers. Homogeneity assumption of factor endowments of the different households and averaging out their relative impacts ignores the different levels of technical competence among farmers [Abdulhamid 1992, Ellis 1987 and Shapiro 1983]. Empirical support for the "efficient but poor" hypothesis was, therefore, lent based on a wrongspecification of production functions which assume that all farmers operate on the same boundary. Thus, frontier functions, which allow inherent differences among farmers with Jondrow et al. (1982), procedure would provide the relative degrees of inefficiency differentials.

3.1.3. Frontier Functions

Compatible to the definition of production function, frontier production functions better enable to set a maximum limit of output to the set of possible input combinations. Thus, frontier functions " ... sets maximum efficiency in accord with the best practices found in the sample" [Shapiro, p-187, 1983]. Given this, technically inefficient farm produces the same level of outputs with more of at least one input, or uses the same level of inputs to produce less of the output compared to its efficient counterpart.

Efficiency has two major components: allocative efficiency and technical efficiency.

I). Technical Efficiency: " The technical inefficiency of a given firm (farm) is defined to be the factor by which the level of production for the firm (farm) is less than its frontier output " [Battese, p-189, 1992]. In other words, technical inefficiency implies excessive use of inputs to produce a given level of output. Such operation in turn has cost implications; higher cost for a given output. Thus, technical efficiency indices could be taken as measures for the ability of producers to obtain the greatest possible output from a given set of inputs.

II). Allocative Efficiency: Allocative inefficiency involves the comparison of the value of marginal products of inputs with their respective factor prices. It is sometimes termed as price inefficiency. The farm is said to be allocativelly inefficient if the ratios of the marginal products of inputs are not equivalent to the ratios of their respective factor costs. The degree of allocative efficiency measures the ability of the farmer to maximise his profits given the marginal revenue product of factor inputs and the respective factor inputs and the associated marginal costs.

Assuming that a farm uses variable input L and fixed input H to produce Y, a set of possible efficient relation between these two inputs and the resulting output given the current state of technology could be described by an implicit production function of the form:

$$F(Y,L,H) \qquad \ldots(1).$$

Let p be output price and w is the price of the variable input, then restricted profit function can be provided as the difference between the total revenue of the farm and its associated variable cost.

Given production function, restricted profit is maximised as:

$$Max \prod^{R} = p'Y - w'L \qquad \ldots(2)$$

$$\text{subject to } F(Y,L,H) = 0$$

The demand for variable inputs mainly depends on the price of outputs, their own price and the amount of fixed inputs under operation. Thus, we have an input demand function with associated cost function as:

$$L = L(p,w,H) \qquad \ldots.(3)$$

$$C = C(p,w,H) \qquad \ldots.(4).$$

Substituting equation (3) into (4); the restricted profit function would be rewritten as:

$$\prod^{R} = p'Y - w'L(p,w,H) \qquad \ldots(5)$$

This specification demonstrates the relationship of production, cost and profit functions.

Førsud et al., (1980) indicated that the underlining assumption behind the specification of production, cost and profit functions are

$$Y \leq F(L,H) \qquad \ldots.(6)$$

$$C \equiv \{w'L / F(L,H) \geq Y, L \geq 0\} \qquad \ldots.(7)$$

$$\prod^{R} = \max_{Y,L} \{p'Y - w'L / F(L,H) \geq Y, L \geq 0, Y \geq 0\} \qquad \ldots.(8)$$

Let Y^0 be actual output levels, a farm is technically efficient if $Y^0 = F(L^0, \overline{H})$; and it is technically inefficient if $Y^0 \prec F(L^0, \overline{H})$. Each farm operates within the boundary of $0 \leq {Y^0}/{F(L^0, \overline{H})} \leq 1$.

Technical inefficiency implies $Y^1 = F(L^0, \overline{H}) \prec F(L^1, \overline{H})$ where $L^1 \succ L^0$ and $C^1 \succ C^0$. The resulting effect of higher cost with given level of output or lower level of output with given level of cost is a profit below the optimal amount.

Allocative efficiency requires the ratios of the marginal products of inputs to be equivalent to the ratios of their respective prices:

$$\frac{F_i^{'}(L^0, \overline{H})}{F_j^{'}(L^0, \overline{H})} = \frac{w_i}{w_j} \qquad \ldots (9)$$

Based on the above expressions, Shapiro(1983) indicated that allocative efficiency is usually considered and measured in terms of inputs combined in production, technical efficiency refers to the manner in which the inputs are used.

In econometrics applications, we have two forms of frontier models employed: deterministic and stochastic.

A. Deterministic Frontier Production Function

Aigner and Chu (1968) were the first to specify a deterministic frontier using a Cobb-Douglas production functional form. Afriate and Richmond (1974) further considered the model by setting certain assumptions about the distributions of the error term and used programming methods [Battese, 1992].

Let a Cobb-Douglas production function be given by

$$Y = A\Pi X_i^{ai} e^{-u}, \text{ where } u \geq 0 \qquad \ldots. (10)$$

and its log linear equivalent is

$$\log Y = \log A + \sum_{i=1}^{n} a_i \log X_i - u \qquad \text{.... (11)}$$

u constitutes farm specific factors, which make the farm operate below the maximum efficiency level of production. Thus, u is taken as " an error in operation" that could otherwise be controlled by the farmer. As it measures the degree of technical inefficiency, this term implies that each observation lies on or below the frontier. Thus, the value of u is always taken to be non-negative.

If we express the actual production values as Y and the estimated frontier values as Y* where

$$Y^* = F(X_i;\beta) \qquad \text{.... (12)}$$

and

$$Y = F(X_i;\beta)\exp(-u_i) \qquad \text{... (13).}$$

Then the magnitude of technical efficiency of a farm would be defined in terms of the random variables as follows.

Let technical efficiency of the i th (farm) is denoted by TE_i such that

$$TE_i = \frac{Y}{Y^*} \qquad \text{... (14)}$$

$$= F(X_i;\beta)\exp(-u) / F(X_i;\beta)$$

$$= \exp(-u_i)''$$

[Battese, 1992: p-189].

A farmer is technically efficient if and only if his actual output given his actual inputs is equal to the predicted output. In other words, if the two levels of outputs are not equivalent, then the farmer is operating below the outer bound of the production function which connects the maximum possible output magnitudes. The extent to which the farmer deviates from the technically possible maximum level is measured by the ratio of observed output to the predicted one.

Deterministic frontier functions suffer from one basic constraint. The model implicitly assumes that all farmers share similar technology, institutional setting and physical input endowments. In this approach, farmers are assumed to have common frontiers. Operation below the maximum profit and production or above the minimum cost level could only be attributed to farm-specific inefficiencies; and that is why it is termed as deterministic.

But farmers differ in resource endowment; land size and quality, draught animals, wealth and in other inputs, as well as in the environment and weather conditions. Thus farmers may operate below the maximum efficiency level not only because of mismanagement and misallocation of resources under their disposal, but also due to factors which are entirely beyond their control.

Even though, the basic concern on the farm level is not how a farmer minimises the effects of exogenous factors but how he could manage to avoid inefficiencies attributed to factors under his control, the effect of external events should also be separately examined. This entails a specification, which enables to sort out farm specific inefficiencies. Stochastic frontier production function comes as a solution for the drawbacks of the deterministic approach.

B. Stochastic Frontier Production Function

As the non-negative error term in the deterministic approach stands only for a measure of efficiency gap, it fails to account for exogenous factors beyond the control of the farm and the effects of measurement error and misspecification of the model. In stochastic frontier models, the error term is decomposed in two parts: the (-u) term as it is defined in deterministic case and (v) which stands to capture " favourable" and "unfavourable" exogenous events that affect farmers efficiency.

The stochastic frontier model with its two error terms is to be specified as:

$$Y = A\Pi X_i^{ai} e^{-u} e^{v} \qquad \ldots(15)$$

or

$$Y = F(X)\exp(v - u)$$

where v_i are assumed to be independently and identically distributed as $N(0,\sigma_v^2)$ independent of u_i 's. Given the stochastic term (v), the maximum production limit Y in stochastic frontiers is bounded above by a stochastic quantity $F(X_i;\beta)\exp(v_i)$. The non-negative error term u, in exp(-u) measures the degree of technical inefficiency. u_i 's is assumed to have non-negative truncations of the $N(0,\sigma_u^{\ 2})$ distribution. Thus, they can assume half-normal, exponential or gamma distribution [Battese, 1992: p-190].

Depending on the values of v, the stochastic production limits exceeds, equals, or lags behind the deterministic production frontier. When favourable external conditions exists (i.e. $v_i \succ 0$), stochastic frontier exceeds the maximum limit of output set by the deterministic frontier. The reverse is true when unfavourable external conditions exist (i.e. $v_i \prec 0$).

Decomposition of the error term in case of estimation is not as simple as specifying the stochastic frontier model. Aigner, Lovell and Schmidt (1977) brought about a procedure called ALS where by they decomposed the error term in two components:

$$\varepsilon = u + v \qquad ...(16)$$

where v follows the usual normal distribution with constant variance and zero mean: $N(o,\sigma_v^2)$ and u follows the truncated normal,

$$F(u) = \frac{2}{\sigma_u\sqrt{2\pi}}\exp\left[\frac{-u^2}{2\sigma_u^2}\right], u \geq 0 \qquad ....(17)$$

[Fishe and Maddala, 1994: p-76].

Furthermore, "Assuming u and v to be independently distributed ... we get

$$F(\varepsilon) = \frac{2}{\sigma}\phi\left[\frac{\varepsilon}{\sigma}\right]\left[1-\Phi(\frac{\varepsilon\lambda}{\sigma})\right] \qquad .... (18)$$

$$\text{where } \sigma^2 = \sigma_u^2 + \sigma_v^2 \qquad ....(19)$$

$$\lambda = \frac{\sigma_u}{\sigma_v} \qquad \text{.... (20)}$$

and $\phi(.)$ and $\Phi(.)$ are density function and the distribution function of the standard normal" [Fishe and Maddala, 1994: p-76]. Given a specified production function $f(X_i, \beta)$, the procedure indicated that ML method can be used to estimate all the parameters. Using a stochastic frontier production function specification of the form:

$$Y = f(X_i, \beta)e^{v-u} \qquad \text{....(21)}$$

the technical efficiency measure for each farm is given in terms of

$$e^{-u} = \frac{Y_i}{\left[f(X_{i,}\beta)e^{v_i}\right]} \qquad \text{.... (22).}$$

Assuming that (-u) has a half-normal distribution, Afriat(1972) provided the mean technical efficiency for the population as

$$E(e^{-u}) = 2\exp\left[\frac{\sigma_u^2}{2}\right]\left[1 - \Phi(\sigma_u)\right] \qquad \text{...(23)}$$

where $\Phi(.)$ is the standard normal distribution function [Fishe and Maddala, 1994: p-77].

From the standard errors of the two different error terms one can generate

$$\lambda = \frac{\sigma_u}{\sigma_v} \qquad \text{...(24)}$$

where λ represents the relative influences of forces that are under the farmers control and events external to them. If λ is high, the farmer is relatively technically inefficient. If he avoids his internal problems, he is likely to improve his output with given resources.

While the algebraic expressions of efficiency measures are as stated above, empirical literature has provided the following estimation procedures. Based on the works of Aigner, Lovell and Schmidt (1977), Assefa (1995) indicated that parameters of the frontier and density functions of the two error terms are estimated through maximising the log-likelihood function, which could be given as

$$\ln L(Y / \beta, \lambda, \sigma^2) = N \ln\sqrt{\frac{2}{\pi}} + N \ln\frac{1}{\sigma} + \sum \ln\left[1 - F(\frac{\phi_i \lambda}{\sigma})\right] - \frac{\sigma^2}{2}\sum \phi_i^2 \qquad \text{...(25).}$$

Since v_i are not observable, computing efficiency magnitudes for each farm using equation (22) is impossible. Given equation (21), Jondrow et al (1982) provided a method to estimate farm level technical efficiency. Provided that the two error terms behave normally as stated in equation 16, Jondrow et al., (1982) showed that farm specific efficiency indices can be calculated through

$$E\left(\frac{u_i}{\varepsilon_i}\right) = \frac{\sigma_u \sigma_v}{\sigma}\left[\frac{\phi(\varepsilon_i \lambda / \sigma \cdot)}{1-\Phi(\varepsilon_i \lambda / \sigma)} - \frac{\varepsilon_i \lambda}{\sigma}\right] \quad ....(26)$$

where $\phi(.)$ and $\Phi(.)$ are standard normal density and distribution functions evaluated at $\frac{\varepsilon_i \lambda}{\sigma}$

and λ is estimated at $\lambda = \frac{\sigma_u}{\sigma_v}$ respectively [Jondrow et al., 1982].

Using equation 26, after we replace ϕ, σ, λ by their estimates, we can find the values of u_i and v_i. From these estimates, technical efficiency indices of individual farmers would be computed as

$$TE_i = \exp[-E(u_i / \varepsilon_i) \quad ...(27)$$

while the average technical efficiency of the whole sample is given by

$$E(e^{-u_i}) = 2\exp(\sigma_u^2 / 2)(1-\Phi^*(\sigma_u)) \quad ....(28)$$

where Φ^* is the standard normal distribution function [Assefa, 1995].

3.2. ESTIMATION AND TESTING PROCEDURES

3.2.1. Model Selection

Assuming that the underlying technology of smallholder agriculture is described by a stochastic frontier Cobb-Douglas production function of the form,

$$Y_i = \Pi A X_i^{\alpha_i} e^{\varepsilon_i} \qquad \text{....(29)}$$

where Y_i is output, X_i are factor-inputs, and ε_i is the error term. Taking logarisms of both sides of equation 29, we would have a linear Cobb-Douglas production function of the form:

$$\log Q_i = A + \sum \alpha_i \log X_i + \varepsilon_i \qquad \text{... (30).}$$

Cobb-Douglas production function has the following main properties[9].

- Elasticity of production for each factor X_i is expressed in terms of the respective coefficient, i.e.;

$$\partial Q / \partial X_i * X_i / Q = \alpha_i \qquad \text{... (31)}$$

- The sum of elasticity coefficients indicates the degree of operation. In other words, returns of scale are characterised by the proportional change in output due to a joint proportionate change of all inputs in production:

$$\frac{dQ}{dX}\frac{X}{Q} = \sum \alpha_i \qquad \text{...(32).}$$

  The returns to scale are increasing, constant or decreasing depending on the condition that $\sum \alpha_i \succ 1$, $\sum \alpha_i = 1$ or $\sum \alpha_i \prec 1$ respectively.

- Marginal physical productivity of each factor input in the C-D setting is expressed as:

$$MPP_{Xi} = \partial Q / \partial X_i = \alpha_i Q / X_i = \alpha_i APP_{Xi} \qquad \text{...(33)}$$

[9] For further discussion on the matter refer Elisabeth Sadoulet and Alian De. Janvry (1995).

where APP_{Xi} is average physical productivity of that particular input. This implies that marginal productivity of factor inputs depend on elasticity of factor inputs and the resulting level of returns to scale.

- The elasticity of substitution between factors of production is unity, i.e.:

Elasticity of Substitution ...(34).

$$\sigma_{es} = \frac{d\ln(X_i / X_j)}{d\ln(MPP_{Xi} / MPP_{Xj})} = 1$$

Cobb-Douglas production function is criticised mainly in its two rigid properties: constant elasticity or factor share parameter and unitary elasticity of substitution. In this respect, the specification is blamed of restricting the prevailing production function farmers might involve in.

Regardless of the shortcomings, Cobb-Douglas production function is widely employed in several economic works. Two main basic reasons are forwarded in this regard. Firstly, "Its simple functional form is computationally economical and yields statistically significant estimates of the coefficients without imposing excessive demands up on data accuracy" [Yotopoulos and Nugent, 1976:p-56].

Secondly, it provides a basis for simple application of economic theory. Without involving into further manipulation, the estimated coefficients themselves indicate the degree of operation and the responsiveness of output with respect each factor inputs. Furthermore, if the purpose of the project is not mainly to provide the general structure of the underlying technology but to measure the degree of efficiency of farmers, the Cobb-Douglas production function could be an adequate specification [Taylor and Shonkwiler, 1986]. On the basis the stated advantages, Cobb-Douglas production function is employed in this study.

3.2.2. Estimation Procedures: Production Function and Technical Efficiency

Depending on the nature of the problem we are dealing with, the following procedures are followed in an attempt to estimate parameters and compare results. Farmers in the larger sample do not have significant technological difference in many respects except in the land owning and using arrangement. Assuming all farmers in the larger sample operate on a similar set of technologies, we will estimate a stochastic production function through the Maximum Likelihood Maximum Iteration Method using Limdep7[10] econometric software. The would be estimated Cobb-Douglas production function is used for calculating technical efficiency of farmers. This is in turn used to test the widely acknowledged hypothesis: peasants are poor but efficient and all peasants operating on a similar technological setting are equally efficient.

