THE ECONOMICS OF RESOURCE USE UNDER THE TRADITIONAL FARMING SYSTEM IN KONDOA DISTRICT: THE CASE OF BEREKO DIVISION

by

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ABSTRACT

The study attempts to investigate the economics of Traditional Farming Systems (TFS) in Bereko division by identifying the physical, technical and policy factors shaping this TFS. In addition the study attempts to determine the likely adjustments of the system given some changes in factors to be identified in the Traditional Farming system.

To analyse the system a multiple regression model was developed for all major crops and two individual crops - maize and fingermillet. The results revealed that there is a positive relationship between output and available resources (of land, labour and capital), and cropping practices. The results also show that there is a negative relationship in relation to technology used. This means that by adding (or improving) the existing resource and cropping practices productivity will increase in the study area.

In order to determine the likely adjustments in the system a LP model was developed for the typical crop mixture in the study area. From the basic model

changes (adjustments) were effected in respect to technology, price and cropping practices - where improved technology and price changes were tested.

The analysis revealed that there is a possibility of increasing agricultural productivity and output and hence income by effecting some changes in technology and other institutional factors. The results also justify that policy reforms on credit facilities and pricing systems will bring some changes to smallholder farmers in Bereko Division.

The results from this study suggest that proper farm management and planning in the form of comprehensive farm plans proper information and workable policies, is needed in the area. These will help to improve the incomes hence living standards of the smallholder farmers.

I, MASHAKA SALUM JILA MWENDA, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation has not been submitted for a degree award to any other University and that it is my own original work.

Signed..................................

MASHAKA SALUM JILA MWENDA

Date:.....05/3/1993.............

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ABBREVIATIONS

BOT - Bank of Tanzania

CIMMYT - Centro Internacional de Mejaramiento de Maiz V Trigo (International Maize and Wheat Improvement Centre) Mexico D.F.

CIDA - Canadian International Development Agency

CRCU - Central Region Co-operative Union (Dodoma)

DADO - District Agricultural Development Officer

DALDO - District Livestock Development Officer

ERP - Economic Recovery Programme

FAO - Food and Agriculture Organization of the United Nations

FS - Farming system(s)

FSR - Farming system Approach to Research

HAZINA - Ministry of Finance and Economic Planning

HADO - Hifadhi Ardhi Dodoma (Dodoma Land Reclaimatation)

KILIMO - Linear Programming

MDB - Marketing Development Bureau (Ministry of Agriculture and Livestock Development)

RADO - Regional Agricultural Development Officer

RDD - Regional Development Director

RIDEP - Regional Integrated Development Programme

RLDO - Regional Livestock Development Office

TFS - Traditional Farming system

CHAPTER I

1. INTRODUCTION

The United Republic of Tanzania is one of the three countries that make East Africa. it is one of the least developed countries in the world whose economy is largely dependent on the agriculture sector. With a population of 23,174 336 and an area of 885,987 square km it has an overall population density of 26.2 persons per square km with growth rate of 2.8% annually (1988 census). The country has been facing chronic problems related to its agricultural production such as insecure harvests owing to wide fluctuations in weather conditions and lack of sufficient grain reserves to relieve periodic shortages (BOT 1986; Tanzania 1988b).

The above problems, however, are pronounced more in some regions like Dodoma which is situated in central Tanzania and forms one of the 20 regions of mainland Tanzania. The region faces many developmental problems. Soils in general are of low nutrient content resulting in low fertility. Rainfall is low (600 mm per annum) and occurs only from December to May with considerable variations over the region and from year to year (Tanzania 1988c). Large parts of the population still practice traditional farming methods and the physical infrastructure in the region is in poor state hence impeding development.

The problems experienced in the region are not, however, uniform. There are areas within the region where these problems are less pronounced than the others. Bereko division rainfall is abit higher - over 700 mm compared to the average of 600 mm. The district and Bereko in particular experiences higher crop output rates than some other parts of the region inside of the poor soils and traditional farming practices (Tanzania 1985; Mgale 1987).

In light of this, the study seeks to identify the major factors that shape the production system in the region using Bereko division (Kondoa district) as a case study.

1.1. Review of Agricultural Development in Tanzania.

1.1.1 Contribution of Agricultural Sector in the Economy

Agriculture is the mainstay of the Tanzania's economy. It contributes 46 per cent of GPD, 75 percent of total export earnings and supports 90 per cent of the population (Tanzania 1988).

The sector also provides raw materials to other sectors of the economy such as agro-based industries and employs about 24 per cent of the salaried personnel in the country (Tanzania 1988b). Because of this important role the country's development depends significantly on the successful development of the agricultural sector.

According to Bureau of Statistics (1981) total labour force employed in the government and private sector was just 5.8 percent of the active population. This means over 94 per cent of the active population is in the rural areas most of it doing farm work. These farmers are self employed, operating on small scale with family labour rather than hired labour, producing their own food and other subsistence requirements as well as cash crops for the markets.

Studies by Making (1967); Livingstone and Ord (1980), however, show that smallholder farmers are willing to produce for the market only after they have catered for their own basic food requirements.

1.1.2 Review of Performance of the Agricultural Sector.

Inspite of the high percentage of the population depending on agriculture, only sixteen percent of the 39.5 million hectares of arable land (under rainfed conditions) are cultivated (Tanzania 1984). Todate, Tanzania's efforts towards the development of agriculture has not put the country in the state of food self-sufficiency. Available statistics (Tanzania 1984; BOT 1986) indicate that the food crop production has been increasing at an average rate of five per cent per annum between 1972-1984 while that of cash crop declined by 3.5 per cent giving an average growth rate of 3.6 per annum.

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The increase in crop production came primarily from area expansion, while yield per unit area has been declining at the rate of 1.4 per cent for food crops and 1.2 per cent for cash crops - which gives an average total yield decline of 1.1 per cent annually (Tanzania 1984). For example situation from 1984 - 1987 indicate that there was an expansion of area cultivated by 22.5 per cent which caused production to increase by 56.8 per cent and yield by 15.8 per cent for food crops (Tanzania 1988). This suggests that increased output is mainly determined by increased acreage cultivated.

The food situation can also be assessed from the import figures for the past ten years. Tanzania has been a net importer of grains (especially main cereals - maize, wheat and rice). Figures from 1976/77 to 1986/87 indicate that the percentage of imports in total food grains consumed varied from 32 per cent in 1976/77 to 73 per cent in 1980/81 and to 60 per cent in 1984/85. The import figures raise questions on the authenticity of the figures given by KILIMO. Moreover, most people agree that the reasons for the decline in agricultural production are not fully understood, and the lack of adequate knowledge precludes the

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1.2 Socio-economic Setting of Dodoma Region

The performance of the agricultural sector in Dodoma region has not been better than that of the country as a whole. In fact with a regional GDP of Tsh.510 million (1979 prices) the region accounts for only 1.5 per cent of the national GDP. The agricultural gross-value product per output of Tshs. 619 in 1989 ranks the region in the last but one position in the country implying that the standard of living of the people in the region is very low and their ability to invest in the agricultural production activities is also limited.

Apart from the agricultural sector, the region is also less developed as far as other sectors are concerned. By 1986 the region had only 3 factories employing a total of 106 people as compared to the national total of 665 industries employing 96,865 persons (Tanzania 1988). The region has insufficient water supply both for human and livestock consumption.

Only about one fifth of villages in the region have a functioning water supply (Tanzania 1987). Energy supply especially charcoal/firewood which, in the rural areas is predominantly required for cooking, is not sufficient. The region has an area of 2.8 per cent only covered by forests (HADO 1988). There are about 862 km of roads in the region which are passable throughout the year although they are not bitumenized. The remaining 3604 km of gravel roads are not passable thought the year (Tanzania 1988d). Therefore the road system within the region is in very poor condition because parts of the region cannot be reached by the common means of transport especially during rainy season.

On the part of health services the region has five hospitals with an average of one bed per 850 people, 15 rural health centres each serving 79,700 people and 173 dispensaries each serving over 6,900 people (Tanzania 1988d).

1.3 Crop Production and Animal Husbandry

The majority of people in Dodoma region are engaged in agriculture (Tanzania 1988d). Reports from

RADO - Dodoma (Tanzania 1988c) suggest that large-scale production in the region is negligible which implies most farmers in the region are smallholder farmers. Traditionally sorghum and bulrush millet have been the main staples, but where rainfall is high, maize is grown both as food and cash crop. Major cash crops in the area are finger millet, sunflower, castor seeds and to a lesser extent sesame. In recent years grape vines have emerged as an important cash crop in the area near
dodoma town (Brown 1977; Tanzania 1988c). Production of fruits and vegetables is insignificant due to limited supply of water.