The stochastic Cobb-Douglas production function to be estimated is specified as:

$$Y_i = \alpha_0 + \sum \alpha_i X_i + v + u \qquad ...(35)$$

where Y= log of cereal output in kg per household,

X_i = logarithm values of direct inputs like labour days, land in hectares, fertiliser in kg, oxen and bulls in numbers as well as some household specific attributes,

u = the technical efficiency parameter which is assumed to take non-positive values with a half normal probability distribution.

v = the usual stochastic disturbance term which is normally distributed with $(0, \sigma_v^2)$.

When we put the variables in logs and get $\log(\hat{X})$, we add number '1' through out for those variables, which may have zero values. Otherwise one may end up with some non-defined values for $\hat{X}$ and can not take a logarithm. In the cases of dummy variables, we do not find logarithm values.

[10] Limdep7 (1998) is Econometrics software written by William H. Greene and M.J. Lowe made the Windows, interface.

Using the above specification, the test for efficiency differential among farmers is made on the hypothesis that all farmers operate on the utmost boundary of the production function so that no output gap could exist between the actual and what could otherwise be, i.e.; $E(u) = 0$.

Farm specific technical efficiency could be estimated through the Jondrow et al., (1982) using equation (27). However, we have assumed that farm specific technical efficiency differential across each and every farm level operating under similar environment is not significant. Further more, as we largely deal with examining average technical efficiency differential of the different group of farmers, it is found to be appropriate to use mean technical efficiency measures. As Battese and Coelli (1988) have argued, it would be inappropriate to take a simple average of farm specific technical efficiency values. Instead, they estimate mean population efficiency measure particularly in case of logarithm specifications as:

$$E(e^{-u_i}) = 2\exp(\sigma_u^2/2)(1-\Phi^*(\sigma_u)) \qquad \text{....(36).}$$

3.2.3. Efficiency Comparison for Different Group of Farmers

One way of comparing efficiency levels of different group of farmers is to test whether they operate on different and independent production functions or not. With the assumption that owner-operators and tenants operate on different production functions, we will estimate a probit function for sample selection and use the predicted values for a two-stage switching regression model. If the probit model lacks strong predictive power or the two-stage model is not statistically significant on the basis of over all model tests, Chow test would be made to conform that the two groups of farmers are not really different in operation. If they are found operating on different set of production technologies, differences in efficiency would be examined through their respective marginal and average productivity and elasticity figures.

Secondly, if owner-operators and tenants share similar production functions, descriptive statistics of technical efficiency levels would be applied for comparison purposes. Dummy variables are used as an alternative mechanism for testing whether tenants (TT) or own-operators (WN) are associated positively with production levels. Even though the two groups may share a common production function, they may not necessarily use the different inputs with similar efficiency. To this end, a Wald test would be used to test whether or not tenant and own-operators are different in efficiency levels on specific key factors of production. Specifications of the comparative models are described as follows.

A. Two Stage-Switching Regression Model

Based on the theoretical framework of Bardhan and Srinivasan (1971), the model proposes that agricultural efficiency and application of variable inputs among farmers depend on the institutional arrangements under which they are operating. One could, therefore, hypothesise that own-land operators and tenants have two different production functions. The underlying assumptions behind the hypothesis is that both tenants and landowners can influence the contractual agreements set by the two parties or the demand for and the supply of land lease to determine the rental share. In other words, the land lease markets are assumed to be non-monopolistic. Unlike the assumption of Bardhan and Srinivasan (1971), the marginal product of land is non-zero in a situation where land scarcity is a crucial problem of many farmers.

Agricultural efficiency depends largely on how farmers apply the desired level of inputs and efforts on the farms. But the rate of input application may be endogenously determined by factors causing farmers to be tenants. Thus, we need to use the two-stage regression models with the criterion function that enables endogenous switching so as to alleviate endogeneity problems.

Given the two types of sample households, we have two linearly specified Cobb-Douglas production functions;[11]

$Y_{1i} = X_i \alpha_1 + \varepsilon_{1i}$ Tenant Farms .... (37)

$Y_{2i} = X_i \alpha_2 + \varepsilon_{2i}$ own-operated farms ... (38)

[11] The model is adopted from Khandker (1987).

where Y_{1i} and Y_{2i} are the levels of out put of the i^{th} farm household, X_i is a vector of inputs, α_1 and α_2 are unknown coefficient vectors, and ε_{1i} and ε_{2i} are error terms.

We can also formulate a " criterion function" which would endogenously determine the behaviour of tenants as;

$$I_i = Z_i\gamma + e_i \qquad \text{.... (39)}$$

where Z_i are exogenous variables influencing farmers' decisions to rent land; γ is a vector of unknown coefficients and e_i are associated error terms. The dummy variable I_i is such that

$$I_i = 0; I_i \leq 0$$
$$I_i = 1; I_i \succ 0$$

Combining equations (37) and (38) with the criterion function (39), we could have a production function, which would take into account all variables that, would affect cereal production as:

$$Y_i = X_i\alpha_2 + dI_iX_i + \varepsilon_i \qquad \text{... (40)}$$

where I_i equals 1 for tenants and 0 for own-land operators.

If we take expected value of equation (40) by setting $E(\varepsilon_i)$=0, the resulting values would be:

$$E(Y_i / I_i = o) = X_i\alpha_2 \qquad \text{.... (41)}$$

$$E(Y_i / I_i = 1) = X_i(\alpha_2 + d) = X_i\alpha_1 \qquad \text{.... (42)}$$

As equation (37) and (38) are combined, ε_i are going to be correlated with ε_{1i} and ε_{2i}. Since ε_i are correlated with ε_{1i} and ε_{2i}, we call it a switching regression model with endogenous switching [See Maddala, 1983 for further discussion].

Assuming $\text{var}(\varepsilon_i) = 1$ and $\varepsilon_{1i}, \varepsilon_{2i}$ and ε_i have a trivariate normal distribution, with mean zero and a covariance matrix

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1e} \\ & \sigma_2^2 & \sigma_{2e} \\ & & 1 \end{bmatrix} \qquad \text{... (43).}$$

Due to endogeneity problems, error terms do not behave normally, so that Ordinary Least Squares can not be applied to estimate equations (37) and (38). Maximisation of the likelihood function would be made through two-stage method. The first procedure is to find the expected values of the two error terms in equation (37) and (38), given the values of I_i.

Thus we have,

$$E(\varepsilon_{1i} / I_i = 1) = E(\sigma_{1e} I_i / I_i \succ o) = \qquad \text{... (44)}$$

$$-\sigma_{1e} \frac{\phi(\gamma' Z_i)}{\Phi(\gamma' Z_i)}$$

where ϕ is the standard normal density function and Φ is the distribution function of the standard normal.

Similarly,

$$E(\varepsilon_{2i} / I_i = 0) = E(\sigma_{2e} I_i / I_i \leq 0) = \sigma_{2e} \frac{\phi(\gamma' Z_i)}{1 - \Phi(\gamma' Z_i)} \qquad \text{...(45)}$$

To simplify matters, let us define,

$$W_{1i} = \frac{\phi(\gamma' Z_i)}{\Phi(\gamma' Z_i)} \qquad \text{.... (46)}$$

and

$$W_{2i} = \frac{\phi(\gamma' Z_i)}{1 - \Phi(\gamma' Z_i)}$$

then equation (37) and (38) can be rewritten as:

$$Y_{1i} = \alpha_1' X_{1i} - \sigma_{1e} W_{1i} + q_{1i} \qquad \text{for } I_i = 1 \qquad \text{...(47)}$$

$$Y_{2i} = \alpha_2' X_{2i} + \sigma_{2e} W_{2i} + q_{2i} \qquad \text{for } I_i = 0 \qquad \text{... (48)}$$

where q_{1i} and q_{2i} with values

$$q_{1i} = \varepsilon_{1i} + \sigma_{1e} W_{1i}$$
$$q_{2i} = \varepsilon_{2i} + \sigma_{2e} W_{2i} \quad \text{... (49)}$$

To summarise the procedures, on the assumption that the trivariate normal distribution of the error term and $\sigma_{11}=1$ and using observations on I_i, first we estimate γ' through probit maximum likelihood estimation method, by substituting the values of γ', we estimate W'_{1i} and W'_{2i} for W_{1i} and W_{2i} respectively. These two figures are Mills' ratios. Finally, equations (47) and (48) will be estimated by substituting the values of the respective Mills' ratios. These procedures are followed so as to purge the selectivity effects arisen from entering in to the tenancy market [Maddala, 1983].

B. Chow Test

Assuming that we have two independent production functions for owner-operators and tenants such that[12]

i) $\mu_{1i} \sim N(0,\sigma^2)$

$\mu_{2i} \sim N(0,\sigma^2)$ ... (50)

ii) μ_{1i} and μ_{2i} are distributed independently,

we first estimate a single "pooled" regression combining both own-operators *(N1)* and tenants *(N2)*, and obtain residual sum of square (s1) with *N1+N2-K* degrees of freedom where *K* is the total number of estimated parameters. Then, run two individual regressions on the basis of the two sub sample farmers and collect the respective residual sum of squares (s2 and s3) with degrees of freedom N1-K, and N2-K. Given all these information, we apply F-test as

$$F = \frac{[s_1 - (s_2 + s_3]/K}{(s_2 + s_3)/(N_1 + N_2 - 2K)} \quad (51)$$

[12] For further discussion of the test please refer to Gujarati (1988).

with degrees of freedom *(DF) =K, N1+N2-2K*. If the computed F-exceeds the critical F-value, we reject the hypothesis that they are the same production function.

C. Wald Test

Assuming a zero covariance between coefficients in the owner-operator and tenant farmers' production functions, a Wald test is applied to test whether there is elasticity variation between the two production functions for each kind of key factors of production [13].

Under the null hypothesis of no difference, the Wald-test statistics is:

$$W = (\beta_i^{own} - \beta_i^{tent})^2 / [Var(\beta_i^{own}) + Var(\beta_i^{tent}) \quad \sim \chi^2_{(1)} \qquad (52).$$

3.3. DEFINITION OF VARIABLES

The following are variables that would be considered in the above equations.

3.3.1 Variables for the Estimation of Production Functions.

1. ***Output (Q):*** Farmers usually harvest a variety of cereals. Any aggregation of different products, therefore, requires monetary measure. As an output variable, the quantities of *teff*, (mixed black and red *teff*), barely, wheat, maize, sorghum and millet are aggregated in the following way. a) The values of each cereal outputs are calculated through their respective prices and the resulting values are added up. b) The share of the value of each cereal types out of the total value of production is derived. c) Each value share is multiplied by the price of each cereal type and the resulting figures are added to derive a weighted price. d) Finally, total value of the different cereal outputs is divided by the weighted prices. The outcome of this process is assumed to represent 'real' output levels.

2. ***Farm Labour (L):*** We have three forms of labour inputs; family labour, hired labour and exchange (like *Debo*) labour. Number of days worked may suffer from problems of

accuracy in reporting from the side of peasants. Even then, number of days worked by family, exchange and hired labour in a given period is the best alternative available to measure labour input. We know that labour is a heterogeneous group, since its productive capacity varies from individual to individual. But no easy and appropriate mechanism exists to account such differences. We have simply assumed homogeneity of farm labour.

3. ***Land (H):*** Land is taken care of through physical measures: the number of hectares under cereal cultivation during the period. There is a possibility of identifying the number of hectares that tenants rented in. But, no clear evidence exists in the data set whether all the land is used only for cereals or not. Indeed, no information exists about the amount of cereals tenant farmers harvest from the rented-in plots. Thus, the land and output variables for tenants include both their own and from the rented-in lands.

4. ***Oxen-Bulls (Ob)*:** Oxen and bulls have been used as draught animals and main vehicles for farming in most parts of Ethiopia. Because there is no direct measure of oxen-bulls ploughing days, number of oxen-bulls under the disposal of the households is considered as a proxy for oxen-bulls input.

5. ***Wealth of Households (M):*** Wealth of the household plays a part in the process of availing modern and traditional inputs. It may be used as collateral for credit provision and gives some information on the level of farmers long time effort to improve their lives. Households may have different assets and animals. Aggregating all of them may not be feasible. Indeed, size of livestock may have two contradictory impacts on production: positive and direct relationship if some of the animals used as inputs or inverse relation if households devote much of their time in animal caring. Thus, the kind of material used for roofing of the houses is taken to represent wealth status of households. Dummy value of 1 is given if the roof is made of wood, galvanised iron, or stone, bricks or cement, and 0 otherwise.

6. ***Fertiliser (F):*** The use of chemical Fertiliser is usually associated with increased output. The variable stands for all kinds of chemical fertilisers measured in terms of kilograms.

[13] Adopted from (Appleton et al, 1994).

There is also an interaction variable, ***Intfhs,*** intended to capture the impact of "large" size (2.5 hectares) land on fertiliser application. ***Intfhs*** has zero value for a land less than 2.5 hectares and F x H for a land of more than 2.5 hectares.

7. **Credit (Cr):** Credit is usually assumed to facilitate production. Thus, those who obtained credit in any of the past three consecutive years (1984, 1985, and 1986) are given a value 1 and 0 otherwise.

8. **Soil fertility (Lq) and topography of lands (Ls):** Every part of land differs in quality. Using the respondents' evaluation, attempts have been made in the survey to differentiate the fertility and topographic suitability of the different plots of land. Quality of land is encoded as 1=*lem* (fertile), 2=*lem-teuf* (medium-fertility) and 3=*teuf* (infertile). Topography or steep nature of the land is encoded as 1=*medda* (flat), 2=*dagath-ama* (semi-flat) and 3=*geddel* (steeply). The value taken for the respective variables is the average of all the dummy values provided for the different plots under cultivation by each household.

9. ***Education*:** Education levels of farmers have a bearing on information access and degree of its assimilation. Thus, education and production levels are expected to positively correlate. But, there are controversies about what kind and level of and whose education could have an impact on the level of production: formal or non-formal, below or above primary or secondary school, for the whole family or heads of the household. Different education variables will be tested. Education levels are very low in rural Ethiopia and in the households under consideration [14]. Education status of head of the household is assumed to mainly affect production level, as he/she is the 'manager of the business'. ***EDLC*** is constructed in such a way that those heads of households who have Adult Literacy Programme certificate or attained a minimum of three years of formal education is given a value of 1 and 0 for others levelled as illiterates. ***LEDH1*** variable has values of zero for those who have no formal schooling or adult literacy certificate. If a farmer can read and write or has adult literacy certificate or religious or traditional he is given 2 and for those who attained primary education but fail to complete, for those who completed

primary, junior secondary and high schools, are provided 3, 6, 8, and 12 numbers respectively. To capture the influences of literate family members other than the head ***EDH*** has given 1 if there is one or more member of the household who can read and write or more, zero otherwise.

10. ***Age of household head and its Square (lA, lA2): lA*** is taken as a proxy variable for experience in farming and 'endurance' as agricultural activities require strength and long-time practices on activity management and timing [Mulat and Croppenstedt, 1998]. Age Square ***(lA2)*** is included to show that the marginal impact of 'increased experience' diminishes over time.

11. ***Rainfall (R2, R3, and R4):*** Whenever rain-fed agriculture is the main feature of a country, rainfall variable would come to be indispensable in agricultural production modelling. These variables indicate timing and relative magnitude of rainfall. They are constructed based on the judgement given by the respondents. For ***R2***, 1= if there was enough rain at the beginning of *Meher* season, and 0= if there was too much or too little. For ***R3***, 1= if there was enough rain during the growing period of cereals, and 0= if there was too much or too little. For ***R4***, 1= if the rain stopped on time, and 0= if the rain stopped too early or too late.

12. ***Family Size (FS):*** In two ways, the size of a family is expected to affect the level of production of farmers; as a source of labour input and as a pushing factor for enhanced output for consumption. ***FS*** is expressed in terms of the number of family members.

3.3.2. Factors Affecting Efficiency of Tenant Farmers

Some of the factors mentioned in tenancy literature as determinants of tenancy efficiency are specified as follows.

1. ***Input Cost Share (CS):*** 0= if there is no cost sharing or tenant covers all the cost, 1= both the owner and the tenant cover the cost, and 2= the owner covers all the costs.

---

[14] See chapter 4 of this paper.

2. ***Tenant Share of Harvest (Sr):*** For sharecropping tenants, there are three forms of rents: 1/3, 1/2 and 2/3. These values are given for the corresponding magnitudes.
3. ***Farm Supervision by Owners (SUP)***: A dummy value 1 is given for those tenants whose operation is supervised by the owner of the land in one of the cropping stages, and 0 otherwise.
4. ***Other Obligation of Tenants (OBG):*** 1 if tenant has other obligations to the landlord (activities not directly relevant to the tenant farm) and 0 otherwise.
5. ***Decision of What and How to Plant (Ds):*** Who decides what crop to plant is taken as if it affects the level of effort tenants exert on their farms. Joint decision could be considered as the result of joint on farm practice of the two groups: the owner and the tenant. Thus, ***Ds*** is given values in accordance with expected positive impact of the source of decision: 1 if owner decides, 2= if tenant decides and 3 = if both of them decide together.
6. ***Oxen and Bulls or Plough Supply Responsibility: Oinput1*** is a dummy variable with 1 and 0 values if the owner of the land supplies oxen and bulls or plough or not respectively. Similarly, ***TTinput1*** stands for if the tenant is responsible for that.
7. ***Seed, Fertiliser or Other Inputs Supply Modality: Oinput1*** equals 1 if owner supply such inputs or 0 otherwise and ***TTinput2*** is a similar variable if the responsibility is for the tenant.
8. ***Size of Land Owned from Government (Hai):*** It is a continuous variable with values stated in terms of hectares.