Livestock production is an important component of the regional economy. The region has an estimated 2.2 million cattle, 0.8 million goats and 0.3 million sheep as compared to the national herd of 15,714,000 cattle, 4,311,800 goats and 7,329,900 sheep. The cattle production accounts for about 10 per cent of the national herd and the region ranks fourth in the country in terms of livestock numbers. Dairy production is very limited even for family consumption (Tanzania 1988e).

1.4 Location of the study Area

1.4.1 Location

Bereko division lies in the north of Kondoa district. The district is one of the administrative districts of Dodoma region and is located between 4° 2' to 5° 38.5' North and between 36° 2' to 36° 22' East. Bereko division covers an estimated area of 78,000 ha. (DADO - Kondoa 1988).

The dominant physical feature in the division is the main chain of hills running from north-northwest to south-southwest with land sloping away to the east to a minimum of 1000 metres. However generally all plains have an estimated elevation of 1200 metres. The western hilly area reaches an altitude of over 1800 metres and is favoured by rainfall with an annual precipitation of up to 800 mm. Temperatures range from 25°C to 20°C with district average of 22.7°C. Mean annual humidity (for the region) is 67% (Tanzania 1985, DADO - Kondoa; HADO - Kondoa 1988; Tanzania 1988c).

The soils are generally of low fertility, deficient in organic matter, of moderate to poor permeability and of shallow depth. They are largely derived from granites and guesses (CIDA 1973; Tanzania 1985). According to Dodoma RIDEP (Tanzania 1985) about 30 percent of Bereko total area 78,000 ha) is covered by sandy soils of moderate fertility. This leaves only 49,000 ha to be distributed to the 64,000 people which means 0.76 ha per head of 4.77 ha per average household of 6.2 persons. Therefore, physically the present cultivated land is scarce.

1.4.2 The Traditional Farming system of the Area

The mostly practised farming system in Bereko division, as the case with most tropical areas, is rainfed farming or dryland farming. This involves the cultivation of (annual) crops that are dependent on natural rainfall (without irrigation). The patterns of farming are influenced by existing (a) density of agricultural population, (b) technical knowledge and capital resources available, and (c) soil fertility.

The traditional cultivation consists of land preparation by ox ploughing (66 per cent) and by hand is distinctly hostile to agriculture. This is evidenced by periodic droughts and food shortages Mgale 1987). As stated in sections 1.2 and 1.3 the district and region has low incomes, and an undeveloped social and economic infrastructure and consequently low potential for development. For example, agricultural data for Kondoa show that crop production has been fluctuating both in acreage cultivated and output.

Table 1.1 shows crop production levels for the four selected crops. The table shows that productivity has been fluctuating year after year and well below national averages with the exception of sorghum. Sunflower is the only reliable cash crop in the district.

Table 1.1. Crop Production Levels for Kondoa district.

	Productivity ('000 kg/ha)				
Crop	1981/82	1982/83	1983/84	1984/85	1985/86
Bulrush millet	0.83	0.70 (0.74)	0.68 (0.74)	0.91 (0.99)	0.79 (0.87)
Maize	0.83	1.08 (1.41)	0.70 (1.34)	0.62 (1.42)	1.26 (1.69)
Sorghum	0.89	1.0 (0.68)	0.70 (0.63)	2.99 (0.76)	0.99 0.33
Sunflower	1.49	0.65 (0.69)	1.27 (0.44)	0.76 (0.39)	0.33 (0.57)

Source: DADO - Kondoa (1988); MDB (1988)
(0.74) - National average figures

Studies have shown that although smallholder farmers use their resources efficiently given their objectives (Schultz 1964; Anandajayasekeram 1986), most of the TFSs in Africa are characterised by low agricultural productivity. There is need, therefore, to improve agricultural productivity which can be brought about through the transformation of the existing situation. But before one talks of transformation, there is need to determine the causes of low productivity. Is it that farmers are irrational? Has research failed to deliver better goods? or Have the agricultural policies failed to respond to the needs of the agricultural sector? These questions are important because the performance of any farming system is influenced by level of technology, policy environment (which influence incentive structure, type of institutions serving agriculture and their operational efficiency); physical environment (such as weather, soils); and socio-cultural factors to which farmers respond. Obviously, how these factors influence agriculture will depend on the FS involved. Measures to transform traditional agriculture will have to take into account the variations that exist across FSs.

The understanding of how traditional systems operate in both static and dynamic sense is important in the identification of constraints and hence in the formulation of optimum prescriptive measures (being they in the form of innovations or policy changes). As Johnston and Kilby (1980) argue, although significant research has been done on the traditional agricultural production, accumulated knowledge still fall short of understanding or ameliorating the agricultural growth problems in many developing countries where production is basically traditional oriented. It is the contention of the researcher that one of the possible causes is a misdirected research thrust and/or inadequacies of methodologies involved.

This study intends to contribute to the ongoing FS studies effort by addressing itself to the economics of resource utilisation under the TFS in Kondoa district - Bareko division. Some understanding of agricultural output/productivity and their inter-relationships will provide a viable base for formulating more effective agricultural policies.

1.6 Objectives of the Study

The main objective is to study the economics of resource use of the TFS in Bereko division. More specifically the study is concerned with the following: (a) To identify the various physical, technological and policy factors that shape the TFS in Bereko division; (b) to determine the likely adjustments of the system given some changes in factors identified in (a) above and (c) To make recommendations of transformation possibilities to improve agricultural productivity.

1.7 Hypotheses to Direct the Research

i. There is no significant relationship between agricultural output and technology used; available resources; and cropping practices.

ii. Smallholder agricultural output and productivity and hence income cannot be changed through changes in production technology, institutional and policy reforms.

1.8 Organization of the Dissertation

The dissertation is divided into five chapters. Chapter I is Introduction - discusses agricultural development in Tanzania and Dodoma region, and highlights the place it takes in the economy, its production system and performance. The socio-economic setting of Dodoma region and the study area, the problem and objectives of the study are also explained.

Chapter II is Literature Review and gives a short account on the work already done in respect to the problem being studied with the aim of getting information on what is known about the problem under study. It covers a short description of the justification for FSR, what is known about FSR in Tanzania, methodologies and analytical tools used.

Chapter III deals with the methodology. It gives the theoretical framework, models used for empirical analyses and ends up by describing the data needs and collection methods. The aim is to give the theoretical support for the analysis being carried out.

Chapter IV presents results and discussions while Chapter V presents a summary of main findings and suggestions and directions for future work.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This section reviews some of the available literature on Farming Systems Research (FSR). The first part discusses the justification for FSR and reviews what is known about Farming Systems (FS) in Tanzania. The second part reviews methodologies and analytical tools that have been used in studying similar problems. Review on uses of production functions and Linear Programming (LP) are also covered. Last is a section on aggregation problems.

2.2 Justification for FSR

There is no need to emphasize on the fact that of late many policy makers in developing countries have been paying more attention to the problems of smallholder farmers with the idea of increasing their production and standard of living. The aim is to understand better their environments, their problems, and technologies used. An approach now being applied widely is the FSR (Shaner; Philip; and Schmehl 1982).

CIMMYT has been developing and promoting FSR in co-operation with national research stations in East Africa. The use of FSR methods has brought benefits not only to farmers, but also to researchers by knowing more about problems of peasant farmers and improving their efficiency in designing technologies appropriate to the needs of small farmers. The aim is to develop, refine and promote FSR methods in order to help improve the relevancy of national agricultural research and extension services. This means that the developed methods are being modified and improved as experience is gained by different agricultural research services.

The increased use of FSR in developing countries is in response to failure of the traditional approaches to bring about significant changes in smallholder agriculture. Studies by Collinson (1980) indicate that traditional research in Eastern Africa has not paid adequate attention on the priorities and economic situations of small farmers. Muriithi (1980) argues that a lot of money, time, and effort have been used to derive recommendations that small farmers have refused to accept.

Historically, literature shows that macro research faded away in 1960s because of the growing awareness of the need for micro studies to unravel the complexities of indigenous FS; the rural household as a production and consumption unit (Eicher and of survey data with the main model variables being land, labour, and capital. The results of the models were compared with the observed data and this became the basis of interpretation of the phenomena of production.

Another FSR was undertaken by Due, White, and Rockie (1987). This was a comparative FSR in Arusha and Morogoro bean zones. The aim was to see similarities and differences of FSR as farm families adopt to differing environmental conditions. The studies carried in three different districts with different ecological, rainfall, and soil patterns, have shown that while they are not homogenous, there are many similarities in the FS, in terms of income generated, cropping patterns, farm sizes and choice of bean seeds.

2.4. Methodological Aspects

2.4.1 Relevancy

The total farm unit consists of a system with various components related to each other and all under the farmer's control. Proper analytical methods helps to ensure that practical recommendations for concrete applications are obtained that yield realistic results within the actual operating constraints. Formal representations of these conditions constitute models of the agricultural production system under study. Through the cooperation and study of such models, possible or actual changes of the real situation can be considered, and the consequences can be predicated or assessed.

2.4.2 Production Functions

The economic theory of production has been covered by Heady (1952); Heady and Dillon (1961); Dillon (1977) and others. A great number of researchers have used production functions in their farm level studies.

A technical (Physical) relationship between inputs and outputs can be expressed in the form:

$$Y = a + B_i X_i + U_n$$

Where

Y = output

a = constant term

b_i = parameter estimates

X_i = inputs

U_n = error term

In agricultural production such a function is not common. This is because it assumes constant returns to each added input at all levels other inputs held constant. The law of diminishing returns is not followed.

According to Heady (1956) other models do exist such as the Cobb-Douglas and the exponential homogeneous function and the transcendental function. Most writers like Strohbehn (1965); Halter, Cater, and Hocking (1957) reject the transcendental function because of the large standard errors of the marginal value product derived from it. However, this rejection was based on their empirical investigation and should not be taken as a generalization (Ishuza 1984). The mostly used form is the Cobb-Douglas production function.

In analysing the economic constraints to potato production and storage in Kenya, Kimburi (1980) used the Cobb-Douglas production function so as to examine the relationship between inputs and outputs. He was able to determine the nature of the returns to scale, and then through the analysis of direct elasticities of response determine the most crucial variable explaining potato output.

Ishuza (1984) used Cobb-Douglas production function to find out if decreasing returns were exhibited by tobacco producers in Tabora region. He analysed the sum o elasticities and found out that worth the sum of elasticities of 0.8 decreasing returns to scale were exhibited by these tobacco farmers.

The production function was used mainly because it gave immediate measures of response to factor inputs and was easy to estimate. It can also be used to estimate returns to scale (i.e diminishing or increasing returns). The major disadvantage of Cobb-Douglas production function is that it cannot show both increasing and diminishing marginal returns in a single response curve.

It also fails to show or give a technical optimum, and therefore it may lead to an over estimate of the economic optimum (at both extremes of input levels). Another shortfall of the function concerns the zero output level. Unless a specific constant term (output) is specified the function can give a zero output for the use of some inputs which can be misleading.

2.4.3 Linear Programming and Farm level Studies

Programming, both linear and nonlinear is entirely a mathematical technique (Baumal 1965). Therefore programming per se cannot tell us anything about the operation of any part of the economy. It helps to determine the implication of the economic information which were already have or are willing to assume. However, it has been widely used because. it is the best for finding optimum or best possible plan for a give set of conditions (Upton 1973). Several researchers have used the techniques with satisfactory results.

Lupatu (1980) used LP to develop optimum production plans that make best use of resources available to typical farmer families in meeting their expressed goals. Using a sample of 50 farmers, he used LP analysis to determine how tea fits in with the potential needs for farm family subsistence and major cash crops based on resources available. Taking 0.6 ha of tea, and including 1.11 ha of cardamon, 0.41 bananas and 0.63 ha of beans he was able to produce a plan which was 17 per cent more profitable.

In his FS study on the factors that affect area and production of cotton in Shinyanga, Kajumulo (1980) used LP to determine, based on characteristics found for the system, a feasible plan for increasing aggregate output of the whole farm unit in the area of study. Applying LP he was able to show that in order to subsist, farmers were to cultivate 1.5 to 1.8 ha of subsistence crops. The LP results indicated that the most profitable crop was sorghum intercropped with groundnuts - because it produced a higher income by one third more. By using ox-ploughs, and engaging school children during vacation the net family income increased by 10 per cent more.

Guantai (1980) used LP so as to find out the most viable planning model in mixed farms. He found out that by reorganizing resources and introducing new activities in the plan a Gross Margin (GM) with double the initial farm returns was realised. He argues that by using LP, the results have shown that there could be great improvement in the farm performance with only slight improvement in technical practice and without major increases in the available resources.

There are, however, methodological limitations to the use of LP for agricultural sector analysis. There is problems of dealing with risk, farmers cultural conditions, variability of soils within farms, water availability in different areas of a farm and other farm level variations (Gittinger 1982). In spite of all the above the LP is chosen because of its major advantage of allowing the consideration of a wide range of alternatives quickly and at a comparatively low cost (Beneke and Winterboer, Kwak, Upton 1973; Mlambiti 1985).

2.4.4 Aggregation Problems

Aggregation problems generally exist with respect to output in farm studies (Heady 1969; Upton 1979). The difficulty arises because most smallholder farmers produce either more than one type of product or several qualities of the same product.

Discussions on the aggregation problem indicate that agreement has not yet been reached on objectives and methods (May 1947). Nevertheless, some definite results have been obtained. Index number are very frequently used in aggregating things - be it input or output aggregation. The problem with regard to aggregation arises because aggregation involves different products and differing functions (either decreasing or increasing). As Theil (1965) argues, there are different types of aggregation. There is aggregation of outputs, inputs, both simple or multiple aggregation. Theil (1965) goes on to suggest that the se aggregations can be done through index numbers e.g. fixed weights index of prices etc.

Dresch (1948) regards an index number as a measure of average relative change and regards value as an economically significant basis for weighting. According to dresch (1948), index numbers can therefore, be expressed as weighted means of relative using some system of value weights.

CHAPTER III

METHODOLOGY

3.1 Introduction

The chapter outlines the methodology which is used to collect and analyse the data. Part one presents the theoretical framework. Production theory is used to show what refutable hypotheses can be obtained in relation to the problem under study.

The second part presents the models to be used for empirical analysis and their utilisation to address research questions. The last part discusses data needs and collection methods.

3.2 Theoretical Framework

3.2.1 Production Process

Production decision concerns what, how and where to produce. The Neo-classical theory of production explains how resources are organized in order to produce at the most economical optimal point. Neo-classical production theory is used to develop the theoretical and analytical framework to be used.

3.2.2 Neo-Classical Production Theory

Production process of a single product involving m variable inputs and n fixed inputs can be represented as

$$Y = f(X_i) \qquad (3.1)$$

Where

X_i = inputs of variable resource

Y = output of product

then for every value of X_i there is a corresponding value of Y and hence are related in a systematic manner. We can develop the above formula mathematically and obtain:

1. The average physical product of X_i as

$$APP_{xi} = Y/Xi \qquad (3.2)$$

2. The Marginal physical product of X_i as

$$MPP_{xi} = \Delta Y/\Delta X_i \qquad (3.3)$$

3. The elasticity of response given as

$$E_i = \frac{\Delta Y}{Y} \Big/ \frac{\Delta X_i}{X_i} = \frac{\Delta Y}{\Delta X_i} \Big/ \frac{Y}{X_i} = \frac{MPP_{xi}}{APP_{xi}}$$

The above relationship gives three stages of production process. Stage I is when increasing average returns are experienced. Since MPP_{xi} > APP_{xi} each extra unit of input i adds more to total product than each of the units already employed and so the average product must be increased by employing more of input i. In this stage increasing units of input i causes increases in both the total product of the given quantities of the fixed inputs and the average product per unit of the variable input. Therefore, if it is profitable to produce any output then the farmer can make more profit by using more of input i as long as the APP_{xi} increases. It is therefore irrational to choose a level of input in Stage I.

It is also irrational to produce at stage III beyond the level of maximum product because the MPP_{xi} is negative and hence extra use of input i decreases the total product. Thus it is advisable to produce in stage II where both MPP_{xi} and APP_{xi} are positive yet decreasing - hence the law of diminishing returns.

3.2.3 The Notion of Returns to Scale

The lqw of diminishing returns only applies where the input of one factor are increased, the quantities of all other factors being held constant. When all inputs are varied together and none are fixed an increase in scale is realized and the low of diminishing returns no longer applies. With returns to scale, when n inputs are increased together by say one per cent output is expected to increased by the sum of their elasticities (e). When e = 1 constant returns to scale are experienced, and when e > 1 increasing returns to scale are experienced, while decreasing returns to scale accrue when e < 1. The analysis of elasticities is important when dealing with the multi-product nature of production process as found in smallholder farmers. Since Bereko farmers are using several resource input together in their production process the notion of returns to scale becomes important in explaining how are they faring in their production process - that is if they are producing economically or not.

3.2.4 Optimization Behaviour of Small Scale Farmers

There are different views concerning the objective of profit maximization in smallholder agriculture. A discussion of this is important because the nature of a farm firm objectives is fundamentally important in influencing the characteristic of the firm's productive activities.

Although in most case business firm's treat profit maximization as a single or dominant objective. this notion takes a multiple objective nature when it comes to agriculture (Mdoe 1985). This is because apart from profit goal, smallholder farmer can aim at food security for the family. However, as Upton (1973) argues, the two are not necessarily in conflict because the greater the output a family produces with its limited resources, the more surplus produce can be realised.

In this essence, the predictive models based on orthodox economic theory which treat objectives of individual small farmers are only profit maximization are unrealistic (Gasson 1973). Although profit maximization might be second, it can not be ignored entirely because resources are scarce as compared to farmers needs.