3.3.3. Factors Determining the Status of being a Tenant

In the Ethiopian context, the possible variables that determine the institutional setting, being a landowner or a tenant farmer, include the following.

1. **Size of land holding (Hai):** farmers who own small cultivable land from government may demand to acquire additional land through tenancy arrangement.
2. **Family Size (FS):** the deriving force of involving in tenancy is scarcity of land. In some cases relative surplus of family labour or the need for more production to satisfy consumption requirements of the family also necessitates the household to rent in land.

3. **Average Age of Adult Male Household Members (Ag):** The presence of young male household members with ages above 15 may force the family to have a rental land arrangement to achieve optimal resource use.
4. **Age of Family Head (A)**: In rural Ethiopia it has been found that " ... people involved as labour suppliers in share cropping (or in other forms of tenancy) are often young men, possibly recently married who have not yet been allocated an area of land by their father." [Sanford and Sanford, 1994: P-4]. Thus, age of the household is expected to negatively affect the status of being a tenant.
5. **The size of draught animals (NOB):** Those who lost their only ox to team up with the ox of another peasant may be forced to rent their land. On the other hand, landless or those who have relatively endowed with adequate oxen but lack proportionate plots of land may demand to be a tenant.
6. **Wealth of House holds (M):** Accumulation of wealth, among other things, requires long years of working on farms with out dislocation. Displaced or young people might not be as wealthy as the 'permanently' settled house hold. Wealth of a household may then be taken as a proxy for a well-established landowner. If the variable is negatively associated with tenancy, it may imply that dislocation and being young household head force a certain segment of the farmers to be tenants. If the wealth indicator variable holds a positive coefficient, it has an indication that farms with better wealth stocks strive to have more-farm land to maximise their production.
7. **Type of soil (lq) and land topography (ls):** The assumption behind including this factor is that farmers who have relatively large size of land may not have incentive to devote their efforts on non-fertile and/or on non- suitable land in terms of topography. Thus, tenant farms may of the above type.
8. ***Sex of Household Head (Fh):*** Female headed households might rent-out their plots of land, and a negative relationship is expected between tenancy and ***Fh*** variable.
9. ***Education Status of Household Heads (EDLC):*** Literate farmers use different alternative mechanisms of increasing their levels of production, one of which may be renting-in land. Thus, this variable is expected to have a positive relationship with tenancy.

4. DESCRIPTIVE STATISTICS

4.1. SOURCE OF DATA AND OVER ALL FEATURE OF THE SAMPLE

The main source of data for this study is the first round of the Ethiopian Rural Household Survey conducted in 1993. The Survey was run by the Department of Economics of the Addis Ababa University in collaboration with the Centre for the Study of African Economies, Oxford University (CSAE). International Food Policy Research Institute (IFPRI) was laying the basis for conducting the Survey as it had previously (1989) collected data from seven draught prone sites.

The survey covered 1477 households in 18 Peasant Associations located in 15 *Woredas* and 6 Regional states. The issues addressed in the survey include household demographic and anthropometric features, asset ownership, land and other inputs use, crop production and marketing, education, livestock ownership, land use arrangements and other socio-economic aspects of rural households. The first round Survey covered a wide range of activities carried out across the different agro-ecological zones and farming systems.

In the course of managing the data, some erroneous figures resulted probably from recording interviews, misunderstanding of measurements and/or data entries are detected. For purposes of indicating missing values, a negative number (-9) was deliberately registered. Other than the stated need, some negative figures were observed. Furthermore, in a wide range of variables, some extremely very low and high values were also identified. Thus, households with such incredible figures, missing observations, inconsistent entries, and extreme values were excluded in the present analysis.

Thus, households cultivating less than 0.25 hectares of land or who use less than 60 (one-man equivalent) working days and producing less than half a quintal in the main agricultural season (*Mehe*r) are excluded from the study. It seems unreasonable to consider households operating below the stated input-output levels as farmers. In this regard a question may arise as what level of operation could farming be taken as a main profession for households under consideration? In relation to this, there is no hard and fast rule. It is believed, however, that for households to be taken as farmers a substantial part of their time has to be devoted on farming and other related activities. But setting input and output limits above the stated levels may very much reduce the sample size.

Furthermore, under the assumption that fertilised and unfertilised farmers as well as households with ox-plough or hand-hoe operate under different technological settings, the study considers only the fertilised farms from both owner-operator and tenant farmer groups with dominant technology of ox-ploughing.

After data cleaning and some minor adjustments, some 196 owner-operators (58%) and 144 tenants (42%), (340 households all together) were selected from areas cited in Table 4.1. The sampled households are selected from twelve different sites of three regional states where around 80% of the population live in [C.S.A., 1998]. Indeed, these regions cover the greater part of the highlands of the country where the latter constitute around 90% of the cropland [MEDaC, 1998]. On the other hand, in terms of natural environment and economic well being, the sites were selected from three different categories: vulnerable to famine, self-supporting and rich. In this sense, the sample could fairly represent cereal producing modern input user farmers working under different natural, and socio-economic environments of the country [Bevan and Pankhurst, 1996]. But in its broader sense, it could not be taken as a representative of all farmers employing different farming technologies.

If one examines the distribution of households across regions, the Amhara Regional State contributes around 43% of the whole sample and 54 % of tenant households. This implies how tenancy land use widely prevails in peasant associations selected from the Amhara Regional State. The Oromia and the Southern Ethiopia Peoples regional states have a share of 48% and 9% from the total number of households.

The distribution of households by land holding arrangements is given in Table 4.2.

Table 4.1. Regional Distribution of Sample Households

Region	Zone	*Wereda*	Peasant Association	Number of Household
Amhara	E. Gojjam	Enemay	Yetmen	31
Amhara	N. Shewa	Debre Berhan	Milki	41
Amhara	N. Shewa	Debre Berhan	Kormargefia	28
Amhara	N. Shewa	Debre Berhan	Karafino	18
Amhara	N. Shewa	Debre Berhan	Fajina Bokafia	19
Amhara	N. Shewa	Ankober	Dinki	10
Oromia	E. Shewa	Adda	Sirbana Godeti	61
Oromia	E. Harerge	Kersa	Adele Keke	30
Oromia	E.Shewa	Shashemene	Turufe Ketchema	53
Oromia	Arsi	Dodota	Korodegaga	20
SEPAR	N. Omo	Bolossosore	Gara Goda	16
SEPAR	Kembata	Kedia Gemila	Aze Deboa	13
Total				340

When one examines the distribution across peasant associations, Yetmen and Kormargefia from the Amhara Region and Gara Goda and Aze Deboa from the Southern Ethiopia Peoples Regional State tenant farmers relatively dominate. In other areas, owner-operators dominate.

Some differences exist among the selected peasant associations in terms of climate, cultivation technology and dominant cereal type. The dominant farming technology in the sampled peasant associations is ox-plough. Hand hoe is widely used side by side with ox-plough in Aze Deboa of Southern Ethiopia Peoples Administrative Region. Rain-fed agriculture is the main feature of Ethiopian agriculture and of the sampled households. Thus, the pattern and modality of rainfall determines both the level and intensity of harvesting. While around 8 Peasant Associations with 58 % of the sampled households could cultivate cereal production twice a year; the rest are unimodal implying no possibility for *Belg* production.

Table 4.2. Spatial Distribution of Sample Households by Land Holding Arrangement

Region	Peasant Association	Owner-Operators (Own)		Tenants		
		No. Households	Of total Own %	No. Households	% Share Of Total Tenants	Tenants/All Households in PA (%)
Amhara	Yetmen	10	5.1	21	14.6	67.7
Amhara	Milki	21	10.7	20	13.9	48.9
Amhara	Kormargefia	9	4.6	19	13.2	67.9
Amhara	Karafino	10	5.1	8	5.6	44.4
Amhara	Fajina Bokafia	13	6.6	6	4.2	31.6
Amhara	Dinki	6	3.1	4	2.8	40
Oromia	Sirbana Godeti	46	23.5	15	10.4	24.6
Oromia	Adele Keke	21	10.7	9	6.3	30
Oromia	Korodegaga	18	9.2	2	1.4	10
Oromia	Turufe Ketchema	32	16.3	21	14.6	39.6
SEPAR	Gara Goda	6	3.1	10	6.9	62.5
SEPAR	Aze Deboa	4	2.0	9	6.3	69.0
Total		196	100	144	100	42.4

Under such conditions, taking annual production as the sum total of the two seasons output creates a gap in production magnitudes that might wrongly be taken as results of efficiency differentials across places. Indeed, for both groups of farmers *Meher* is the main growing season. Thus, only *Meher* production is taken to represent annual output across all observations.

Average family size of the sample is 7.03 with 2.26 dependent (below 10 and 65 years and above) per household. In rural Ethiopia, even most of those who are taken here to be dependent might contribute a share in terms of livestock rearing, collecting firewood and other domestic activities. The average age of adults participating in farming and related 'domestic' works is 35.2 while the respective figure for heads of the household is 47.3. The average number of schooling of household members is 1.33 years. On the other hand, only 34% of the household heads have Adult Literacy Programme Certificate or attained formal education for about 3 years and above.

Table 4.3. Some Agro-Climatic Features of Sample Peasant Associations

Peasant Association	Rainfall Modality	Farming Technology	Main Cereals
1. Yetmen	Unimodal	Ox-plough	*Teff*, Barely
2. Sirbana Godeti	Unimodal	Ox-plough	*Teff*, Barely, Wheat
3. Adele Keke	Unimodal	Ox-plough and Hand hoe	Sorghum, Maize
4. Korodegaga	Unimodal	Ox-plough	Maize, Beans
5. Dinki	Bimodal	Ox-plough	*Teff*, Sorghum, Maize
6. Turufe Ketchema	Bimodal	Ox-plough	*Teff*, Barely, Maize
7. Aze Deboa	Bimodal	Hand-hoe and Ox-plough	Maize, *Enset*, Coffee
8. Gara Goda	Bimodal	Ox-plough and Hand-hoe	Barely, Tubers
9. Milki	Bimodal	Ox-plough	Wheat, Barely
10. Kormargefia	Bimodal	Ox-plough	Wheat, Barely
11. Karafino	Bimodal	Ox-plough	Wheat, Barely
12. Fajina Bokafia	Bimodal	Ox-plough	Wheat, Barely

Source: Bevan and Pankhurst, 1996

The mean value of cereal outputs for the selected households in *Meher* season is 1857.5 Ethiopian *Birr*, which is around 247.60 US Dollars at the current exchange rate *(1USD = 7.50 Birr)*. In addition to income from farming, households have reported non-farming income of around 156 Ethiopian *Birr* on the average. [15]

With regard to inputs use, the average cultivated land of the sampled households is 1.88 hectares per household which is almost double to the national average (around 1 hectare [Croppenstedt and Mulat, 1997]). The distribution could be viewed as follows.

Table 4.4. The Skewness of the Distribution of Cultivated Land

Cultivated Land in Hectares	Number of Households	Percentage	Cumulative Percentage
0.25-1.0	87	25.6	25.6
1.01-2.0	140	31.2	66.8
2.01-3.0	68	20.0	86.8
3.01 and above	45	13.2	100
Total	340	100	100

Weighted average figures on the quality of land indicated that land holdings in almost all sites of the Amhara region are *Lem-teuf* with medium fertility. In other areas, the quality of land is in favour of fertile or *lem* soils. On the other hand, in terms of slope or topography, the land in all sites is more of *Medda* (flat land) than land with sharp slope.

The average working days (family, hired and exchange labour) is 291. The respective shares of family, exchange and hired labours are 68%, 19% and 13%. Lack of access in the nearby areas for drinking water and fuel-wood force the rural people to spend part of their productive time to collect from distant areas. On the average household members need 15 minutes and 40 minutes (one way) to collect drinking water and fuel-wood respectively.

[15] Incomes from non-cereal crops, perennial trees, etc., are not part of the calculation. Mulat and Croppenstedt (1997) found 37 US Dollars per capita (225 US Dollars per household) for the sample of 344 households of similar data source.

Around 23 % of all households accepted credit more or equal to 50 Ethiopian *Birr* with in 3 consecutive years (1984, 1985 and 1986 E.C.).

4.2. COMPARATIVE ANALYSIS OF OWN-OPERATORS AND TENANTS

Several possible factors were mentioned in the forgoing chapters, which brought about tenancy land use arrangements. One of the many reasons for providing land for rent is lack of male labour and/or ox and bulls to properly utilise the available land holding.

In the sample households, about 20% of owner-operators are female headed while only 8 % of the tenant households are governed by females. Female headed tenant households have 2.2 oxen and bulls and 1.75 male adults above 15 years of age on the average and operate on the average on 1.49 hectares of land. On the other hand, female headed owner operators have only 0.93 oxen and bulls, 1.15 of adult male labour and cultivate 1.52 hectares of land on the average. Except the size of land, all other differences are statistically significant.

Regarding the stock of labour, 5.6 % of owner-operators do not have adult male above 15 years of age and use hired labour and below-age farmers, but only one tenant household (0.4%) lacks such an opportunity. In average terms, the difference in male resource endowment between the two groups of farmers is not found to be statistically significant.

The average ages of owner-operator household heads and tenants are 48.9 and 45.1 years respectively and the figures for adult household members involved in farming and domestic activities are 36.4 and 33.5 respectively which are significantly different from each other. This result goes with the findings of other studies that states most tenant farmers have younger male adult members compared to owner-operators [Yohannes, 1994]. On the average, therefore, tenant households have better adult labour that would vigorously perform farming activities compared to owner-operators. The average number of dependent per household is 2.28 for owner-operators and 2.23 for tenants but the difference is found to be insignificant.

With respect to draught power, owner-operators have 1.51 ox-bulls on the average while tenants hold 1.92 ox-bulls. The mean difference in oxen and bulls availability among the two groups of farmers has not only been statistically significant but the pattern of distribution also reveals the situation. Although significance levels do not firmly support the argument, variations in the extent of the problem on labour, and oxen and bulls supply have its own indication that there is a problem of resource mix. Around 28% and 16% of owner-operators have reported that they suffered from lack of oxen and labour respectively at the right period. These figures are slightly lower for tenants: 21% and 12%.

Table 4.5. Oxen and Bulls Ownership Status: Owner Operators and Tenants

Number of Oxen and Bulls	Owner-Operators		Tenants	
	%	Cumulative %	%	Cumulative %
No at All	34	34	23	23
One	28	62	26	49
Two	13	75	22	71
Three and Above	25	100	29	100

The kind of residence households owned could be taken as a proxy for the amount of wealth they posses. Around 51% of tenant households live in houses with a roof made of galvanised iron, bricks, cement or wood and the respective figure for owner-operator households is 40%. This difference in the relative 'wealth' status is statistically significant.

As an indicator of access to information and easier assimilation of new technologies and market situations, one could examine educational levels of household-heads and radio possession. Nearly 40% of tenant household heads have either Adult Literacy Program Certificate or attained formal education for 3 years or above and 32% of owner-operated household heads reached the same level of education. 17% of tenant households have the possibility of attending programmes through their own radios, but the respective figure for owner-operators is as low as 13%. However, the gap both in radio possession and educational levels between the groups are not statistically significant.

With regard to land use, the average cultivated land area for owner-operators is 1.93 hectares and 1.81 for tenants. Of the latter, on the average 1.04 hectares is rented from others[16]. This indicates that tenant farmers use more rented-land than they have so as to fulfil their effective demand which emanates from better endowments of complimentary resources.

An attempt is made to examine whether households rent-out part of their land whose quality is relatively poor. In relation to this, we have observed that on the average the qualities of lands under tenant farmers are slightly inferior compared to lands under own-operators but the difference is statistically significant. In terms of topography both groups of farmers operate on similar terrain on the average.

Independent mean values indicated that there is around 6% difference in the quality of land between the two farmer groups. From this result alone, one could not strongly maintain the opinion that land holdings are rented-out for tenant farmers because they are inferior in quality or not suitable for farming due to steep nature of the land. Over all comparative results lead us to hold the position (but with some caution until conformed by econometric results) that tenancy arrangement adjusts different land holding sizes with labour, draught power and other complimentary inputs. Through the system of land lease-rent arrangement, resources would be used more efficiently than put under utilised [Bereket and Croppenstedt, 1995]. Indeed, tenant households are also seen to be relatively wealthier and well informed as compared to their owner-operator counter parts unlike normally anticipated. This may be against the view that owner-operators rent out their land to extract surplus products unwisely from poor tenants.