The desire to maximize profit among smallholder farmers in Bereko division can be explained by their reaction towards changes in relative prices offered to certain products like fingermillet and cowpeas, many farmers have shifted resources to the production of these two crops (section 4.3.5.1; table 4.8 and 4.9). This is because farmers react positively to price increases. While food is treated as a restraint which have to be satisfied in achieving the objective of profit maximization, it is the contention of the researcher that smallholder farmers in Bereko seek to maximize profit.

3.3 Models for Empirical Analysis

3.3.1 Descriptive Statistics and Tabular Analysis

Before other models were used different tables and figures were constructed from raw data. These formed a basis for describing the present TFS in Bereko division and provided required data to answer objective (a).

3.3.2 The Cobb-Douglas Production Function

3.3.2.1 Background

The economic theory of production has been covered by Head (1952); Heady and others. One of the basic objective of this study is to identify the factors that shape the TFS of Bereko division with the aim of finding which factors do affect more the system and hence determine the likely adjustments of the system given changes in these factors.

In order to test the hypothesis that there is no significant relationship between agricultural output and technology used, available resources, and cropping pattern, a Cobb-Douglas production function is fitted to the data. The aim is to examine existing relationship between inputs and outputs.

Through multiple regression analysis, input coefficients are estimated in order to determine which variables among them are critical in explaining the level of output in Bereko division. An analysis of returns to scale helped to explain if Bereko farmers are operating at increasing or decreasing returns to scale while the direct elasticities of each input helped to explain if farmers are using these inputs economically or not.

3.3.2.2 Formulation of the Cobb-Douglas Function

In transforming this function the value of all variables are transformed into their natural logarithms

i.e $Y = AX_1^{b1} \; X_2^{b2}$ .... (3.4)

where A and b coefficients are estimated by converting all the variables measured both inputs and outputs, into their natural logarithms and then using least squares multiple regression on the logarithms. Hence the transformed equation becomes:

$\ln Y = \propto + b_1 \ln X_1 + b_2 \ln X_2$ ....(3.5)

whereby equation (3.4) is the antilog of (3.5), and A is a multiplicative constant and the antilog of $\propto$. Working on equation 3.4 gives

(1) $\frac{\sigma Y}{\sigma X_i} = b_i Y/X_i$ ....(3.6)

which implies that the function is continuous or,

(2) $\frac{\sigma^2 Y}{\sigma X_i} = b_i (b_i - 1) Y/X_i^2$................(3.7)

which implies that diminishing returns to the input factor X_i will prevail as long as $b_i > 0$ and < 1 (ie $1 > b_i > 0$)

(3) $\Sigma(X_i/Y)(\sigma Y/\sigma X_i) = \Sigma b_i$...................(3.8)

which implies decreasing returns to scale will prevail as long as $\Sigma b_i < 1$.

3.3.2.3 Interpretation.

In equation (3.5), b_1 and b_2 are direct measures of the elasticities of response for each of the input variables. To arrive at the marginal product, b coefficient must be multiplied by the average product (i.e. $APP_{Xi} = Y/X_i$). The average physical product varies depending on the level of input, and hence it is estimated at average levels. When b_1 and b_2 are less than one diminishing marginal returns are observed .

A b coefficient of exactly 1 implies constant marginal returns and when greater than 1 implies increasing returns to scale. If all inputs have been included in the function the Cobb-Douglas function may be used to estimate returns to scale because the effect of scale is measured by the sum of elasticities of response for all inputs. The results will, therefore, help to answer hypothesis (a) of the study.

3.3.2.4 Model Specification

The model to be estimated is of the form:

$$Yin = AX^{c1}_{n1} X^{c2}_{n2} X^{c3}_{n3} Uo \quad ....(3.9)$$

where

Yin = Physical output of all crops in kg.

Xn1..3 = Selected inputs (namely land, labour and capital)

C_1 ...3 = Production elasticities

Uo = Error term

A = constant term.

In order to estimate the elasticities of production (Ci) the above model is transformed to a logarithm form such that:

$$\ln Y = \ln A + c_1 \ln X_1 + c_2 \ln X_2 + c_3 \ln X_3 + \ln Uo \quad ..(3.10)$$

where

Y = Output of crops. Weighted total output is used to aggregate the crops. The production inputs are specified as follows:

X_1 = hactares planted with crops

X_2 = total labour used in the production

X_3 = total amount of cash used in the production

Uo = Error term

A = Constant.

$C_1 \ldots 3$ = Production elasticities

3.3.3 Linear Programming

Neo-classical theory of production gives a means of maximizing profits by using optimal input and/or product mixes. Since the study aims at analysing production process a neo-classical production is again used to develop the analytical framework - which is based on the assumption that the major objective of Bereko smallholder farmers is to maximize profit. The maximization is confined to the resource endowments and technology embodied in the existing production process. Objective here is the maximization of total net revenue of the enterprises in question.

3.3.3.1 Neo-Classical Theory and Profit Maximization

Basing on the main objective of profit maximization, neo-classical theory of marginal analysis can be used in making production process related to optimal input mix and/or output mix in a single or multi-enterprises firms. This implies that the neo-classical theory of marginal analysis can be used to determine simultaneously the optimum resource mix and output mix in each of the enterprises undertaken by the Bereko farmers. The major setback with the application of the neo-classical theory of marginal analysis is based on the assumptions made which stern from the law of diminishing returns that ensures concavity of the production function.

The assumption of strict concavity may not hold. Several local maxima can be observed in production function from which a global (absolute) maxima is selected (Boumal 1965; Chiang 1974). Each local maximum satisfies the first and second order conditions at that point but at some other point, the function may be convex. Again, imperfect institutions can frequently intervene in the input and output markets. These institutions do not facilitate allocation of resources to productive process and cannot be avoided.

The above limitation and the complexity of using marginal analysis principles with large number of competing enterprises hinders the use of the neo-classical marginal analysis approach in analysing optimization problems. Many researchers have, therefore, turned to LP technique to avoid computational problems involved in applying the principles of marginal analysis.

3.3.3.2 LP and Profit Maximization.

LP is one of the mathematical programming procedures. Mathematical programming differs from classical optimization in that it seeks to tackle the problems in which the optimize faces inequality constraints of the form $g(x,y) < c$ rather than $g(x,y) = c$ (Chiang, 1974). The LP is the simpler variety of mathematical programming (compared to non linear programming or game theory), in which the objective function as well as the constraint inequalities are all linear. It is a systematic mathematical procedure for finding the best possible plan for a given set of conditions (Upton 1973).

3.3.3.3 LP and Smallholder Farmers.

On constructing a LP for smallholder farmers the planner is advised to take note of some salient features of smallholder farmers. First, it is true that for most smallholder farmers, social and economic variables are not so easily separable. Therefore if objectives are mostly non-economic the results may be misleading. Second, there is the data problem. The degree of reliability of data from the smallholder farmers is low and therefore the planner should be knowledgable enough to deal with such problems.

The third problem is related to risk and uncertainty. Crops and livestock yields are highly dependent on the weather. Rains may arrive too early or late or there may be too much or too little rain for normal plant growth. Outbreaks of pests or diseases will affect yields. Other problems are that returns from some enterprises vary greatly from year to year; while other enterprises are stable. For example a farmer may be forced to grow drought resistant crops which are more stable than a higher yielding variety which is less stable. Five, to avoid more risk diversification of enterprises is mostly preferred such as intercropping or fragmentation of farms.

Apart from the above, there are other limitations associated with LP (Beneke and Winteboer 1973). One problem concerns homogeneity of enterprises. Programming proceeds as if the price and input - output expectations formulated were equally reliable for all farm products. No allowance is made for risk preferences. Another problem concerns the restraints. It is difficult to know how much labour will be available during the coming month. The third problem is that LP assumes that each additional unit of output requires the same quantity of input. No allowance is made for diminishing returns.

Inspite of all the above, LP is used because it allows one to test a wide range of alternative adjustments and to analyse their consequences thoroughly with a small input of management time.

3.3.3.4 Selection of the representative farm.

In analysing the TFS of Bereko by use of LP, a representative farm approach has been used. Many researchers use "Farm size" based on area as the selection criteria as compared to a representative farm. Mlambiti (1985) argues that the problem with farm size criteria is that it takes into account only one factor of production namely land and ignores all other resources of the farm.

In this study the representative farm was chosen by taking into consideration the mostly practised production mix in the division. The production mix chosen was that one which was practised by the majority of the people (appendix D). The farm size used was the average farm size of the study area (appendix A and table 4.4).

3.3.3.5 The Aim of the LP Analysis.

The LP is used to explain the existing production mix and from this model results, which are assumed optimal, adjustments are made in respect to changes in such factors as output prices, input prices; technology etc.

3.3.3.6 The General LP Model

The general model to be used for all cases is of the form:

Maximize $\pi = C_j.X_j$ for all j 1...n..........(3.15)

Subject to $B_i = Ai_j.X_j$ for all j=1..n j= 1..m..(3.16)

$X_j \geq 0$ ....(3.17)

where

π = profit (net revenue),

X_j = the level of the jth activity.

C_j = the net revenue of the jth activity

B_i = the level of the ith constraint

A_{ij} = the amount of the ith constraint used by the jth activity.

In the above model equation (3.15) is the objective function. Equation (3.16) is the group of constraints which make up the core of the linear program and specify that no more resource can be used by the activities X_j than are present in the resource base B_i. Equation (3.17) Specifies that all activities X_j can only take nonnegative values.

3.3.3.7 The Objective Function

Table 4.20a is a complete tableau for LP basic model for Bareko. The objective function used in the analysis is maximization of profit (total gross margins).

$$\pi = Py\ Y - \Sigma Pi\ Xi \ \ldots.(Py,\ Pi \geq 0) \ldots\ldots.(3.18)$$

where

π = profit (total net revenue)

P_y = value of output Y

P_i = value of input i.

In the basic LP model, (Table 4.20a) row 0 is the objective function which explains how net revenue will change by the addition of one more unit of an activity. This is the expected cost or price of one unit of activity. The total receipts less total costs give the net revenue. For example column 1 through 4 the sign of the net revenue is negative because production costs reduce the value of the objective function. In contrast the selling activities i.e column 8 to 11 the sign is positive since selling activities add to the value of the objective function.

3.3.3.8 The Constraints

Row 1 to 14 contain the resource requirements for the production activities and the amounts of the various resources that an average farmer in the division has at his disposal. These include land, capital and labour.

Row 2 to 13 shows labour availability per month. The constraint column show what is required of each resource by one unit of the activity.

Row 14 is the capital constraint while row 15 through 18 shows the supply of the farm products and the negative sign in the respective column indicate the amount of output to be added by each activity in the model. Rows 19 to 21 represent the institutional constraints i.e. subsistence requirements by the farmer's family which has to be met first.

3.3.3.9 The Columns

As most LP matrices do, the columns in the model represent activities. The activities could be for production, consumption, selling, buying, borrowing, hiring etc. Coefficients at their point of intersection with the rows show addition or subtraction of the resource or product.

Column 1 through 4 are production activities of the major crops in the division while column 5 to 7 are consumption activities. Column 8 to 11 are for selling activities.

3.3.3.10 The Model coefficients

The model coefficients do specify the magnitude of a restraint or transfer row and how it is influenced by an increase or reduction of one unit of each activity in the model. In the simplest and most common case these coefficients do reflect the demand or supply one unit of activity makes on the resource represented by the row in which the coefficients appear. Except for the objective function. coefficients with positive signs in a row usually signify demand whereas negative coefficients normally signify supply.

3.3.3.11 Calculation of Subsistence Food Levels for an Average Family

This is the amount needed to feed the household family. It has been established that a normal person needs 3,000 calories a day which can be produced by one Kg of maize, or millet or sorghum. He also needs 70 gm of protein eg from meat, beans, peas; and 35 gm of other food such as fruits, roughage and vegetables (WHO 1974). A child needs half of the quantities.

In this analysis maize, sorghum and millet are considered as starch while beans and peas are for protein. No fruits are produced in the area. Since maize is mostly prefered (see 4.4.4 below) as food crop it contributes more to total starch needed by the farmers. Beans are also prefered to peas. The ration adopted for maize to sorghum and beans to peas was 2:1.

3.4 Data Needs and Collection Methods:

3.4.1 Types and Sources of Data Required

Secondary data on total area of the region, district and division; total arable land; population size; rainfall distribution; and administrative structure were collected from sources such as RDD's Office; DADO - Kondoa, and research findings and publications.

In order to build a picture of farm level activities in Bereko division primary data were collected at farm level.

3.4.2 Methods of Data Collection

3.4.2.1 Questionnaire Design and Administration.

A single visit survey was undertaken using a structured questionnaire as an instrument. The questionnaire was designed to collect data on age. sex, educational level and physical fitness of the household members. Another data collected related to the amount of labour available, number of farms owned/used by the household and their acreage including types of crops grown, how planted and reasons for such cropping pattern. Data on labour were also collected plus data on supply and use of inputs such as seeds, insecticides etc. Lastly data on produce management, farm expenses, off farm income, sources of funds, and extension services were collected.

Before the questionnaire was administered to the farmers the researcher had to report to the regional and district authorities for introduction. The questionnaire was administered by the researcher in Kiswahili. the language well understood by the farmers in the study area. Apart from the questions already prepared, the researcher was forced to observe and analyse some data especially when assessing acreage of different households and other variables for the purpose of crosscheking the obtained data.

3.4.2.2 Sampling

The survey was conducted in Bereko division - Kondoa district. A multi-stage random sampling technique was used to select 120 households. The first stage involved random selection of 10 villages from the 25 villages in the division. In stage two 120 households were selected randomly from the 10 villages using the method of proportional allocation. The proportion was determined in the field after getting the sizes of different villages. The number of households sampled was just 1.4 per cent of the total households in the division. The proportions were as shown in table 3.1.

Table 3.1 Bereko division: Proportions of respondents interviewed

Village	Number of People	Number of Households	Number of Respondents
Bereko	6850	680	20
Kilimo	1694	260	8
Huruwi	1225	276	8
Itololo	1407	250	8
Kandaga	2700	516	16
Kisese Disa	3000	458	14
Kisese Sauna	2500	504	15
Kwayondu	1450	200	6
Masawi	7000	649	19
Mkekena	1000	172	6
10	28856	3953	120

Source: Bereko Division Headquarters 1988.
Calculations done by the researcher.

3.4.2.3 Problems Encountered in Data Collection

First, there was a problem with the basic data like age, number of wives, children or acreage. Because of development levy issue, some farmers gave low ages to children (below 18 years) and less numbers as regards number of wives. To minimize the problem village records were sought so as to countercheck the data.

Second problem was on timing of the research. Most farmers had harvested their crops and so most information depended on memory of the farmers. Since some of the produce had been consumed, sold, given away, there arose the problem of getting data on total crops harvested per crop. Related problem was on crops already sold through the parallel market. It was difficult to verify the authenticity of farmers memory due to lack of records. For crops sold through CRCU it was easy to check as a copy was available in the village of crops sold per farmer per crop.

Third, there was a problem of estimation. Eye witness which was mostly used in estimating acreage and sometimes harvests was not very accurate because both the farmer and the researcher were not qualified in the estimation. Distance of the farms from homesteads was also another problem because it was difficult for the researcher to visit farms situated far away from the homes.

Fifth. Problem on cropping pattern. It was difficult to know proper cropping pattern because crops had been harvested. The general criterion used was to divide the acreage by the number of crops grown to get rough estimates of acreage for each crop.

3.5 Data Analysis

Several tools have been used in the analysis. Descriptive statistics and tabular analysis has been used in order to group the raw data so as to be able to describe the existing TFS of the study area. Regression analysis has been used in order to evaluate the effect of various variables (inputs) on total output. LP has been used to see how the present system will change if some changes were effected on some of the variables in the TFS.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is divided into four parts. Part one identifies and explains the factors shaping the Bereko divisions' farming system (4.3). All major factors are taken into consideration. Part two (4.6) analyses the magnitude of the effect of some selected factors in the system by the use of multiple regression analysis.

Part three (4.7) deals with some possible adjustments to the system by effecting some changes in factors explained in parts one and two. The analysis is by the use of LP. The last part (4.8) presents a summary of the chapter.

4.2 Description of Bereko Divisions' Farming System

4.2.1 The Structure of Farming

The purely commercial farmer may be regarded as being motivated primarily by the objective of profit making - while small holder farmer has multiple objectives that contribute to maximizing family satisfaction. Any enterprise or productive process that allows the family greater security and satisfaction might take precedence over those that are more profitable. (Livingstone and Ord 1980).

The Bereko farmers who grow drought resistant cereals like bulrush millet and sorghum at small - scale level so as to feed their families do fall in the second category of small - holder farmers. As such these farmers are not motivated primarily by profit making but by several objectives.

The commonly grown crops in Bereko division include maize, sorghum, beans and peas as food crops; and fingermillet, sunflower, and castor seeds as cash crops. The distribution of these crops in the study area is shown in table 4.1. The distribution indicates that food crops occupy 79.4 per cent of total land while cash crops occupy 14.4 per cent and others 6.2 per cent. Of the total land in food crops maize takes the largest area i.e. 62.5 per cent or 78.7 per cent of total area under food crops. The crop is grown by all interviewed farmers. Sorghum occupy only 7.7 per cent of total land cultivated or 9.7 per cent of total area under cultivation or [illegible].2 per cent of total area under cash crops. This means that finger millet is the most preferred cash crop in the division (in terms of acreage planted with crops and was found to be grown by the largest percentage of farmers apart from maize).