Given the above variation in some resource endowments, the basic issue is whether or not such differences are reflected in the level of production. The mean *Meher* cereal output of own-operators is 12.3 quintals while the respective figure for tenants is 13.2 quintals. This

---

[16] But there is no clear information whether or not all the land is used for cereals and the share of output from the rented land.

gap in production levels between the two groups is not found to be statistically significant. We have examined the extent of the difference in output and stock of resources. The question then is, whether there is any substantial difference in the flow of resources or not?

The sample under consideration does not provide strong justification for the view that tenants under supply variable inputs, as they do not benefit according to their efforts. Owner-operators use chemical fertilisers with an average of 115.2 kg per household, the respective figure for the tenants' is 136.3 kg. Tenant households spend 328 (one-man equivalent) working days on the average in terms of family, hired and exchange labour but owner-operators use only 263 days per household. On the average, tenant farmers perform 13.6 ploughings but own-operators perform only 9.4 ploughings.[17] These differences are statistically significant at conventional probability values. In terms of other activities tenants are found to spend more labour time on ploughing and harvesting but in terms of weeding owner-operators spend more.

4.3. SOME FEATURES OF TENANT FARMERS AND RENTED LAND

The study considers 144 tenants, of these 107 are sharecroppers and 19 are involved in fixed rent arrangements. The type of contractual agreement is not clearly specified for the other 18 tenants. As it could be observed from Table 4.6 while Amhara region holds 65% of sharecroppers, the Oromia region hosts around 70% of (26 out of 37) tenants with fixed rent and other forms of arrangements. Sirbana Goditi Peasant Association of the Oromia region alone accounts for around 42% of fixed rent and 17% non-specified tenants, and Adele Keke Peasant Association from the same region has around 50% of tenants whose contract type is not specified. In the Southern Ethiopia People Administrative Region, two tenants are involved in sharecropping, the specific mode of contractual agreement is not stated for the other tenant household.

While the difference of mean output levels between owner-operators and tenants, as a whole is insignificant as described previously, there is a substantial per household output gap

[17] This is the number of times ploughings are performed on the different plots of land for the different types of cereals.

between sharecroppers and non-sharecroppers within the tenant farmers group. Sharecroppers produced an average of 10.6 quintals and fixed rent and tenants whose contract mode has not been specified produced 17.4 quintals. This performance gap among tenants is found to be statistically significant at conventional probability values.

Table 4.6. Regional Distribution of Tenants

Regions	Sharecroppers		Fixed Renters		Contract Not Specified		All Tenants	
	Number	%	Number	%	Number	%	Number	%
Amhara	70	65	4	21	4	22	78	54
Oromia	21	20	13	68	13	42	47	33
SEPAR	16	15	2	11	1	6	19	13
Total	107	100	19	100	18	100	144	100

If one examines labour and fertiliser uses, non-sharecroppers are found to employ more compared to sharecroppers. Sharecroppers use 284 labour working days and 121 kg of fertilisers while non-share tenants employ 421 labour working days and 169.8-kg fertilisers. In terms of quality of land and credit variables, we found that non-share tenants operate on more fertile land and around 35% of these tenants got credit while this figure is 17% for the sharecroppers. Indeed, around 70% of the non-share tenants are in Oromia region where the capital city of the country is located with a possibility of having better access for modern technologies and output markets. On the other hand, no statistically confirmed gap exists in terms of oxen-and-bulls and land size.

The observed output variation between groups of tenants may be attributed to differences in labour, fertiliser and credit uses and better accesses to modern information. In this regard, there was an attempt to examine output per the different input levels. However, this may provide a misleading result as partial measures in terms of particular factors of production conceal the effect of all other variables[18].

[18] Even though we have observed that there is a significant production difference between the two groups of tenants, the variation might be attributed to variations in input applications under similar returns to scale. Aside from assuming this on the basis of similarity on production technologies, data limitations for non-sharecropper tenants force us to treat all tenants in one production function.

The magnitude of rental share is usually blamed for determining the degree of inefficiency of tenant farmers. Of the total number of 107 sharecroppers, around 53% take half of the harvest and provide the left over to the owner of the land. To some extent, this may go with the universally prevailing rate of 1:1 share. Around 43% and 4% of the sharecroppers hold 2:1 of the total outputs and provide the rest to the claimants respectively.

The magnitude of rental share varies across regions and peasant associations. In region 3, 62% of the sharecroppers pay 1/3 of their harvest to the land owners, while 87 % and 100% of the sharecroppers in Oromia and southern People Administrative region share their harvest equally with the owner of the land. If we view the rental share across peasant associations, in Yetmen, Adele Keke, Turufe Ketchema, Aze Deboa and Gara Goda half-half share between owner-operators and tenants widely prevail. In Sirbana Godeti, Kormargefia, Karafino and Fajina Bokafia tenants have better share - 2/3 of the harvest. Exceptional case is Dinki where 50% of the tenants provide 2/3 of the harvest as rental of the land and are left only with one-third of their output.

Of the 37 other tenants, 19 pay a fixed amount of cereals for the use of rented land and 18 tenants do not report explicitly the amount or form of payment expected of them.

How input costs shared between tenants and owner-operators have also a determinant role on the degree of efficiency of farms. In 20% of the cases either owner pays input costs like seeds before harvest or tenants initially pay the cost and they are fully compensated during the harvest. In 74 % of the cases, tenants bear all the costs while in 5% of tenant farms both the tenant and the landholders equally share the costs.

Interlocking markets can have different forms one of which may be expressed in terms of fulfilling other obligations like helping the landowner when he works on his land. In 66% of the cases, tenants are required to support owners on their own farm whenever the need arises. In 28% of the cases, tenants reported that there is supervision of their activities by landowners either regularly or some time on certain stage of the planting or harvesting time.

5. EMPIRICAL FINDINGS

5.1. INTRODUCTORY NOTES

This chapter presents the empirical findings of the study and it is organised as follows. First, the OLS and MLE stochastic frontier Cobb-Douglas production function results and the associated technical efficiency levels of households in the whole sample will be analysed. Second, the existence and extent of technical efficiency differential between owner-operators and tenant farmers would be examined. Finally, possible factors affecting the magnitude of technical efficiency in the tenancy farms would be assessed.

Before presenting estimated results, it would be important to review once again how problems in the data set and estimation processes are dealt with. As it has been discussed earlier, the data set has several limitations. In many cases, variables are provided with extremely low or high values. In some extreme cases, we even encounter incredible figures like having 160 hectares of land for a single household. To this end, attempts are made to clear such extreme magnitudes. Households operating below a certain threshold level in terms of production and labour use are excluded. Indeed, those households who use neither ox-plough as a dominant farming technology nor chemical fertiliser are not considered as part of the study[19].

Not only vivid discrepancies are corrected through visual clearing but also statistical diagnostic checks on the existence of outliers and influential points are undertaken using the SPSS statistical package. Normality is also checked for non-dummy variables through graphical displays and variance-covariance matrices.

Collinearity between variables is a common problem in most of the data sets. For instance, along with the age of the household head, its square was included in the model to capture the diminishing contribution of experience to production. Due to perfect collinearity between the two variables, the variance-covariance matrix came to be singular and Limdep7 Programme

[19]The specific threshold levels and the reasons why such magnitudes are set have been discussed in chapter 4.1.

could not let estimation with these variables possible. Number of ploughing days may be a better proxy for the contribution of oxen and bulls in the production process compared to their mere number. The variable is found to be highly collinear with the total number of working days (0.91). Thus, the inclusion of variables is made depending on the degree of collinearity between the different variables.

Heteroscedasticity is a usual econometric problem in a cross section data with the resulting effect of providing inefficient estimates. To this effect, all estimated models in this study are corrected for heteroscedasticity, and the coefficients are standard-error robust estimates. All the results need to be viewed against this short background.

5.2. PRODUCTION FUNCTION AND TECHNICAL EFFICIENCY OF FARMERS: THE WHOLE SAMPLE

5.2.1. Production Function Results

Estimated results of both OLS and MLE stochastic frontier Cobb-Douglas production function for the whole sample are presented in Table-5.1 for comparison purposes. In both estimation procedures, most of the coefficients have a priori expected signs and found to be statistically significant at conventional probability values.

In the case of OLS, the estimated production function is specified with the assumption of equal average efficiency across farmers unlike the case of stochastic frontier production function, which is estimated through MLE. Given this difference in specification, we will use OLS for the analysis of elasticity figures as the former helps to describe average responses of farmers under study.

From the direct set of inputs (land, labour and drought power), elasticity of land (H) possesses the highest magnitude while ox-bulls (OB) follows. Assuming all other factors held constant, a one percent change in the size of land will bring about more than 0.32 percent change in the level of production while the respective percentage output variation attributed from changes in the services of oxen and bulls is around 0.26. The result on land goes in line with findings of Croppenstedt and Mulat (1997) and Wendwoson (1998). Assuming other indirect inputs remaining constant, more of the variations in output would come from changes in the size of cultivated land and draught power. This conforms that land and drought power are relatively scarce resources in the Ethiopian peasant agriculture.

The elasticity coefficient of labour (L) is significant at 1% and 5% percent in the OLS and MLE estimates respectively but it shows a relatively lower magnitude (0.15). This might partly indicates that labour input is less scare in the sample households. Although the variable is found to be insignificant at conventional probability values, the negative sign of the coefficient of family size might also justify the result on labour.

In the second group of inputs, many of the variables are found to play a pivotal role in the determination of output levels. Coefficients representing the degree of adequacy of rainfall at the beginning and during the growing season (R2 and R3 respectively) are not only significantly different from zero, but also have very high magnitudes. Other things remaining constant, if the rain does not come on time and with adequate amount at the beginning, the level of production would be around 56 % below the expected magnitude. If cereals receive adequate rainfall in the germination and growing periods, at what time the rain stops might not very much affect the level of production unless it creates problems on harvesting. The variable that takes care of the latter phenomenon (R4) indicates unexpected sign but it is not statistically significant. Overall, results on rainfall variables reflect that the volume of rainfall plays a pivotal role in the variation of production levels, as the Ethiopian agriculture is highly vulnerable to natural conditions.

Compared to the figures for land and oxen and bulls, and the expectations of farmers from modern inputs, elasticity of fertiliser with respect to output (0.23) is low[20]. But this figure is higher than the elasticity of labour input and the absolute value of land quality parameter in both of the estimation procedures[21]. The empirical evidence documented that given non-

[20] While chemical fertiliser is supposed to substantially enhance the level of production, its effect largely depends on the prevailing weather condition, timely delivery and application [Croppenstedt and Mulat, 1997].
[21] Note that land quality and topography are encoded in the data set inversely to the impact they are supposed to exert on production. For further information, see section 3.3.

expanded nature of land and acute shortage oxen and bulls, intensifying chemical fertiliser application is

Table 5.1. OLS and MLE Estimates of Stochastic Frontier Cobb-Douglas Production Function

Variables	O L S		M L E	
	Coefficients (t-ratios)	Probability Values	Coefficients (t-ratios)	Probability Values
Constant	4.057 (7.19)	0.000	4.614 (7.746)	0.000
L	0.1533 (2.67)	0.008	0.1384 (2.168)	0.03
H	0.3256 (3.315)	0.001	0.3213 (3.13)	0.002
OB	0.262 (3.789)	0.000	0.2597 (3.56)	0.000
M	0.4062 (4.837)	0.000	0.40 (4.6810	0.000
CR	0.2847 (3.004)	0.000	0.2923 (3.377)	0.001
R2	0.560 (4.78)	0.000	0.5354 (4.606)	0.000
R3	0.291 (2.46)	0.01	0.2868 (2.6160	0.009
R4	-0.241 (-0.2)	0.840	-0.3063 (-0.255)	0.799
Lq	-0.103 (-1.57)	0.116	-0.1126 (-1.72)	0.08
Ls	-0.9 (-0.759)	0.45	-0.1017 (-0.799)	0.424
Edh	-0.54 (-2.52)	0.012	-0.5052 (-2.515)	0.01
F	0.2315 (3.71)	0.000	0.2344 (3.79)	0.000
Intfhs	-0.783 (-0.293)	0.76	-0.1149 (-0.374)	0.709
La	0.116 (0.87)	0.38	0.1206 (0.885)	0.376
Ledhl	0.232 (2.19)	0.001	0.2339 (3.39)	0.001
Lfs	-0.125 (-1.343)	0.1793	(-1.255) (-1.572)	0.21

the most feasible alternative for enhancing productivity of land[22]. To this end, the efforts of government to promote the use of modern inputs like chemical fertiliser needs to be expanded in

its coverage. The interaction variable of fertiliser and land size of more than 2.5 hectares of land shows an insignificant coefficient with a negative sign. Even though, the argument is not strongly backed by the econometric result, this negative sign may have an indication that farmers with lower size of land extensively use fertilisers to compensate output shortfalls due to scarcity of land.[23]

Land quality and topography affect both the intensity of farming activities and production levels. The variable for topography or sloppy nature of the land is found to be statistically insignificant. Quality of land coefficient while insignificant up to 10% in OLS, it is found to be statistically different from zero in MLE. As quality of land improves, the level of output would respond positively.

Wealth proxy dummy (M) and the credit dummy (CR) have their expected positive sign with elasticity of 0.40 and 0.28 respectively. Both variables are assumed to take care of the capacity of the farmer to finance the necessary marketed inputs. Particularly, households whose roof of residences are made of galvanised iron, stone, bricks or cement are in a better condition to have higher level of output compared to the others. This may be due to the fact that households with such residences are likely to be wealthier and relatively well-informed as in rural areas such residences are usually taken to be status symbols.

Both education status (ledh) and farming experience (la) variables have shown their expected sign. We note from the coefficient of education variable that literate farmers are more productive compared to the illiterates. This may be the fact that literate farmers make advantage of having better access to information about the use of modern inputs and farming

[22] Intensified use of fertiliser beyond a certain limit might turn out to affect the health of the soil and become counter productive. Care needs to be taken not to exceed the limit. The recommended rate is around 150 to 200 kg per hectare [Croppenstedt and Mulat, 1997].
[23] The average per hectare fertiliser application for a land size less than 2.5 hectares is 96.16 kg while the respective figure for land size larger than 2.5 hectares is 44.05 kg.

techniques as well as adopting better operation and management practices from both the traditional and modern mode of farming.[24]

Literate family members are believed to promote efficiency through their indirect impact on the decision process. However, the variable for whether or not there is/are one or more literate household member(s) (other than head of the household) exist(s) (EDH) has shown a negative sign and it is found to be significantly different from zero. A partial correlation between this education variable and adult family members indicated a very weak association[25] so that these " literate" household members may be below "farm-age". Thus, such young members of the family may not provide meaningful advice since they do not practically and actively involved in farming and other relevant activities. Rather they may compete for the limited financial resource and working time the household may have at least for the short run.

To capture the effect of farmer's experience on production, age of the household head (la) is incorporated into the production function and it is found to be insignificant. We remember that the average age of household heads is around 47 years and this reflects the existence of many "old" family heads. Increasing age beyond a certain level might in turn lead to two possible contradictory effects: a positive association with experience and production on the one hand and an inverse relationships with physical strength and absorbing capacity of possible hardships on the other [Croppenstedt and Mulat, 1997].

5.2.2. Technical Efficiency Measures

In general terms, both in MLE and OLS estimation procedures of the Cobb-Douglas production function; the estimates have shown similar signs with little difference in significance levels and coefficient magnitudes. Their major difference basically lies on the intercept term, which is resulted from differences in their assumptions about the specifications of the error term.

---

[24] Studies on the area indicated that education is believed to influence after a certain threshold level. However, as descriptive statistics figures indicated educated farmers are rare and discrimination based on education levels may not provide meaningful result. We also learnt from the findings of Abay (1997) on a similar data set that in the Ethiopian peasant agriculture, any level of education for the household has positive contribution to production.

[25] The result shows a negative sign with a partial correlation coefficient of 0.14.

OLS addresses the mean responses of production levels of "all households" for changes of input levels. On the other hand, MLE, as a stochastic frontier estimator, treats what would be the response of output levels of farmers to changes in factors of production with "best-practised" farmer being the reference line. Since OLS gives no room for differences in individual specific features or attributes and assumes that all farmers perform on a similar efficiency level, the constant term in this mode of estimation would naturally be lower or equal to the MLE estimate [Assefa, 1995].

In our case, the coefficient of the constant term in the MLE is higher (4.614) compared to the OLS (4.057). The result reveals that all farmers do not operate on a similar performance path. Due to farm specific and household controlled "errors in operation", there exist variations in efficiency levels of farmers. With the assumption that best-practising farmer efficiently utilises resources under his disposal, he operates over and above the average farmers production line. This is exhibited by the difference between constant terms of the OLS and MLE estimates.

From the following parameters in the MLE stochastic frontier estimates, it is recognised that household controlled errors (u) bring about differences on the level of technical efficiency of farmers. The relative magnitudes of σ_{μ}^{2} and σ_{v}^{2} also indicated that the effect of household controlled factors on the variation of production levels is 12.6 percent more compared to the exogenous variables.

Table 5.2. Estimates of Technical Inefficiency Indicators

Parameters	Coefficients (t-ratios)	Probability Value
σ_{μ}^{2}	0.37015	
σ_{v}^{2}	0.3399	
σ^{2}	0.8379 (8.6)	0.00
$\lambda = \sigma_{\mu} / \sigma_{v}$	1.056 (2.2)	0.026

The coefficient of λ also reflects that the relative influence of the two error terms in production is statistically conformed towards the one-sided error term. From this result, we could learn three important points. First, there exists inefficiency in traditional farming. Second, the magnitude of inefficiency differs among farmers operating within a similar technological setting. Finally, factors that are under the control of farmers' play a more active role compared to the externals.

As it is observed from Table 5.3, the mean level of technical efficiency for all sampled farmers considered in the study is 62.8% relative to the frontier or "best-practice" level of operation. The implication is that due to lack of ability to use resources at their disposal with utmost effectiveness, households loose on the average 37.2% of the output that would have been produced otherwise. There is almost a 63 % technical efficiency gap between the operation of efficient farmers next to the best and the most inefficient ones.

Table-5.3. Technical Efficiency of Farmers over Educational Status, land Size and Region

Statistics	Whole Sample	Education Status		Land Size		Regional States		
		Literate	Illiterate	Below or Equal to 2 Ha	Above 2 Ha	Amhara	Oromia	Southern Peoples
Minimum	0.22044	0.30654	0.22044	0.37026	0.22044	0.24255	0.30138	0.22044
1st Quartile	0.3790	0.43850	0.3790	0.48021	0.3790	0.3839	0.43970	0.31371
Mean	0.62757	0.63850	0.62540	0.633356	0.624689	0.6380	0.645416	0.425619
Median	0.64056	0.65610	0.63075	0.64808	0.63855	0.65434	0.66466	0.43103
3rd Quartile	0.6961	0.70322	0.6961	0.70012	0.69610	0.66658	0.75633	0.50022
Maximum	0.85465	0.83558	0.85465	0.85465	0.81007	0.80792	0.854654	0.5935

While the first 25% of the most inefficient farmers operate very much below the mean level, the degree of inputs use efficiency of the 25% farmers above the mean do not very much differ from the centre in relative terms. Not only the median is higher than the mean by 0.013 but also the first and third quartiles indicate that technical efficiency magnitudes of the different households are negatively skewed. This implies that there is a very significant technical efficiency differential in the lower level of operation than among the relatively "efficient" farmers.

Efficiency differential among farmers may be reflected through different attributes or condition of farmers under which they operate. Examining the level of technical efficiency among literate and illiterate farmers reveals that in terms of all stated central tendency measures, literate farmers perform better than otherwise. This variation in efficiency may arise not only due to mere difference in educational status but also due to its implication on resource endowment and input use. Literate farmers have larger stock of oxen and bulls, apply more fertiliser and have better access to credit[26].

Examining the level of technical efficiency in terms of land size has both equity and efficiency implications. In our case, given the mean size of land being1.88 hectare, 2 hectare is taken as a reference point for grouping farmers based on land size. Farmers cultivating two or below two hectares of land on the average operate more efficiently compared to farmers having relatively larger land sizes. This is mainly because of the incompatibility of other resource endowments with the available land size[27]. This implies that land use reallocation through a certain form of arrangement would not only maximise technical efficiency of farmers but also enhances equity in the distribution of the fruits of land.

Efficiency of farmers across regional states is also seen to be different. While the level of operation vis-à-vis the frontier for farmers of the Oromia is better than their counterparts in the Amhara regional state, technical inefficiency of the Southern Peoples Administrative region (SPAR) farmers is found to be highly pronounced. Part of technical efficiency differential of farmers across the regions is resulted from differences in input applications and

[26] While literate farmers on the average use 135.4 kg fertiliser, own 1.72 ox-bulls and 25% of them acquired credit, the respective figures for illiterate farmers are 118.3, 1.67 and 22%.

[27] Small land farmers spend 99.32-kg chemical fertilizers, 208.44 labour days and 1.2 oxen and bulls per hectare of land while large size farmers use 54.29 kg, 134.53 labour days and 0.86 ox-bulls. In terms of quality of land, the mean figures are in favour of the small landholders (1.65) compared to the others (1.79). Given the lowest elasticity of land quality variable holds, the main cause of inefficient operation for 'large' lands could be incompatibility of resources.

natural conditions.[28] Farmers of Southern Peoples Administrative Region (SEPAR) used the lowest amount in terms of labour, oxen and bulls, and fertiliser. Regarding timing and adequacy of rainfall and land quality, Region 3 is not in a favourable condition.

5.3. EFFICIENCY DIFFERENCE BETWEEN OWNER-OPERATORS AND TENANTS

Different testing mechanisms are applied to examine possible efficiency differences that might exist between groups of farmers operating on the different land use arrangements: owner-operators and tenants.

5.3.1. Two-Stage Switching Regression Model and the Chow Test

Agricultural efficiency largely depends on how farmers apply the desired level of inputs and efforts on their farms. The rate of inputs application may be in turn determined endogenously by the kind of land use arrangement: being a tenant or owner-operator. In this regard, some special own or externally associated features have been mentioned in different studies on Ethiopian tenant farmers that differentiate tenants from own-operators.[29]

To this effect, an attempt is made to use a two-stage regression model with the criterion function that enables endogenous switching to alleviate possible problems of endogeneity. Using equations 37 through 49 from section 3.2.3.A, we first estimate an indication function, $I^* = \beta' x + e_i$ which involves the different attributes of the two groups of farmers in the variable X[30]. In this model, I^* is unobservable and I=1 if $I^* \geq 1$ and I=0 if I<0. This

[28] Average Input application and Natural Conditions of Farmers across Regions

Variables	Region 3	Region 4	SEPAR
Labour Days	281.6	323.16	153.7
Oxen and Bulls	2.16	1.40	0.86
Land Quality	1.94	1.46	1.76
Fertiliser in Kg	120.7	139.47	61.54
Rainfall Comes on Time	0.45	0.70	0.63

[29] Salient features are provided in chapter 2.3 of this paper and for further discussion please refer papers submitted to the Workshop on Land Tenure and Land policy in Ethiopia after the *Derg*, organised by IDR, 1994.

[30] Tenancy land use determining variables included in the model are female headed household (FH), number of oxen and bulls (NOB), land quality (Lq), land topography (Ls), average age of farmer household member (Ag), size of land "owned" from government (HAI), farmer

indication function is for households that in some way participate in land use markets either in sharecropping or leasing in land on some fixed rate or other forms.

OLS and MLE results of sample selection binary probit estimation for the 2-stage switching regression model are presented in Table 5.4. From the binary probit estimate we note that all significant coefficients have their expected sign and a tendency towards a possibility of grouping farmers on the basis of land use arrangement. Statistically significant coefficients indicated that better wealth status, having younger farmers in the family and lower size of land acquired from the state contribute positively for being a tenant. Female-headed households and involving in tenancy are negatively related. The results have gone with our expectations.

In over all, regardless of indicating a certain tendency, the variables could not predict tenants on a sufficient degree of accuracy. While there are 144 tenants included in the survey, the model able to predict only 67 of them. Estimating two different production functions through two stage regression procedures based on 47 percent predictive power might provide misleading results. This implies that even though there are some usually mentioned peculiar features of Ethiopian tenant farmers with certain associated variables, strong econometric background lacks to endogenously group farmers based on such behavioural factors.

Failure to estimate two different production functions through two-stage method does not necessarily imply that the two groups of farmers share a common production function. Whether or not differences in ownership of land lead to different production functions is examined through Chow-test. Assuming normally distributed error terms, Cobb-Douglas production functions for the whole sample and the two different sub-samples are estimated. From detail results described in Appendix 4 and 5, the required parameter estimates for the test and the respective computed F-value are as follows:

$s1 = 158.54$	$N1 = 196$	$F\ computed = 1.56938$
$s2 = 102.35017$	$N2 = 144$	$F(17, 306)$ at 1% ≈ 2.62
$s3 = 43.48569968$	$K = 17$	$F(17, 306)$ at 10% ≈ 1.74

attained a minimum of three years of formal education or has Certificate of Literacy Campaign (EDLC), farmers with galvanised iron sheet residences (M), family size (FS) and age of the family heads.

Table 5.4. OLS and MLE Estimates of Binary Probit Model for Sample Selection

Variables	OLS Coefficient (t-ratio)	MLE Coefficient (t-ratio)
Constant	0.61345 (3.855)*	0.339265 (0.746)
Fh	-0.2569867 (-3.496)*	-0.8401736 (-3.546)*
NOB	0.32407 (2.223)*	0.1301357 (2.202)*
Lq	0.808297 (1.955)**	0.2263467 (1.930)**
Ls	-0.51577 (0.5071)	-0.12187 (-0.551)
Ag	-0.839781 (-2.461)*	-0.251758 (-2.469)*
HAI	-0.5826 (-4.167)*	-0.344418 (-1.518)**
EDLC	0.2137 (0.358)	0.34470 (0.8409)
M	0.1287 (2.442)*	0.38242 (2.508)*
FS	-0.1199196 (-1.419)	-0.33527 (-1.399)
A	0.332692 (0.147)**	0.1449 (0.221)**
Log Likelihood	-216.497	-203.3505
F-value	5.49	-
Chi-square	-	56.6548

_ * Significant at 5%, and ** significant at 10%.

Actual	Predicted 0	Predicted 1	Total
0	164	32	196
1	77	67	144
Total	241	99	340

Since the computed F-value based on equation 52 of section 3.2.3.B is lower than the critical F-values at conventional probability magnitudes, we do not reject the hypothesis that owner-operators and tenants operate on a the same production function. We know that factors like production level associated rent, obligation of tenants to carry out certain activities for the landowner own benefit, insecurity of land use for a longer period are usually mentioned to be major bottlenecks for tenants' efficiency. In practice, land ownership difference and the problem associated to tenant farmers do not significantly let two group of farmers have different production functions. Even though there are some differences in resource endowments, no econometrically valid variation could be mentioned between the two groups that may force one of them to operate under an inferior or superior production function.

5.3.2. Descriptive Statistics and other Econometric Tests

Since we reached on the conclusion that the two classes of farmers operate on a similar and one production function, efficiency comparison would be possible under the umbrella of a single stochastic frontier production function.

Table 5.5. Efficiency Differential between Own-operators and Tenant Farmers

Statistics	Whole Sample	Owner-Operator	Tenants
Minimum	0.22044	0.24255	0.22044
First Quartile	0.3790	0.39558	0.36463
Median	0.64056	0.63926	0.64115
Third Quartile	0.69610	0.70163	0.65301
Maximum	0.85465	0.85465	0.79720
Mean	0.62757	0.629416	0.6251
95% Confidence interval Mean	0.6446	0.6464	0.6423

As it is observed from Table 5.5, except the median, owner-operators seem to be more efficient compared to their tenant counter parts, in terms of all other central tendency measures. The result also indicates that the most efficient farmers are from own-operators class and the most inefficient farmers are tenants. Regardless of some differences in terms of visual observations, the efficiency gap between the two group of farmers is found to be statistically not different from zero as F-test reveals (F=0.125). If mean is computed after the 5% extreme low and high efficiency levels are excluded, the difference would further become negligible.

To conform the above finding and examine the relative role of being an owner-operator or a tenant on efficiency, two different production functions are estimated by incorporating one dummy variable at a time reflecting the kind of land use arrangement. The result indicates a positive coefficient for the owner-operator and negative coefficient for a tenant variable but the variables are found to be statistically insignificant in both cases.[31]

To conclude, even though both the above descriptive statistics figures and the signs of coefficients for the mode of land use arrangements tend to slightly favour owner-operators, the efficiency difference between them is not significantly observable. This finding stands against the views of the Marshallians and the General equilibrium model. Marshallian and others contend the view that tenants are inefficient either because of the effect of "insecurity of land" on long run investments and/or the rent paid for the landlord is a positive function of their output.

Dynamic population growth and continuous land distribution on the one hand, absence of any limit as to the scale of redistribution and minimum land holding size on the other create a sense of insecurity even on sustainable functioning of own-operators themselves. Lack of security in turn has created a disincentive effect on conservation and long run land improvement measures [Yibeltal, 1995 and Abbi, 1995]. A study on sample peasants of Shashemene and Dale of Oromia and Southern Peoples Administrative regions respectively indicated that most of the plots in steep slops are eroded and most of the farmers do not have conservation structures [Yibeltal, 1995]. In other words, although tenant farmers are accused of exerting little effort in terms of conservation and land improvement activities [Yohannes, 1994, Dejene and Teferri 1995], overall insecurity of land holding in the system significantly

[31]The coefficient of owner-operator dummy (WN) in OLS and MLE with associated t-ratios is found to be 0.770 (0.93) and 0.10 6 (1.24) while the respective figures for tenant dummy (TT) are -0.697(-0.841) and -0.105 (-1.22). See Appendix-6.

reduces the difference in this respect among farmers operating under the different land use arrangements.

The view that 'tenants are inefficient' is based also on the proposition that paying part of the total output to landowners discourages production intensity. However, these scholars do not properly take in to account the opportunity cost of tenant labour in countries like Ethiopia. We have witnessed from the results of the study under consideration that farmers do not usually use hired labour and their access for additional income from other sources is very limited[32]. It is also argued that,

> " In peasant agriculture farming is not a business; it is a way of life. ... Food accounts for the bulk of the family budget. ... In densely populated and capital and land-scarce areas, labour seems to be a relatively less scarce resource that can intensively be utilised" [Dejene, 1995: PP. 4&5].

Under the given structure of the economy, limited employment opportunity for rural labour, dynamic population growth and back pressing scarcity of land, the optimal option that might be left for landless or land scarce farmers is to work with landowners on the basis of the available option. In other words, the need for survival under the condition of limited opportunity for other means, would likely to force tenant farmers so as to operate under the prevailing norm of inputs' application and technology, and use resources at their disposal as efficient as their counter part owner-operators.

The other possible reason is that when variable input use markets, like labour and oxen and bulls, are imperfect and risky, the operation of tenant farmers may not be less efficient to owner operators. In the Ethiopian situation, even though tenant farmers lack adequate access for land, they are better endowed with all other resources as we have learnt from Chapter 4. Under the prevailing socio-economic environment of the country, mixing the rented-land with their complimentary inputs would allow tenant farmers to operate comparable to own-operators.

Further more, regardless of differences in land use arrangement, the households considered in the study are those which operate under similar technological setting in terms of fertiliser use

[32] The average non-farm income of households is 19 US Dollars (143.17 *Birr*) per annum [Appendix 1].

and ox-plough. It is, therefore, not unreasonable to have similar production functions and insignificant efficiency difference between the two groups of farmers.

Non-existence of significant over all efficiency difference does not necessarily imply that these two group of farmers are similar in specific input uses. To examine possible input specific elasticity differences for some key inputs, two independent Cobb-Douglas production functions are estimated for the two groups using MLE (on labour, land, oxen and bulls, fertiliser and a rainfall variable) and a Wald test is applied.

Table 5.6. MLE Estimates of Cobb-Douglas Production Functions for Wald Test

Variables	Owner-Operators		Tenants		For the Two Groups		
	Coefficients	Standard Errors	Coefficients	Standard Errors	Sum of β Variances	Square of βs Differences	Chi Square (1) for Wald
Constant	3.65678*	0.41800	4.005712*	0.39308	0.329241	0.1217	0.37
L	0.18575*	0.088634	0.9333520	0.016146	0.012031	0.5589	46.5
H	0.109210	0.113296	0.601790*	0.115578	0.026241	0.24263	8.62
OB	0.25962*	0.094693	0.16979*	0.098892	0.018747	0.00807	0.43
R2	0.58851*	0.0128918	0.813287*	0.128468	0.016674	0.05052	3.03
F	0.34954*	0.0829694	0.321019*	0.802091	0.013623	0.11284	8.28
Ledh1	0.18404*	0.0897825	0.985686	0.780618	0.077425	0.6426	8.23

* Significant at 5%.

As it is indicated on Table 5.6, no statistically valid difference exists between the two production functions in terms of the intercept, the coefficients of the oxen and bulls, and rainfall variables (as critical value for $\chi^2_{(1)}$ at 5% = 3.84). In this respect, we do not reject the null hypothesis of equal elasticity. But in terms of all other stated inputs, statistically significant output elasticity differences are observed. Output fairly responds to fertiliser application in both farms but the elasticity is higher for the case of owner-operators. While land is found to be insignificant in the owner-operators' function, education and labour inputs happen to be so in the tenants' function.

The implication of the above results is that there is relatively 'excess' land holding in the hands of owner-operators and labour is not a scarce resource for tenant households. We have also observed in section 5.2.2 that large size farms are relatively inefficient compared to smaller plots. This calls for some sort of adjustment towards moving labour and/or land from their/its improper use to the efficient ones. This would partly be feasible if those large landowners that do not have adequate complimentary inputs enter into land use arrangements with tenants[33] who lack optimal land size given their resource endowment.