Table 4.1 Bereko Division: Distribution of Crops in the Sampled Area for 1987/88 Season

Crops	Total area grown ha	Number of farmers	Percentage of total area	Percentage of farmers
Maize	652.4	118	62.5	100.0
Sorghum	80.0	54	7.7	45.8
Peas	52.6	41	5.0	34.7
Beans	43.9	15	4.2	12.7
Fingermillet	119.6	67	11.4	56.8
Sunflower	29.3	13	2.8	11.0
Castor Seeds	2.7	5	0.2	4.2
Others	64.4	101	6.2	85.6

Source: Survey data (1988).

4.2.2 Cropping Pattern

Cropping pattern is highly determined by the FS of the area including the general experience of the farmers in the area. Most farmers in the study area do practise monocropping. The survey has revealed that

818.2 ha or 78 per cent of all cultivated land by sampled farmers were monocropped; 136.8 ha or 13 per cent intercropped; and 89.9 ha or 7 per cent mixed cropped. There were 230.95 ha which were left fallow because of unreliable rainfall in the 1987/88 season. The preceding data indicate that the most common cropping pattern is monocropping. However, the practise of mixed cropping and intercropping (although not most common cropping pattern) can be explained by the fact that rainy period is short - 60 days on average (DADO - Kondoa 1988). Sometimes the rains fall for less than 60 days and less than the regional average of 600 mm as shown in table 4.2. The farmers are therefore, forced to intercrop to avert risk of having zero crop.

Table 4.2 also shows that rain falls mostly in December and January and in most cases ends in March. this means Kondoa district receives only one rainy season and is unevenly distributed. The rainy days per month are less than 15 in average which means there are few wet months in the district. It is evident, then, that rainfall pattern does affect highly the Bereko farming system and helps a lot in shaping the Farming system of the area in terms of crops grown because drought resistant crops are preferred to others.

Table 4.2 Rainfall distribution in Kondoa district for the past six years

Month	1982/83 mm	1982/83 days	1983/84 mm	1983/84 days	1984/85 mm	1984/85 days	1985/86 mm	1985/86 days	1986/87 mm	1986/87 days	1987/88 mm	1987/88 days
Sept.	-	-	-	-	6.9	(2)	-	-	-	-	-	-
Oct.	22.2	(4)	-	-	18.4	(4)	-	-	3.6	(1)	-	-
Nov.	131.3	(9)	25.6	(4)	84.4	(4)	93.1	(3)	126.0	(4)	5.9	(4)
Dec.	187.6	(11)	186.1	(9)	150.0	(10)	39.5	(6)	378.4	(17)	86.8	(6)
Jan.	191.3	(15)	189.1	(13)	234.4	(15)	212.1	(14)	216.3	(17)	152	(15)
Feb.	86.8	(9)	83.2	(7)	99.0	(8)	246.2	(12)	69.6	(5)	75.8	(7)
March	47.2	(5)	21.3	(9)	33.6	(6)	241.2	(20)	101.5	(8)	170	(17)
April	33.5	(5)	134.2	(8)	-	-	92.7	(9)	117.5	(11)	22.5	(9)
May	27.1	(7)	-	-	-	-	-	-	-	-	-	-
June	-	-	-	-	-	-	-	-	-	-	-	-
July	-	-	-	-	-	-	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-	-	-	-	-
Total	727.0	(62)	639.5	(50)	623.7	(49)	924.8	(64)	1012.8	(63)	512.8	(55)

Source: DADO - Kondoa (1988)

Notes: . Average rainfall per annum: 740.1 mm

. Average days of rainfall per annum 57 days
. Regional average rainfall: 600 mm
. Regional Average rain days 60 days

4.2.3 Livestock Keeping

Out of the 118 farmers interviewed 68 or 57.6 per cent own cattle. Grazing area is 44.210 hectares (DADO - Kondoa 1988). With present total livestock number of 150,718 there are only 0.51 ha per livestock unit. The regional recommended land carrying capacity is one livestock unit for 10 acres or 4.05 ha (Tanzania 1988e). Obviously the above statistics show that there is serious overstocking in the area.

The issue of overstocking should be looked vis-a-vis ox-ploughing in the area. As shown in section 4.3.4.1 below ox-ploughing plays an important role in the area. The ox-ploughing operation is a necessity given the short rainy season and total amount of land needed to be ploughed. It is true that with ox-plough more land can be ploughed as compared to hand hoe. Ox-plough is also cheaper compared to tractor and so the reference to oxen as an important tool for production in Bereko division warrants some attention.

Overstocking on the other hand, means that cattle do loose condition and weight during dry season due to shortage of adequate feed - which is both poor in quality and quantity. With the onset of the rains, the first flush of new grass causes severe diarrhoea in cattle resulting in greater loss of condition and weakness. Since oxen are needed to work throughout the dry season in pulling ox-carts and ox-ploughs during farming season it is a clear indication that the farming system in the area owes much from the livestock sector of the area - and, therefore, proper policies on livestock are necessary to help Bereko farmers use their oxen effectively.

4.3 Factors Shaping Bereko Farming System

4.3.1 Land Availability

As explained in 1.4.1, land availability in Bereko division is scarce and hence expansion of agricultural output (in terms of increased acreage) is seriously limited (given adequate rainfall whereby all land is put into crops). While most farmers possess plots in their respective villages, some are forced to move some distances to look for new areas. Out of the 118 farmers interviewed 53 or 44.9 per cent possess land (for farming) outside their respective villages. However with short rains not all land is cultivated and some is left fallow. As shown in 4.5.1, about 1.95

ha per family were left fallow in the 1986/87 season due to unreliable rainfall.

4.3.2 Soil Fertility

Studies by Dodoma RIDEP(Tanzania 1985) estimated Bereko division as having an area of 78,000 ha (equivalent to 780 sq. km) out of which only 36.4 per cent are suitable for rainfed agriculture. The remainder include poorly drained soils, rocks, hills and escarpments which are unsuitable for agriculture. The land limitation means that agricultural production through expansion of acreage is not possible in the area - and hence the best alternative is through increased productivity per ha. Thus, land is one of the crucial factors which helps to shape the TFS of Bereko division.

4.3.3 Land Use

Bereko division is densely populated and cultivated. There are 82 persons per square km or 3.4 ha of arable land per head. The only land reserves are the heavy black soils towards the Masai Steppe. Due to high erosion on the mountains many farmers were forced to resettle on the lowlands - hence increasing population pressure on these areas (HADO 1988). Present land use in Bereko division is given in table 4.3.

Table 4.4 shows that food crops do occupy a larger part of the cultivated arable land compared to cash crops. This is explained by the fact that farmers do give first priority to food crops. The preceding facts indicate that Bereko farmers do prefer food crop production to cash crop and thus although they may be interested in profit maximization other objectives of self-sufficiency in food products take considerable weight.

4.3.4 Technology

4.3.4.1 Land Preparation

From the survey data, the area of study used more tractor in land preparation in the 1987/88 season compared to ox-plough or hand hoe. Out of the total 1044.9ha cultivated, 548.2 ha or 52.5 per cent of land preparation was done by use of tractor, 487.2 ha or 46.6 per cent by ox-plough and 9.5 ha or 0.9 per

Table 4.3 <u>Present land use in Bereko division</u>

Land use	Area ha	Percentage of total area
Cultivated area	28400	36.4
Grazing land (grass, bush and mountains)	44200	56.6
Forest reserve	5400	7.0
Total	78000	100.00

Source: HADO - Kondoa (1988).

Table 4.4 Crop mix for an average farm of 7.0 hectares Bereko division: 1987/88 (a)

Crop		Amount ha	Percentage of total cultivated land	
Food grains		5.3		76
. Maize	4.48		64	
. Sorghum	0.27		4	
. Bulrush millet	0.27		4	
. Others	0.28		4	
Cash crops		1.1		15
. Sunflower	0.20		3	
. Castor seeds	0.01		0	
. Finger millet	0.80		11	
. Others	0.09		1	
Others		0.6		9
. Beans	0.29		4	
. Peas	0.35		5	
Total		7.0		100

Source: Survey Data (1988).
(a) The average farm has been calculated from the survey data and differs with the one mentioned in paragraph 1.4. which was calculated by Dodoma RIDEP (1985) for the whole division.

cent by hand-hoe. However the survey data also show that only 27 farmers used tractor alone (22.9 per cent) in land preparation while 67 farmers (56.8 per cent) used ox-plough alone and 23 farmers (19.5 per cent) used both. Only one farmer used hand hoe to cultivate his 0.81 ha although hand hoe is the only technology used in weeding. Hand-hoe technology is commonly used to prepare small gardens around the homestead because of the size of the

plots.

The above data indicate that ox-plough is the mostly used technology in the division. The disadvantage with ox-plough compared with tractor, is the small amount of acreage which can be prepared per day.