5.4. FACTORS AFFECTING EFFICIENCY OF TENANT FARMERS: SOME INDICATIONS

In tenancy literature several factors are usually mentioned to take the blame of affecting the level of tenant farmers' efficiency. To assess the influences of such variables, technical efficiency of tenant farmers are calculated independently of owner-operators and an examination is made on the influences of such factors. Before we deal with assessing the impact of such factors on the degree of operation of tenant farmers, let us examine the level of efficiency gap that might exist between sharecroppers and other forms of land lease arrangement.

Of the different land lease contracts, most literature stand against sharecropping. Even though we may observe a tendency of supporting the above argument on the basis of mean and maximum technical efficiency figures, the difference is not very much pronounced. We have observed that the maximum and the mean figures favour non-share tenants. On the other side, on the basis of the first and third quartiles, the median and among farmers working around the bottom of the production function, sharecroppers seem to show a better performance. In over all, these results could not lead to a strong position in favour of a certain form of contract on the basis of efficient use of resources.

Table 5.7. Efficiency Differential between Tenants

Descriptive Statistics	Sharecroppers	Non-Sharecroppers	Total
Minimum	0.24149	0.14947	0.14947
First Quartile	0.36435	0.32832	0.3473
Mean	0.623969	0.62978	0.62546
Median	0.64558	0.62604	0.6413
Third Quartile	0.70000	0.68602	0,6952
Maximum	0.852922	0.86487	0.86487

To have a solution for such illusions, after excluding 10% of the most efficient and inefficient farmers from the sample, technical efficiency central tendency and scatter variability figures are computed and the results stand against sharecropping. This finding supports the views of the Marshallian and the proponents of the General Equilibrium Model and goes in line with the descriptive statistics results of Chapter 4.

However, one must be cautious in providing a strong conclusion even for the case under consideration. Many of the non-sharecroppers are located in Oromia region where the latter stands first for efficient use of factor inputs while the majority of the sharecroppers are found in Amhara regional state where efficiency is lower for the whole sample compared to the former. In this regard, region specific social and geographical conditions may have their own impact on the result.

Table 5.8. Efficiency Differences between Groups of Tenants: Excluding 10% Extreme Values

Statistics	Sharecroppers	Non-Sharecroppers	Total
Minimum	0.3576	0.3665	0.3576
Mean	0.6287	0.6423	0.6320
Median	0.6468	0.65728	0.6493
Maximum	0.8173	0.8199	0.8199

[33] In this connection, one should not undermine the possible effect of future redistribution of land on efficiency if it is led on the basis of maximising benefits of complimentary inputs and enhancing land productivity.

Mode of input cost financing (CS) is statistically significant and holds a priori expected sign. Efficiency is an increasing function of CS[34]. This implies that the modality of input cost financing has a certain influence on the level of tenants' operation. It is also found that when tenants are responsible for the supply of fertiliser, seeds or other similar factor inputs, efficiency tends to rise. This might be because when individuals who are actually operating on the land are responsible to acquire such inputs, it is likely that not only the supply would be timely but also the amount would be as necessary.

The decision variable (DS) holds its expected sign and found to be significant. The implication behind this result is that joint decision of 'land-owners' and tenants on what, when and how do they perform agricultural activities would likely to enhance production as it would involve two-minds and experience regarding timing, intensity of activities, and keeping the balances of natural factors.

Regarding ox and bulls, and plough supply by either of the two parties, the coefficients appear to be significant with a negative sign. In theory, oxen and bulls supply by owners is expected to facilitate operation of tenants. In our case the variable is found to be inversely correlated with the level of efficiency. As shortage of oxen and bulls is a critical problem particularly for renters of lands, the inverse relationship may arise due to one basic reason: owners may fail to provide the stated input on time and/ or with the required number.

The variable (Hai) is included in the model to capture the impact of having a certain magnitude of land from the state on the level of tenants' efficiency. *Hai* variable is found to be insignificant but the sign provide an indication that tenants who have more own-land may tend to over concentrate their effort on their own land and tend to under supply variable inputs for the rented one. Discriminatory concentration in turn tends to minimise the level of efficiency that would otherwise be.

Of all the variables, non-significant share-rental coefficient is against the traditional tenancy theory. But at least for this specific result, we have some possible reasons. We know that the

---

[34] Recall that CS has values of zero, one, and two on the condition that owners do not at all finance input costs, both equally share the cost, owners finances such costs respectively.

Marshallian theory assumes perfect market system where by resources and outputs of every kind can move easily. Perfection in input and output markets is not very much relevant to the situations of rural Ethiopia to say the least. Under the prevailing land scarcity and limited option for other means of employment, the result instead forces us to believe that the degree of inputs application by tenants may not be necessarily affected by the magnitude of the rental share. This is because the life of peasants is almost solely attached with the level of production. In other words, by applying inputs using 'standard norms', tenants would try to maximise the level of output that may be left for them after paying the rent.

However, we have noted from the previous result that the very nature of the contract (sharecropping or fixed rent etc.,) to some extent influences the level of efficiency. Even this result is partly attributed to some geographical and the specific social environment. Many of the sharecroppers in general and with better share (2/3) in particular operate in the Amhara region where the overall efficiency is medium. In the regions where efficiency is the highest or the lowest the universally accepted norm is 1/2:1/2 so much so that it would not be abnormal to have weak association between efficiency and the rental share.

6. CONCLUSION AND POLICY IMPLICATIONS

The study tried to address three main objectives: examining technical efficiency of farmers; investigating and analysing efficiency differentials between own-operators and tenants, and between sharecroppers and non-sharecroppers; and finally assessing some factors that might affect efficiency of farmers. Detail descriptive statistics and econometric results of 340 households from the 1993 Ethiopian Rural Household Survey are presented in Chapters four and five. This part of the study provides conclusions and their policy implications. The following are the major findings.

1. The result of this study indicated that inefficiency prevails in the Ethiopian peasant agriculture and there is a considerable potential for improving efficiency and production within the given the state of art. The mean technical efficiency for sampled farmers is 62.8 percent relative to the 'best-practice' farm level of operation. The study indicates that efficiency of farmers differ across land size, education status of household heads, and regions. Farmers cultivating below or equal to two hectares of land perform better compared to farmers working relatively on 'large' size of land. This is mainly because of the incompatibility of other resources with the available land size. Literate farmers operate more efficiently than their illiterate counter parts. This may be due to the fact that literate farmers are relatively wealthier, more informed and accessible to capital markets. They are better endowed with oxen and bulls, apply more fertiliser and most of them use credits. Both OLS and stochastic frontier MLE estimates of the Cobb-Douglas production function further indicate that wealth of the household, credits, oxen and bulls, the amount of fertiliser application, and rainfall adequacy significantly contribute to the volume of production.
2. The results of the study reveal that mode of land holding does not bring about an observable efficiency difference between groups of farmers. On the basis of two independent average Cobb-Douglas production functions, Chow-test is conducted. The result indicated that both owner-operators and tenants on the average share a similar production function. Given this production function, technical efficiency figures also indicate that no statistically sound difference exists between owner-operators and tenants:

an average of 62.9 percent and 62.5 percent respectively. To further examine the impact of mode of land holding on production, two different Cobb-Douglas production functions are estimated by incorporating one dummy at a time that reflects the kind of land holding. While owner-operator variable indicates a positive sign, the tenant variable is negative. But both variables are found to be insignificant. All these attempts consistently lead us to believe that the assertions of the Marshallian and others do not go in line with the situations in Ethiopia. This may be a result of four possible reasons. Firstly, lack of other feasible employment opportunities may force tenants to concentrate on their farms and maximise that part of output that would be left for them. Secondly, resource mobility between the two groups of farmers in terms of land may enable for both of them towards having a similar combination of inputs. Thirdly, while landholders involve in high risk and uncertainty in the supply of labour and oxen and bulls during pick season, tenants do have relatively adequate complimentary inputs to make productive use of the land they rented-in. Finally, similar expectations on the security of land holding may cause farmers to operate on a similar production function and efficiency regardless of differences in the mode of land holding. Wald test on the other hand indicates that while elasticity of land is higher in the case of tenant farmers, the reverse is found to be the case for labour. In relative terms, therefore, land is 'excessively' utilised under owner-operators and labour is not very much a problem in tenant farms.

3. Based on data for all tenants considered in the study, we have found no basic efficiency difference among different group of tenants. We have observed that while non-sharecroppers report both minimum and maximum figures, the higher figures for the first and third quartile are favouring sharecroppers. An examination is made on what would happen to the situation if 'extreme' farmers were out of discussion. After excluding the most efficient and inefficient 10 percent households, the computed mean values and other statistical measures reveal that non-sharecroppers are more efficient relative to sharecroppers. This finding is in accord with the Marshallian hypothesis. However, it needs to be taken cautiously since most of the non-sharecroppers are found in Oromia region where efficiency of farmers for the whole sample is the highest.
4. In an attempt to examine the impact of some tenancy associated behavioural factors on efficiency, the estimated model is found to explain only 15 % of the variation ($R^2 = 0.158$). The mode of cost financing (CS), the activity decision variable (DS), land-

owners and tenants responsibility to avail oxen and bulls (Oinput1 and TTinput1) respectively and tenants responsibility to supply seed, fertiliser and other similar inputs (TTinput2) are found to be statistically significant. Rental share (Sr) and the size of land acquired from the state have their a priori expected sign but not found to be statistically significant. This might have some indication that in a situation where other means of living is limited, such factors may not very much influence the motives of tenants to maximise the level of production and their share thereof.

Under the given nature of the data set and its associated problems explained in the previous parts of the study, it would not be worthwhile to provide conclusive policy recommendations. However, some general policy implications and issues for further study on the area may be drawn from the above findings.

1. Given the limited access for additional resources into the system, efforts towards providing training, education, and extension services for households focusing largely on practical problems of using the available inputs more efficiently should be strengthened. Resolving the contradiction between the demand for oxen and chemical fertilisers and the limited capacity to acquire them with adequate magnitude, among other things, necessitates the services of credit facilities. Efforts towards establishing micro-enterprises and government supports in availing credits in rural areas need to be strengthened and widened with their coverage. Technical advice also play a pivotal role on how farmers would wisely utilise resources they are indebted from such financial institutions. By examining its validity, government is also required to pay its attention for creating an enabling environment through which concerned bodies would facilitate the movement of production factors such as oxen and bulls across areas for better economic and social return. Realising the potential of irrigated farming, as a means of minimising the vulnerability of cereal production due to rainfall variability, is not a simple endeavour. With this limitation, however, strengthening efforts exerted to date and providing favourable conditions for joint participation of donors, government institutions and beneficiaries for the formulation and feasible implementation of small-scale irrigation schemes should not be over looked.

2. It would be for the benefit of the country if both 'large size' land holders with inadequate complementary inputs and those who do not have direct access to the 'state land' and/or own smaller plots jointly form a certain land use arrangement. The policy has already created an enabling environment for land rent and leasing activities. On the basis of this, encouraging the functioning of land use markets and maintaining the security of holding rented-lands for a certain optimal period helps to maximise the efficiency of farmers through its impact of reallocating both labour and land to their better use.
3. Some indications are observed that fixed rent leasing enhances technical efficiency of tenant farmers better than sharecropping does. This calls for a fixed rent contractual agreement as against sharecropping. Nevertheless, further study on a comparative analysis of the impact of different contractual agreements on efficiency of tenant households is recommended for conclusive policy implications.
4. The conclusion emerged in relation to the behavioural factors affecting efficiency of tenant farmers does not lead itself to any sort of policy implication. The available results, however, have some indications that making joint decisions on activities, providing tenants the responsibility of availing the required amount of seed, fertiliser and other similar inputs on time and allowing them to be fairly financed by landholders for input costs could increase efficiency of tenant farmers.

BIBLIOGRAPHY

Abay Asfaw (1997), " *The Impact of Education on Allocative and Technical Efficiency of Farmers: The Case of Ethiopian Smallholders*", M.Sc. Dissertation, Addis Ababa University.

Abbi Mamo (1995), 'Environment, Population and Agricultural Development in Ethiopia' in "*Ethiopian Agriculture: Problems of Transformation*", Proceeding of the Fourth Annual Conference on the Ethiopian Economy, (Eds.) Dejene Aredo and Mulat Demeke, Addis Ababa.

Abdulhamid Bedri Kello (1992), "The Peasant Economy: a Review of the Different Theories", in *'Ethiopian Journal of Economics'*, Vol 1, No.2, Addis Ababa.

Abrar Suleiman (1996), " Technical Efficiency of Fertilised Farms in Ethiopia: An Application of Stochastic Frontier Approach", *Ethiopian Journal of Development Research*, Vol. 18, No. 2.

Alemayehu Seyoum (1989), " Technical and Allocative Efficiency of Farm Households in Ethiopia: Tentative Findings of a Case Study of Two PAs. *Proceedings of the Workshop on Problems of Rural Development in Ethiopia*, Institute of Development Research, Addis Ababa University, Addis Ababa.

Appleton, S, J.Hoddinott, P.Krishnan, and K.Max (1994), "*Does the Labour Market Explain Lower Female Schooling? Evidence from Three African Countries*"; Centre for the Study of African Economies, Oxford.

Assefa Admassie (1995) "*Analysis of Production Efficiency and the Use of Modern Technology in Crop Production: A study of Smallholders in the Central Highlands of Ethiopia*", PhD. Dissertation, Wissenschattverlag Vauk Kiel (3), 1995.

Bardhan, P. and T.N. Srinivasan (1971), "Crop Sharing Tenancy in Agriculture: A Theoretical and Empirical Analysis" *American Economic Review*, Vol. 61, PP. 48-64.

Barrows, R.L. (1973), *"Individualised Land Tenure and African Agricultural Development: Alternatives for Policy"* , LTC Research Paper, No. 85, Madison: Land Tenure Centre, University of Wisconsin.

Battese, G. E., (1992) "Frontier Production Functions and Technical Efficiency: A Survey of

Empirical Applications in Agricultural Economics", *Journal of Agricultural Economics,* Vol. 7, PP.185-208.

Battese, G.E and T.G. Coelli (1988), "Prediction of Firm Level Technical Efficiencies with a Generalised Frontier Production Function and Panel Data", *Journal of Economics*, Vol.38.

Bell, C. (1977) "Alternative Theories of Sharecropping: Some Tests Using Evidence from Northeast India" *Journal of Development Studies*, Vol. 13.

Bell, C. and P. Zusman (1976), "A Bargaining Theoretic Approach to Cropsharing Contracts", *American Economic Review*, Vol. 15, PP. 578-588.

Bereket Kebede and Croppenstedt (1995), "The Nature of Sharecropping in Ethiopia: Some Preliminary Observations in Ethiopian Agriculture: in *"Ethiopian Agriculture: Problems of Transformation*", Proceeding of the Fourth Annual Conference on the Ethiopian Economy, (Eds.), Dejene Aredo and Mulat Demeke, Addis Ababa.

Bevan, P. and A. Pankhurst (1996), (Eds.), *"Ethiopian Village Studies*", Addis Ababa.

Braverman, A. and T.N. Stiglitz (1982), "Sharecropping and Interlocking Agrarian Markets", *American Economic Review*: Vol. 72, PP. 695-712.

Bruce, J.W. (1986) *"Land Tenure Issues in Project Design and Strategies for Agricultural Development in Sub Saharan Africa*", LTC Research Paper, Madison: Land Tenure Centre, University of Wisconsin.

Byres, J.J. (1983), "Historical Perspectives on Sharecropping", *The Journal of Peasant Studies;* Vol. 10, No-2, PP. 7-41. Frank Class and Co-Ltd.

Cheung, S.N. (1968) "Private Property Rights and Sharecropping', *Journal of Political Economy*, Vol. 76, PP. 1107-1122.

Cheung, S.N. (1969) "Transaction Costs, Risk Aversion and the Choice of Contractual Arrangement", *Journal of Political Economy*, Vol. 12, PP. 93-111, 1969.

Central Statistical Authority (C.S.A), *'Agricultural Sample Survey: 1980/81-96/97'*, 1981-1997, Addis Ababa.

Central Statistical Authority, *'Summary Report on 1995 Population Census'*, Addis Ababa, 1998.

Clay, D.C., Daniel Molla and Debebe Habtewold (1998), "*Food Aid Targeting in Ethiopia: A Study of Household Food Insecurity and Food Aid Distribution*", GMRP Working Paper 12, MEDaC, Addis Ababa.

Croppenstedt, A. and Mulat D. (1997), "*An Empirical Study of Cereal Crop Production and Technical Efficiency of Private Farmers in Ethiopia: A Mixed Fixed-Random Coefficients Approach*", Addis Ababa University, Addis Ababa.

Daniel Molla, Hagos Gebre, T.S. Jayne and J. Shaffer (1997), "*Designing Strategies to Support a Transformation of Agriculture in Ethiopia*", GMRP Working Paper, MEDaC, No. 4, Addis Ababa.

Dejene Aredo (1990), "The Evolution of Rural Development Policies in Ethiopia", in *Ethiopia: Rural Development Options* , Zed Books Ltd. Pausewang, S. et al. (Eds.).

Dejene Aredo (1995), 'Transforming Peasant Agriculture: Conceptual Framework' in "*Ethiopian Agriculture: Problems of Transformation*", Proceeding of the Fourth Annual Conference on the Ethiopian Economy, (Eds.) Dejene Aredo and Mulat Demeke, Addis Ababa.

Dejene A. and Teferri R. (1995) "Land Tenure and Policy Issues in Ethiopia" in *"Ethiopian Agriculture: Problems of Transformation"*, Proceeding of the Fourth Annual Conference on the Ethiopian Economy, Eds. Dejene Aredo and Mulat Demeke, Addis Ababa.

Dessalegn Rahmato (1984), *'Agrarian Reform in Ethiopia'*, Uppsala, Scandinavian Institute of African Studies.

Dessalegn Rahmato (1994), 'Land Policy in Ethiopia at the Cross-Roads', *Paper Submitted to the Workshop on Land Tenure and Land Policy in Ethiopia after the Derg*, Organised by the Institute of Development Research (IDR), Addis Ababa University.

Ege, S. (1990) "Changing Patterns of Land Tenure in Ayne, Mafud *Warada"* in Svein Ege (Eds.) *Ethiopia: Problems of Sustainable Development A Conference Report*, Trondheim, University of Trondheim, Working Papers on Ethiopian Development, No.5, PP. 225-236.

Ege, S. (1994), "Land Tenure and Land Use: Some Tendencies in N. Shewa' *Paper Submitted to the Workshop on Land Tenure and Land Policy in Ethiopia after the Derg,* Organised by the Institute of Development Research (IDR), Addis Ababa University, Addis Ababa.

Ellis, F. (1987*), "Peasant Economics: Farm Households and Agrarian Development*", Cambridge: Cambridge University Press.

Ellis, G. (1980), " Land Tenancy Reform in Ethiopia: A Retrospective Analysis", *Economic*

Development and Cultural Change, Vol. 28, No. 3, PP. 523-546.

Ethiopian Government (1975), Proclamation No. 31: *A Proclamation to Provide for the Public Ownership of Rural Lands,* Addis Ababa, PP. 93-101.

EHRS, (Ethiopian Highland Reclamation Study) (1984), "*Resources for Rural Development*", MOA/FAO, Addis Ababa.

EHRS, (Ethiopian Highland Reclamation Study) (1986), "*Ethiopia*", Final Report, Vol.1, Rome, FAO.

FAO, (1996) "*World Food Summit Follow up Draft Strategy for National Agricultural Development Horizon 2010*", Rome.

FAO/UNDP, (1988), Master Land Use Plan, Rome, FAO.

Fishe, R.P.H and G.S. Maddala (1994), "Technical Change, Frontier Production Functions and Efficiency Measurement" in Maddala (Ed.) *Econometric Methods and Applications*. Vermont.

Førsud, F.R, C.A. Knox Lovell and P. Schmidt, "A Survey of Frontier Production Function and the Relationship to Efficiency Measurement", *Journal of Econometrics*, Vol. 13, No. 5, 1980.

Gavian S. and S. Ehui (1996), "*Measuring the Relative Efficiency of Alternative Land Tenure Systems: A Model from Sub-Saharan Africa*", International Livestock Research Institute, Addis Ababa.

Greene, William H. (1994), *"Econometric Analysis",* Second Edition, Prentice Hall, Englewood Cliffs.

Greene,William.H, (1991) *Limdep Version 6. Users' Manual and Reference Guide*, Econometric Software Inc., New York. Greene, William. H, Limdep Version 7(1985-1999), Econometric Software with Windows Interface by M.J.Lowe, Econometric Software Inc.

Gujirati, Domdar. N (1988), "*Basic Econometrics*", 2nd Edition, McGraw-Hill Book Company.

Huang, Y. (1975), " Tenancy Patterns, Productivity, and Rentals in Malaysia", *Journal of Economic Development and Cultural Change*, Vol. 23, No. 4, PP. 703-718.

Hossain, M. (1977), "Farm Size, Tenancy and Land Productivity in Bangladesh Agriculture", *The Bangladesh Development Studies*, Vol. 5, No. 3, PP. 285-348.

Hossain, M. (1978), "Factors Affecting Tenancy: The Case of Bangladesh Agriculture", *The*

Bangladesh Development Studies, Vol. 6, No. 2, PP. 139-162.

Jabbar, M.A. (1977), "Relative Efficiency of Different Tenure Classes in Selected Areas of *Bangladesh", Bangladesh Development Studies*, Vol. 5, No. 1, PP. 17-50.

Johnson, D.G. (1950), "Resource Allocation Under Share Contracts", *Journal of Political Economy*, Vol. 58.

Jondrow, J., C.A.K. Lovell, I.S. Materov, and P. Schmidt (1982), "On Estimation of Technical Inefficiency in Stochastic Frontier Production Function Model", *Journal of Econometrics,* Vol.19.

Junakar, P.N. (1976), "Land Tenure and Indian Agricultural Productivity", *Journal of Development Studies,* Vol. 13, No. 1, PP. 42-60.

Kalirajan, K. (1981), "Testing the Hypothesis of Equal Relative Economic Efficiency Using Restricted Aitken's Least Squares", *Journal of Development Studies*, Vol. 17, No. 4, PP. 307-314.

Khandker, S.R. (1987), "Input Management Ability, Occupational Patterns, and Farm Productivity in Bangladesh agriculture", *The Journal of Development Studies'*, Vol.19

Lipton, M. (1985), "Land Assets and Rural Poverty", *World Bank Staff Working Paper*, No. 744.

Lucas, R. E.B. (1979), "Sharing, Monitoring and Incentives: Marshallian Misallocation Reassessed", *Journal of Political Economy*, Vol. 87, PP. 501-52.

Maddala, G.S. (1983), "*Limited Dependent and Qualitative Variables in Econometrics*", Cambridge University Press, New York.

Majid, N. (1994), " Share Tenancy, External Risk and Labour Use: A Note on Pakistani Data", *The Journal of Development Studies,* Vol. 30, No. 3.

Mesfin Wolde Mariam (1991), "*Suffering Under God's Environment: A Vertical Study of the Predicament of Peasants in the North Central Ethiopia*", Missouri, African Mountains' Association, Geographic Bernensia, Walsworth Publishing C. Marceline.

MEDaC, (Ministry of Economic Development and Co-operation)(1998), "*Agricultural Sector*", Addis Ababa, (Unpublished).

Mulat Demeke, Ali Said and T.S. Jane (1997), "*Promoting Fertiliser Use in Ethiopia: Performance, Input Market Efficiency, And Farm Management*", GMRP Working Paper, MEDaC, No. 5, Addis Ababa.

Mulat Demeke, V. Kelly, T.S. Jayne, Ali Said, J.C. Le Vallee (1998), *"Agricultural Market Performance and Determinants of Fertiliser Use in Ethiopia"*, GMRP Working Paper, MEDaC, No. 10, Addis Ababa.

Newbery, D.M.G. (1977), "Risk Sharing, Sharecropping and Uncertain Labour Markets', *Review of Economic Studies*", Vol. 94, PP. 585-594.

Newbery, D.M.G. and J.E. Stiglitz (1979) ' Sharecropping, Risk Sharing and Importance of Imperfect Information' in Roumasset, J.M. Boussard and Singh (eds.*), Risk, Uncertainty and Agricultural Development*, New York: Agricultural Development Council.

Quibria, M.G. and S. Rashid (1984), "The Puzzle of Sharecropping: A Survey of Theories", *World Development*, Vol. 12, PP. 149-172.

Rao, J.M. (1987), "Productivity and Distribution Under Cropsharing Tenancy", *World Development"*, Vol. 15, No. 9, PP. 1163-1178.

Raquibbuzaman, M. (1973), "Sharecropping and Economic Efficiency in Bangladesh", *The Bangladesh Economic Review*, Vol. 1, PP. 149-172.

Sadoulet, E. and Janvry, D. Alain, " *Quantitative Development Policy Analysis*", The Johns and Hopkens University Press, Baltimore & London, 1995.

Sanford, J. and S. Sanford (1994), "Land Tenure in *Enset* Growing Region", *Paper Submitted to the Workshop on Land Tenure and Land Policy in Ethiopia after the Derg,* Organised by the Institute of Development Research (IDR), Addis Ababa University.

Schmidt, P. C.A.K. Lovell (1979), " Estimating Technical and Allocative Inefficiency Relative to Stochastic Production Function and Cost Frontiers*", Journal of Econometrics*, Vol.9.

Seleem, T.S. (1988), "Relative Efficiency of Cotton Farms in Sudanese Irrigated Agriculture", *World Development*, Vol. 16, No., PP. 975-984.

Shapiro, K.H (1983), 'Efficiency Deferential in Peasant Agriculture and their Implications for Development Policies, *Journal of Development Studies*, Vol. 19, N0.2, PP. 179-190.

Schultz, T.W. (1964), *"Transforming Traditional Agriculture";* New Haven: Yale University Press.

Silver, M.S. (1984), *"Productivity Indices: Methods and Applications"*. Gower Publishing Company Limited. London.

Stiglitz, J.E., (1974), "Incentives and Risk Sharing", *Review of Economic Studies,* Vol.61, PP. 219- 256.

Taylor, T.G. and Shonkwiler, J.S. (1986), "Alternative Stochastic Specifications of the Frontier Production Function in the Analysis of Agricultural Credit Programs and Technical Efficiency", *Journal of Development Economics*, Vol.21.

Teferi Abate (1994), "Land Scarcity and Landlessness in North Shewa: A Case Study from Wayu and Anget Mewgiya PA", *Paper Submitted to the Workshop on Land Tenure and Land Policy in Ethiopia after the Derg*, Organised by Institute of Development Research (IDR), Addis Ababa University.

Tegene G/E (1995), "An Assessment of Ethiopia's Agricultural Land Resources" in "*Ethiopian Agriculture: Problems of Transformation*", Proceeding of the Fourth Annual Conference on the Ethiopian Economy, (Eds.), Dejene Aredo and Mulat Demeke, Addis Ababa.

Teslim, M.A. (1988), "Tenancy and Interlocking Market Issues and Some Evidence", *World Development*, Vol. 16, No 6.

Toutique, K.A. (1988), "Sharecropping: Efficiency and Risk", *The Bangladesh Development Studies*, Vol. 16, No. 2, PP. 91-94.

Warriner, D. (1973), " Results of Land Reform in Asian and Latin American Countries', *Food Research Studies in Agricultural Economics, Trade and Development,* Vol.12, No. 2.

Wendwosen Feleke (1998) 'Technical Efficiency and Determinants of Food Production in the Highlands of Ethiopia', MSc Dissertation, AAU, 1998, Addis Ababa.

World Bank (1977), '*Economic Memorandum on Ethiopia'.*

World Bank: *World Development Reports,* 1982, 1986, 1993, 1994 and 1995.

Yibeltal Gebeyehu, ' Population, Agricultural Land Fragmentation and Land Use: A Case Study of Dale and Shashemene *Weredas*, Southern Ethiopia' in "*Ethiopian Agriculture: Problems of Transformation*", Proceeding of the Fourth Annual Conference on the Ethiopian Economy, Eds. Dejene Aredo and Mulat Demeke, Addis Ababa.

Yohannes Habtu (1994), 'Land Access and Labour Market Constraints: A Study from North Shewa', *Paper Submitted to the Workshop on Land Tenure and Land Policy in Ethiopia after the Derg*, Organised by the Institute of Development Research (IDR), Addis Ababa University.

Yotopoulos, P.A. and Nugent, J.B. (1976), *"Economics of Development: Empirical* Investigation". Hoper and Row Publishers, New York.

APPENDIX 1

Descriptive Statistics of Some Key Variables for the Whole Sample

Variables	Mean	Standard Deviation	Minimum	Maximum
Output in Kg	1266.09	1114.83	50.0	7511.54
Value of Output in Birr	1857.48	1633.77	77.5	13886.0
Land in Hectares	1.88	1.25	0.25	9.25
Labour Days	290.75	322.06	60.0	2253.0
Fertiliser in Kg	124.15	106.52	4.0	800.0
Oxen and Bulls	1.69	1.79	0.0	14
Land Quality	1.69	0.64	1.0	3.0
Land Topography	1.23	0.34	1.0	3.0
Family Size	7.03	3.26	1.0	22
Adults above 15yrs of Age	1.95	1.2	0.0	9
Dependent	2.26	1.63	0.0	11
Age of HH Head	47.3	16.2	18.0	90.0
Age of Adults	35.2	9.7	19.0	85.0
Hired Labour Share	0.13	0.22	0.00	1.0
Exchange Labour Share	0.19	0.23	0.00	0.91
Family Labour Share	0.68	0.29	0.00	1.00
HH Taking Credit	0.23	0.42	0.00	1.00
Female Headed HH	0.15	0.36	0.00	1.0
EDLC	0.34	0.47	0.00	1.0
HH Members Yrs of Schooling	1.33	1.99	0.00	10.0
Credit	0.23	0.42	0.00	1.0
Non-Farm Income	143.17	353.68	0.00	4500.00
Households with Galvanised Iron Sheet	0.45	0.50	0.0	1.0
HHs with Radio	0.15	0.35	0.00	1.00
HHs with Labour Problems	0.14	0.35	0.00	1.00
HHs with Oxen Problems	0.25	0.43	0.00	1.00
Water Acquiring Time in Minutes	15.18	20.27	0.00	300.0
Firewood Acquiring Time in Minutes	39.86	57.86	0.00	420.0

APPENDIX 2

A Comparative Analysis of Mean Values: Owner operators -Vis-à-vis- Tenants

Variables	Owner operators	Tenants	F-Value
Age of Household Head	48.9	45.1	4.85
Average Age of Adults (Ag)	36.4	33.5	7.82
Dependent	2.28	2.23	0.17*
Oxen and Bulls	1.51	1.92	4.45
Houses with Galvanised Iron Sheet (%)	40	51	4.1
Radio Possession (%)	13	17	1.4*
EDLC(Read and Write or Adult Literacy Certificate for the Head)%	32	38	1.3*
Output in Kg	1229.2	1316.3	0.5058*
Fertiliser in Kg	115.2	136.3	3.26
Land in Hectares	1.93	1.81	1.27*
Labour	263	328	3.38
Credit	0.24	0.34	0.406
Labour for Ploughing	61.1	82.4	5.97
Labour for Harvesting	111.0	164.17	4.42
Labour for Weeding	91.2	81.5	3.35
No. of times (Ploughing)	9.4	13.6	39.4
Share of Family Labour (%)	66	72	3.36
Share of Hired Labour (%)	12.3	12.2	0.002*
Share of Exchange Labour (%)	22	16	4.9
Edh1	1.34	1.33	0.00*
Output per Labour	7.1	6.4	0.9
Output per Oxen and Bulls	713.4	757.8	0.23*
Land in Hectares	1.93	1.81	1.35*
Land Quality	1.65	1.75	1.75
Land Topography	1.23	1.22	0.05*
Female Headed Households (%)	20	8	8.8
No of Adult Farmers	1.95	1.96	0.004*
Family Size	7.2	6.8	1.15*
HHs with Labour Problem at Right Time (%)	16	12	1.1*
HHs with Oxen and Bulls Problem at Right Time (%)	28	21	2.01*

APPENDIX 3

A Comparative Analysis of Mean Values between Tenants

Variables	Sharecroppers	Non-Sharecropping	F-value
Output	1061	1741	17.6
Labour	284	421	3.47
Fertiliser in Kg	121	169.8	3.15
No. of Oxen and Bulls	1.97	1.61	1.07*
Land Quality	1.827	1.51	6.7
Land Topography	1.21	1.247	0.35*
Land in Hectares	1.79	1.87	1.3*
Fertiliser in Kg	73.6	171.7	19.6
HH Possessing Credit (%)	17	35	16.7
Houses with Galvanised Iron Sheet (%)	51.3	51.4	0.00
Years of Schooling (Head)	1.49	1.28	0.18*

* Insignificant at 10% probability value.