4.3.4.2 Fertiliser Application

The most commonly used fertiliser is the manure (kraal manure) and of the 17 (14 per cent) farmers who used fertilisers only two used chemical fertilisers while the rest used manure in their farms. The quantity of chemical fertiliser applied was nevertheless, very small (< 50 kg/ha).

The low level of application of fertiliser can be shown by the low consumption level of fertilisers in the district as table 4.5 shows. From the table it can be seen that an average of 34,000 kg of fertilisers have been purchased every year. Taking an average of 200 kg per ha the amount is enough for only 170 ha. This amount is obviously small compared to the total area cultivated in the district amounting to 924.630 ha (DADO - Kondoa 1988).

plots.

The above data indicate that ox-plough is the mostly used technology in the division. The disadvantage with ox-plough compared with tractor, is the small amount of acreage which can be prepared per day.

4.3.4.2 Fertiliser Application

The most commonly used fertiliser is the manure (kraal manure) and of the 17 (14 per cent) farmers who used fertilisers only two used chemical fertilisers while the rest used manure in their farms. The quantity of chemical fertiliser applied was nevertheless, very small (< 50 kg/ha).

The low level of application of fertiliser can be shown by the low consumption level of fertilisers in the district as table 4.5 shows. From the table it can be seen that an average of 34,000 kg of fertilisers have been purchased every year. Taking an average of 200 kg per ha the amount is enough for only 170 ha. This amount is obviously small compared to the total area cultivated in the district amounting to 924,630 ha (DADO - Kondoa 1988).

plots.

The above data indicate that ox-plough is the mostly used technology in the division. The disadvantage with ox-plough compared with tractor, is the small amount of acreage which can be prepared per day.

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The low level of application of fertiliser can be shown by the low consumption level of fertilisers in the district as table 4.5 shows. From the table it can be seen that an average of 34,000 kg of fertilisers have been purchased every year. Taking an average of 200 kg per ha the amount is enough for only 170 ha. This amount is obviously small compared to the total area cultivated in the district amounting to 924,630 ha (DADO - Kondoa 1988).

Table 4.5 Purchase of fertilizers in Kondoa district.

Type	1981/82 kg	1982/83 kg	1983/84 kg	1984/85 kg	1985/86 kg	1986/87 kg	1987/88 kg	Average
NPK 20:10:10	-	33000	34000	[illegible]	[illegible]	-	-	31175
CAN	200	23000	4000	-	5050	-	-	10683
TSP	-	-	-	-	33350	30300	2700	39217
SA	-	-	-	-	-	90400	79100	79750

Source: DADO - Kondoa (1988)

4.3.4.3 Insecticide Application

The situation is a bit worse with insecticides because out of the 118 farmers interviewed only 6 (5 per cent) used insecticides - the type of which they could not exactly tell. This can be an indication that there are less diseases and pests in the district or may be because of the reasons advanced by the farmers that it was difficult to find the insecticides and when found proved to be very expensive. This is supported by purchase figures for the district in table 4.6.

4.3.4.4 Seeds

Most farmers interviewed showed readiness to use improved seeds but they claimed that it was difficult to get and were expensive. In most cases the seeds came late for planting. For example the researcher found more than 50 bags of 10 kg each of maize (ICW) of last season unsold in one village (Kisese Sauna). The explanation from Ward Secretary was that the seeds arrived very late for planting.

Table 4.6 Amount of insecticides purchased in Kondoa district

Type	1981/82 kg	82/83 kg	83/84 kg	84/85 kg	85/86 kg	86/87 kg	87/88 kg	Ave. kg
DDT 5%	10500	19840	16000	34000	1500	1500	12390	12390
Actellic1%	3200	-	1300	2638	1500	-	2160	2160
Malathion*	9000	-	-	-	-	1275	4125	4125
DDT 25%	-	4000	3000	4000	1000	-	3000	3000

* Measurement in litres

Source: DADO - Kondoa (1988).

Table 4.7 shows that the district is not purchasing enough seeds for the farmers. For example an average of 15.666 kg of maize seeds have been purchased every year which is enough for 627 ha only in the district (assuming all is distributed). Serena seeds which are highly recommended for the district because of climatic reasons is enough for 808 ha only.

Assuming that effective demand is high, the data for the three inputs suggest that there is not enough inputs to help raise productivity of the area.

Table 4.7 Purchase of seeds in Kondoa district

Seed Type	1981/82 kg	82/83 kg	83/84 kg	84/85 kg	85/86 kg	86/87 kg	87/88 kg	Aver kg
Maize (ICW)	7000	25813	33700	16000	10000	1430	-	15664
Maize	5000	3013	-	-	8415	6935	14500	7573
Maize (Hybrid)								
Maize (Katumani)	-	-	-	-	1000	10000	5000	5333
Serena	12000	28856	33700	16000	19445	16547	14856	20201
Lulu	24000	54857	32400	39270	18547	2000	2000	24725
S/Flower	10500	24752	23400	10702	-	-	14500	16771
G/nuts	-	-	3000	450	-	-	7000	3483
Simsim	-	-	800	-	-	-	-	800

Source: DADO - Kondoa (1988)

4.3.5 Institutional Factors

4.3.5.1 Pricing system.

Survey results (table 4.8) have established that most farmers do sell a major portion of their produce through the parallel market. For example all fingermillet and over half of peas was sold through the parallel market in 1987/88 season. The explanation is that the parallel market offered higher producer prices compared to those offered by CRCU.

Table 4.9 gives a comparison of official and parallel market prices in the 1987/88 season. Pricing system (policy), therefore, influences a lot the market of produces as shown in table 4.8. For certain crops (such as finger millet and peas) the official market can hardly compete with the parallel market if prices are taken as the criterion. The parallel market for some crops as table 4.9 shows, gives higher prices while prices for other crops are even lower than the official prices. This is where the law of demand and supply could be used. That is the market should be left to decide on the prices for the products. This is needed in order to assist farmers to make rational

Table 4.8 Bereko division: Amount of crops sold through CRCU and parallel market in sampled area in 1987/88 Season

Crop	Total Harvest kg	Amount Sold Through		
		CRCU kg	Parallel Market kg	Percentage of 4 to 2
1	2	3	4	5
Maize	730883	565000	0	0
Sorghum	54160	9790	0	0
Beans	42955	34500	5200	12
Peas	22050	7750	12650	57
F/millet	61945	0	58500	94
Sunflower	6330	6100	0	0
C/Seeds	580	430	0	0

Source: Survey Data (1988).

decisions on which crops to grow in order to maximize their incomes.

Table 4.9 Bereko division: Comparison of Official and parrel Prices in 1987/88 Season

Crop	Farmgate official price shs/Kg	Parallel price shs/Kg	Difference shs/Kg	Percentage difference
Maize	9.00	10.00	1.00	11.1
Beans	24.85	25.00	0.15	0.6
Sorghum	6.60	6.00	-0.60	-9.1
F/millet	12.00	37.50	25.50	212.5
S/Flower	13.90	10.00	-3.90	28.1
Peas	12.00	30.00	18.00	150.0
C/seeds	8.15	8.00	-0.15	-1.8
G/Nuts	29.60	40.00	10.40	35.1
Rice	17.50	25.00	7.50	42.9

Source: CRCU Dodoma - 1988: Survey Data (1988).

4.3.5.2 Agricultural Credit.

All farmers interviewed indicated that they had not been provided with agricultural credit and most of them did not know if credits were available. On the other hand, low repayment rate of loans by farmers/villages has been explained as the cause of low agricultural credit to Kondoa farmers (DADO - Kondoa 1988). With high input prices as shown in table 4.21 and low producer prices as shown in table 4.9, credits may help the smallholder farmer take off as it will enable the farmer to produce more through area expansion and intensive resource utilisation and be able to get better incomes to pay for the inputs as well as invest for increased agricultural production.

4.4 Agricultural Output for Kondoa District

4.4.1 Agricultural Productivity

According to reports of DADO - Kondoa. agricultural productivity in the district has been fluctuating as table 1.2 shows. Similar trend can be attributed to Bereko Division as it is governed by same factors. Table 4.10 gives a comparison of average yields for major crops under the TFS and other systems.

These yield levels do differ slightly among different parts of the district and division mainly due to soil fertility and rainfall reliability. The higher altitude zone has more rainfall than the eastern lowlands while on the other hand the northern lowlands are more fertile than the rest of the division but have less rainfall.

Table 4.10 Bereko division: Average yield levels for major crops

Crop	(a) Average yield kg/ha	(b) Average yield kg/ha	(c) Average yield kg/ha
Maize	900	1100	3900
Beans	1100	1200	2100
Sorghum	1000	800	2500
F/millet	960	900	1800
Sunflower	850	60	1500
Peas (cow)	-	1500	2000
Castor Seeds	-	700	1850

Source: DADO - Kondoa and Survey results (1988).