APPENDIX 4

RESULTS OF A STOCHASTIC COBB-DOUGLAS PRODUCTION FUNCTION:POOLED SAMPLE

```
+----------------------------------------------------------------------------+
| Limited Dependent Variable Model - FRONTIER   Regression                   |
| Ordinary    least squares regression    Weighting variable = none          |
| Dep. var. = Y         Mean=   6.764450500    , S.D.=    .9490891482        |
| Model size: Observations =       340, Parameters =  17, Deg.Fr.=      323  |
| Residuals:  Sum of squares= 158.5468382     , Std.Dev.=            .70061  |
| Fit:        R-squared=  .480789, Adjusted R-squared =              .45507  |
| Model test: F[ 16,     323] =    18.69,     Prob value =            .00000 |
| Diagnostic: Log-L =    -352.7469, Restricted(b=0) Log-L =       -464.1725  |
|             LogAmemiyaPrCrt.=     -.663, Akaike Info. Crt.=        2.175   |
+----------------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	4.057043432	.56402253	7.193	.0000	
L	.1533279282	.57544076E-01	2.665	.0077	5.3046580
H	.3256029164	.98225977E-01	3.315	.0009	.43139455
OB	.2623632695	.69264689E-01	3.788	.0002	.79383793
M	.4062529124	.83984615E-01	4.837	.0000	.45000000
CR	.2847316145	.93605543E-01	3.042	.0024	.23235294
R2	.5599532215	.11707451	4.783	.0000	.36764706
R3	.2909663876	.11824964	2.461	.0139	.35294118
R4	-.2408478036E-01	.12023374	-.200	.8412	.30294118
LQ	-.1030228560	.65545590E-01	-1.572	.1160	1.6933326
LS	-.9001782573E-01	.11864604	-.759	.4480	1.2310305
EDH	-.5413195700E-01	.21511356E-01	-2.516	.0119	1.3340900
F	.2315440609	.62455852E-01	3.707	.0002	4.5338446
INTFHS	-.7831626205E-02	.26750719E-01	-.293	.7697	2.3918206
LA	.1163274289	.13331555	.873	.3829	3.7866718
LFS	-.1246948886	.92846934E-01	-1.343	.1793	1.8436391
LFDH1	.2319541110	.72657622E-01	3.192	.0014	.47816286

Normal exit from iterations. Exit status=

```
+----------------------------------------------+
| Limited Dependent Variable Model - FRONTIER  |
| Maximum Likelihood Estimates                 |
| Dependent variable                   Y       |
| Weighting variable                 ONE       |
| Number of observations             340       |
| Iterations completed                24       |
| Log likelihood function      -352.1159       |
| Variances: Sigma-squared(v)=     .33199      |
|            Sigma-squared(u)=     .37015      |
+----------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Primary Index Equation for Model				
Constant	4.614083679	.59565789	7.746	.0000	
L	.1383904211	.63829492E-01	2.168	.0301	5.3046580
H	.3213050081	.10264275	3.130	.0017	.43139455
OB	.2596528423	.72922862E-01	3.561	.0004	.79383793
M	.4002032763	.85490064E-01	4.681	.0000	.45000000
CR	.2923294727	.86806300E-01	3.368	.0008	.23235294
R2	.5354478346	.11625194	4.606	.0000	.36764706
R3	.2867612605	.10961331	2.616	.0089	.35294118
R4	-.3062557722E-01	.12028681	-.255	.7990	.30294118
LQ	-.1126358943	.65359242E-01	-1.723	.0848	1.6933326
LS	-.1017459858	.12737329	-.799	.4244	1.2310305
EDH	-.5051564112E-01	.20088492E-01	-2.515	.0119	1.3340900
F	.2344152476	.61844503E-01	3.790	.0002	4.5338446
INTFHS	-.1148564484E-01	.30721023E-01	-.374	.7085	2.3918206
LA	.1206427112	.13629811	.885	.3761	3.7866718
LFS	-.1089390798	.86803365E-01	-1.255	.2095	1.8436391
LEDH1	.2338663733	.68953071E-01	3.392	.0007	.47816286
	Variance parameters for compound error				
Lambda	1.055909931	.47467487	2.224	.0261	
Sigma	.8379341610	.97327000E-01	8.609	.0000	

APPENDIX 5

COBB-DOUGLAS PRODUCTION FUNCTION FOR TENANTS AND OWN-OPERATORS: OLS RESULTS

```
+-----------------------------------------------------------------------+
| Ordinary     least squares regression    Weighting variable = none     |
| Dep. var. = Y         Mean=   6.803574219     , S.D.=    .9619584425   |
| Model size: Observations =       144, Parameters =  17, Deg.Fr.=    127 |
| Residuals:  Sum of squares= 43.48569968     , Std.Dev.=           .58516 |
| Fit:        R-squared=  .671377, Adjusted R-squared =            .62998 |
| Model test: F[ 16,     127] =    16.22,    Prob value =          .00000 |
| Diagnostic: Log-L =    -118.1157, Restricted(b=0) Log-L =     -198.2405 |
|             LogAmemiyaPrCrt.=     -.960, Akaike Info. Crt.=       1.877 |
| Autocorrel: Durbin-Watson Statistic =   1.84031,    Rho =         .07985 |
| Results Corrected for heteroskedasticity                              |
| Breusch - Pagan chi-squared =    17.5890, with  16 degrees of freedom |
+-----------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	t-ratio	P[|T|>t]	Mean of X
Constant	4.575944855	.63018599	7.261	.0000	
L	.1828484474	.57365816E-01	3.187	.0018	5.3660404
H	.4642306761	.13456385	3.450	.0008	.57976401
OB	.2753349628	.86940767E-01	3.167	.0019	.88531448
M	.3911047417	.10147646	3.854	.0002	.51388889
CR	.1141242966	.12622204	.904	.3676	.21527778
R2	.7522708024	.18158279	4.143	.0001	.31944444
R3	.2702143674	.18455751	1.464	.1456	.27083333
R4	-.3561752980E-01	.15674294	-.227	.8206	.24305556
LQ	-.2024898831	.81679790E-01	-2.479	.0145	1.7463293
LS	.1773514709	.17628933	1.006	.3163	1.2226478
EDH	-.5607182192E-01	.31554466E-01	-1.777	.0780	1.3296216
F	.1999676524	.71914522E-01	2.781	.0063	4.6255908
INTFHS	.3435510618E-01	.28886539E-01	1.189	.2365	2.9583761
LA	-.1441885054E-01	.15198621	-.095	.9246	3.7434927
LFS	-.3513591320	.11031197	-3.185	.0018	1.8093418
LEDH1	.1438366836	.96728233E-01	1.487	.1395	.53949446

```
--> RESET
--> LOAD;file="C:\Program Files\ES\Limdep\PROGRAM\ownolscorr.lpj"$
LOAD has reconstructed your previous session.
--> REGRESS;Lhs=Y;Rhs=ONE,L,H,OB,M,CR,R2,R3,R4,LQ,LS,EDH,F,INTFHS,LA,LFS,LEDH1
    ;Het$

+----------------------------------------------------------------------+
| Ordinary    least squares regression    Weighting variable = none     |
| Dep. var. = Y         Mean=    6.735706544    , S.D.=    .9409533878  |
| Model size: Observations =     196, Parameters =  17, Deg.Fr.=    179 |
| Residuals:  Sum of squares= 102.3501718     , Std.Dev.=         .75617 |
| Fit:        R-squared=  .407187, Adjusted R-squared =           .35420 |
| Model test: F[ 16,     179] =     7.68,    Prob value =         .00000 |
| Diagnostic: Log-L =    -214.4399, Restricted(b=0) Log-L =    -265.6818 |
|             LogAmemiyaPrCrt.=      -.476, Akaike Info. Crt.=     2.362 |
| Autocorrel: Durbin-Watson Statistic =    1.88376,    Rho =      .05812 |
| Results Corrected for heteroskedasticity                              |
| Breusch - Pagan chi-squared =     19.8891, with  16 degrees of freedom |
+----------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	t-ratio	P[|T|>t]	Mean of X
Constant	3.736068901	.87909302	4.250	.0000	
L	.1522445009	.83754734E-01	1.818	.0708	5.2595608
H	.3394818957	.13064001	2.599	.0101	.32238841
OB	.2132428259	.89688289E-01	2.378	.0185	.72663067
M	.3346027603	.11450616	2.922	.0039	.40306122
CR	.3816680354	.13064910	2.921	.0039	.24489796
R2	.4005061418	.15501181	2.584	.0106	.40306122
R3	.3211101442	.17431419	1.842	.0671	.41326531
R4	-.1659722774	.16959995	-.979	.3291	.34693878
LQ	-.8736598851E-01	.92271414E-01	-.947	.3450	1.6543963
LS	-.2761146907	.14702657	-1.878	.0620	1.2371892
EDH	-.2513625963E-01	.30063455E-01	-.836	.4042	1.3373728
F	.2725951707	.90019061E-01	3.028	.0028	4.4664393
INTFHS	-.6552759753E-01	.34838992E-01	-1.881	.0616	1.9755757
LA	.1785039355	.20103142	.888	.3758	3.8183953
LFS	.5421913087E-01	.13742296	.395	.6937	1.8688371
LEDH1	.2733295724	.10003185	2.732	.0069	.43310291

APPENDIX 6

COMPARATIVE ANALYSIS OF TENANTS(TT) AND OWN-OPERATORS(WN) DUMMIES

```
+------------------------------------------------------------------------------+
| Limited Dependent Variable Model - FRONTIER   Regression                      |
| Ordinary    least squares regression    Weighting variable = none             |
| Dep. var. = Y        Mean=    6.764450500    , S.D.=    .9490891482           |
| Model size: Observations =      340, Parameters =  18, Deg.Fr.=       322     |
| Residuals:  Sum of squares= 158.1004192      , Std.Dev.=             .70071   |
| Fit:        R-squared=  .482251, Adjusted R-squared =               .45492    |
| Model test: F[ 17,     322] =    17.64,     Prob value =              .00000  |
| Diagnostic: Log-L =    -352.2675, Restricted(b=0) Log-L =      -464.1725      |
|             LogAmemiyaPrCrt.=     -.660, Akaike Info. Crt.=         2.178     |
+------------------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	4.049048840	.56416411	7.177	.0000	
L	.1535615947	.57552686E-01	2.668	.0076	5.3046580
H	.3313662366	.98425544E-01	3.367	.0008	.43139455
OB	.2649724730	.69328448E-01	3.822	.0001	.79383793
M	.4135022841	.84339787E-01	4.903	.0000	.45000000
CR	.2838728559	.93623033E-01	3.032	.0024	.23235294
R2	.5681537203	.11740638	4.839	.0000	.36764706
R3	.2790552552	.11892414	2.346	.0190	.35294118
R4	-.2705668449E-01	.12029103	-.225	.8220	.30294118
LQ	-.1001067377	.65626101E-01	-1.525	.1272	1.6933326
LS	-.9170590944E-01	.11867592	-.773	.4397	1.2310305
EDH	-.5423866304E-01	.21514671E-01	-2.521	.0117	1.3340900
F	.2337389606	.62507030E-01	3.739	.0002	4.5338446
INTFHS	-.6292714678E-02	.26803113E-01	-.235	.8144	2.3918206
LA	.1016174478	.13422378	.757	.4490	3.7866718
LFS	-.1276985208	.92913398E-01	-1.374	.1693	1.8436391
LEDH1	.2351289870	.72744076E-01	3.232	.0012	.47816286
WN	.7736025823E-01	.81130687E-01	.954	.3403	.57647059

Normal exit from iterations. Exit status=0.

```
+----------------------------------------------+
| Limited Dependent Variable Model - FRONTIER  |
| Maximum Likelihood Estimates                 |
| Dependent variable                     Y     |
| Weighting variable                   ONE     |
| Number of observations               340     |
| Iterations completed                  25     |
| Log likelihood function        -351.3547     |
| Variances: Sigma-squared(v)=      .30823     |
|            Sigma-squared(u)=      .43286     |
+----------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Primary Index Equation for Model				
Constant	4.669522265	.58662235	7.960	.0000	
L	.1352948799	.63394103E-01	2.134	.0328	5.3046580
H	.3281640914	.10246239	3.203	.0014	.43139455
OB	.2625475789	.72451119E-01	3.624	.0003	.79383793
M	.4090563936	.84729483E-01	4.828	.0000	.45000000
CR	.2931129209	.86555423E-01	3.386	.0007	.23235294
R2	.5413645350	.11482862	4.715	.0000	.36764706
R3	.2700579056	.11045232	2.445	.0145	.35294118
R4	-.3495997142E-01	.11935287	-.293	.7696	.30294118
LQ	-.1119353156	.65112719E-01	-1.719	.0856	1.6933326
LS	-.1048655270	.12720604	-.824	.4097	1.2310305
EDH	-.5005753141E-01	.20215985E-01	-2.476	.0133	1.3340900
F	.2370042248	.61080858E-01	3.880	.0001	4.5338446
INTFHS	-.9672060602E-02	.30316303E-01	-.319	.7497	2.3918206
LA	.1005681983	.13711021	.733	.4633	3.7866718
LFS	-.1096743269	.87119948E-01	-1.259	.2081	1.8436391
LEDH1	.2375281955	.69257138E-01	3.430	.0006	.47816286
WN	.1001524527	.85516462E-01	1.171	.2415	.57647059
	Variance parameters for compound error				
Lambda	1.185057254	.46413812	2.553	.0107	
Sigma	.8608657954	.92568288E-01	9.300	.0000	

```
--> FRONTIER;Lhs=Y;Rhs=ONE,L,H,OB,M,CR,R2,R3,R4,LQ,LS,EDH,F,INTFHS,LA,LFS,LEDH
    ,TT$

+-----------------------------------------------------------------------+
| Limited Dependent Variable Model - FRONTIER   Regression               |
| Ordinary    least squares regression    Weighting variable = none      |
| Dep. var. = Y        Mean=   6.764450500    , S.D.=    .9490891482     |
| Model size: Observations =       340, Parameters =  18, Deg.Fr.=    322 |
| Residuals:  Sum of squares= 158.1004192     , Std.Dev.=           .70071 |
| Fit:        R-squared=  .482251, Adjusted R-squared =             .45492 |
| Model test: F[ 17,     322] =   17.64,     Prob value =          .00000 |
| Diagnostic: Log-L =    -352.2675, Restricted(b=0) Log-L =     -464.1725 |
|             LogAmemiyaPrCrt.=     -.660, Akaike Info. Crt.=      2.178 |
+-----------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	4.126409098	.56877315	7.255	.0000	
L	.1535615947	.57552686E-01	2.668	.0076	5.3046580
H	.3313662366	.98425544E-01	3.367	.0008	.43139455
OB	.2649724730	.69328448E-01	3.822	.0001	.79383793
M	.4135022841	.84339787E-01	4.903	.0000	.45000000
CR	.2838728559	.93623033E-01	3.032	.0024	.23235294
R2	.5681537203	.11740638	4.839	.0000	.36764706
R3	.2790552552	.11892414	2.346	.0190	.35294118
R4	-.2705668449E-01	.12029103	-.225	.8220	.30294118
LQ	-.1001067377	.65626101E-01	-1.525	.1272	1.6933326
LS	-.9170590944E-01	.11867592	-.773	.4397	1.2310305
EDH	-.5423866304E-01	.21514671E-01	-2.521	.0117	1.3340900
F	.2337389606	.62507030E-01	3.739	.0002	4.5338446
INTFHS	-.6292714678E-02	.26803113E-01	-.235	.8144	2.3918206
LA	.1016174478	.13422378	.757	.4490	3.7866718
LFS	-.1276985208	.92913398E-01	-1.374	.1693	1.8436391
LEDH1	.2351289870	.72744076E-01	3.232	.0012	.47816286
TT	-.7736025823E-01	.81130687E-01	-.954	.3403	.42352941

APPENDIX 7

Estimated Area of Cultivated Land for Major Crops by Private Peasant Holdings (1980/81-1997/98)

Area in '000' Hectares

Year	Under Cereals (C)	Annual Growth $(C_{t+1}/C_t - 1)$ %	Under All Major Crops (MaC)	Annual Growth Rate $(MaC_{t+1}/MaC_t - 1)$%
1980/81	4502	---	5184	-
1981/82	4362	-3.2	5118	-1.3
1982/83	4776	9.5	5546	8.4
1983/84	4422	-7.4	5391	-2.8
1984/85	4554	3.0	5343	-0.89
1985/86	4667	2.5	5395	0.97
1986/87	4643	-0.5	5650	4.7
1987/88	4915	5.9	5502	-2.6
1988/89	4774	-2.9	5148	-6.4
1989/90	4859	1.8	5390	4.7
1990/91	4340	-10.7	4818	-10.6
1991/92	4304	-0.8	4742	-1.6
1992/93*	3974	-7.7	4891	3.1
1993/94*	4114	3.5	6561	34.1
1994/95	5746	40.0	6960	6.1
1995/96	6653	15.8	7849	12.8
1996/97	6689	0.5	8072	2.8
1997/98	4902	-26.7	6071	-24.8

Source: CSA Various Publications and MEDaC (1998) for the years (*) information was not available from the latter.

APPENDIX 8

Major Descriptive Results for Estimated Area of Cultivated Land

Parameters	Land Under Cereals	Land Under Major Crops
Mean- for All Years	4844	5757
" " -for 1980/81-1985/86	4548	5330
" " -for 1986/87-1991/92	4639	5082
" " -for 1992/93-1997/98	5346	6734
Minimum	3974	4742
Maximum	6689	8072
Range1(Max-Min)	2715	3330
Range2 (Max-1980/81's)	2185	2880
Standard Deviation	768	982
Average Annual Growth Rate*	1.33	1.57

-* Average annual growth rate (Gr) is calculated as:

$$Gr = \frac{1}{(N-1)}\sum\left(\frac{C_{t+1}}{C_t} -- 1\right)X100$$

DECLARATION

This thesis is my own original work, has not been presented for a degree in any other university, and that all sources of material used for the thesis have been duly acknowledged.

Declared by	Certified by
Worku Gebeyehu Alemayehu	Dr. Abdulhamid Bedri Kello
	(Advisor)