Notes: (a) Yield levels adopted from DADO - Kondoa
(b) Yield levels obtained from survey data
(c) Yield levels recommended for improved farming practice.

4.4.2 Gross Margin Analysis

Appendix B_1 shows the calculation of gross output. gross margin and net income for an average family farm of 7.0 ha assuming all crops are grown in conformity with crop pattern in table 4.1 and 4.4. The results indicate that the net farm income for this farm is Tshs. 36 151.4 per annum or Tshs 3012.6 per month. This income compares poorly with the rural minimum wage of Tshs 1447.5 per month - because given an average family of four adult persons each gets Tshs 753.2 per month which is about half of the government rural minimum wage rate.

4.5 Factors of Production (Resources)

In the TFS the main resources for the peasant are land and labour. These resources have special role to play in the peasant farmers agricultural production and consequently they are examined in detail to find out how they have been utilised under the TFS in Bereko division. Capital which is often a limiting factor in peasant agriculture but of less importance is considered as cash used to meet daily farm expenses (operating expenses). Its major source is from farmer's savings.

Table 4.11 Calculation of Gross Margin for Bereko: Traditional Farming System

Item	Unit	Crops: Maize	Sorghum	Beans	Finger millet	[illegible]	[illegible]	[illegible]	Total
1.Farm Size	ha								[illegible]
.Cropped	ha								[illegible]
.Fallow	ha								[illegible]
2.Land use	ha	1.0	1.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
3.Output									
.Total	kg	1100	800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
.Losses(30%)*		330	240	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
.Production	kg	770	560	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
.Farmgate Price	Tshs/kg	9.0	6.6	24.85	[illegible]	[illegible]	[illegible]	[illegible]	
4. Gross Output	Tshs	6930	3696	20874	7560	[illegible]	5833	3994	51492
Variable Costs									
. Seeds	Tshs								
. Fertilizer	"								
.Insect.	"								
.Maint.	"	300	300	300	300	300	300	300	
.F/Operations	"	800	500	800	500	400	300	200	
.Packing		800	300	800	500	1000	400	700	
Sub Total Tshs		1900	1100	1900	1300	1700	900	1200	10000
6. Gross Margin Tshs.		5030	2596	18974	6260	10900	4933	2794	1492

Table 4.11 Calculation of Gross Margin for Bereko: Traditional Farming System

Item	Unit	Maize	Sorghum	Beans	Crops Finger/millet	Peas	S/flowers	C/seed	total
1.Farm Size	ha								7.0
.Cropped	ha								[illegible]
.Fallow	ha								[illegible]
2.Land use	ha	1.0	1.0	1.0	1.0	[illegible]	[illegible]	[illegible]	
3.Output									
.Total	kg	1100	800	1200	900	1500	[illegible]	[illegible]	
.Losses(30%)"		330	240	360	[illegible]	450	[illegible]	[illegible]	
.Production	kg	770	560	840	[illegible]	[illegible]	[illegible]	[illegible]	
.Farmgate Price	Tshs/kg	9.0	6.6	24.85	[illegible]	[illegible]	[illegible]	[illegible]	
4. Gross Output	Tshs	6930	3696	20874	7560	[illegible]	5833	3994	61492
Variable Costs									
. Seeds Tshs									
. Fertilizer	"								
.Insect.	"								
.Maint.	"	300	300	300	300	300	300	300	
.F/Operations	"	800	500	800	500	400	200	200	
.Packing		800	300	800	500	1000	400	700	
Sub Total Tshs		1900	1100	1900	1300	1700	900	1200	10000
6. Gross Margin Tshs.		5030	2596	18974	6260	10900	4933	2794	1492

Table 4.12 Calculation of Gross Margin for Bereko: Improved Farming system

Item	Unit	Crops							
		maize	sorghum	beans	f/millet	peas	s/flower	o/seeds	total
1. Farm-size	ha								[illegible]
. Cropped	ha								[illegible]
. Fallow	ha								[illegible]
2. Land use	ha	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0	[illegible]
3. Output									
. Total	kg	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
. Losses (10%)		390	250	210	[illegible]	200	150	185	
. Production	kg	3510	2250	1890	1620	1800	1350	1665	
. Farmgate price	Tsh.kg	9.0	6.5	24.35	12.0	12.0	[illegible]	8.15	
4. Gross Output		31590	14630	45957	19440	21600	13765	13570	166791
5. Variable costs									
. Seeds	Tshs	2137	150	521	360	240	[illegible]	120	
. CAN	"	2760	2760	2760	2760	2760	2760	2760	
. TSP	"	1375	1375	1375	1375	1375	1375	1375	
. Insect	"	1000	1000	1000	-	-	-	-	
. Maintanance	"	500	500	500	500	500	500	500	
. F/Operation	"	2500	2000	800	1500	1400	500	600	
. P/material	"	3900	2000	1500	1600	1600	1800	1500	
Sub - Total		13272	9765	8556	8095	7875	7115	6955	61654
6. Gross Margin		18317.5	5065	33410.25	11345	13725	11650	6614.75	105127

Source: Survey Data (1998).

4.5.1 Land Resource

As explained in 4.3.1 not all land in Bereko division is suitable for crops under rainfed agriculture. The survey results have shown that average total area per household is 10.81 ha. average area cultivated in 1987/88 season was 8.85 ha per household. However this included farms outside the survey area and so the average cultivated area in the survey area was 6.87 ha as shown in appendix A. At the same time 1.95 ha were left fallow in average by each family. Given the average household size of 6.8 persons (survey results), and with the high population growth rate of 2.8 per annum (1988 census), the farm sizes per person comes smaller as years go by. This will lead to the land problem in the study area.

4.5.2 Labour Resource

4.5.2.1 Labour Requirements.

The size of the family labour determines the size of the farm and timing of operations. Table 4.13a and 4.13b shows the labour requirements per crop per operation in Bereko and figure 1 shows the timetable for different operations.

Table 4.13 Bereko division: labour requirements for different operations - existing situation (TFS)

	Maize md/ha	Beans md/ha	Sorghum md/ha	Peas md/ha	F/millet md/ha	S/flower md/ha	C/seed md/ha
Preparation	18	10	18	15	20	16	16
Sowing	6	3	6	4	6	4	4
Weeding I	20	12	22	18	22	18	16
Weeding II	10	0	10	0	12	0	0
Harvesting	14	6	15	12	24	6	8
Others	3	3	3	5	6	3	4
Total	71	34	74	54	90	47	43

Source: Survey data (1988).

Table 4.13 shows that fingermillet, sorghum and maize are labour intensive crops as they require high levels of labour from land preparation to harvesting. On the other hand beans, sunflower and castor seeds are less labour intensive crops. The labour intensive crops require two weeding periods as compared to less labour intensive crops which require only one weeding period. The table again reveals that land preparation and weeding are the two most labour intensive operations while sowing is the least labour intensive operations.

Table 4.14 Bereko division: Labour requirements for different operations - improved practices

	Maize	Beans	Sorghum	Peas	F/millet	S/flower	C/seeds
L/Preparation	6	6	6	6	6	6	6
Sowing	22	12	22	20	22	10	10
Weeding I	20	12	22	18	22	18	16
Weeding II	10	0	10	0	12	0	0
Harvesting	14	6	15	12	24	6	8
Others	4	4	4	6	6	4	3
	76	40	79	62	92	44	43

Source: Survey data (1988).

Figure 1 Bereko Division: Timetable for Different Farm Operations

	Timing											
Operation	J	F	M	A	M	J	J	A	S	O	N	D
Land Preparation	**	*									**	**
Sowing	*	*									**	**
Weeding I	**	**										
Weeding II			*	*								
Harvesting						*	**	**				
Winnowing												
Others (Thrusting (Marketing etc)										**	**	

Source: Survey data (1988).

From figure 1 it can be deduced that November, December, January and February are the busiest months in Bereko farmers. The farmers are obliged to prepare land, and do weeding of other plots planted in November and December. Apart from a second weeding which is only for a few crops like maize, sorghum and fingermillet, the whole period from March to June is the time of less farm work for farmers. There is a substantial amount of idle labour which can be realised and utilised effectively by introduction of other farm and non-agricultural activities.

4.5.2.2 Family Labour Availability and Utilisation.

The availability of labour is very central for smallholder farmer for the fact that it determines the size of farms and the scope of the improvement which can be introduced and successfully implemented.

Timing of labour available is essential because during dry season there is frequently an abundant labour surplus relative to labour requirements. Social events like holidays, wedding, festivals, funerals, and travelling do affect labour supply in all seasons. Table 4.15 shows calculated available labour per month for an average family in Bereko. As indicated in section 4.5.2.1 above the total labour available suggests that no labour is used for farmwork in May, (see figure 1) while January, February, July, August, November and December months use more labour in farm work.

Table 4.15 Bereko division: Calculated available mandays per month for an average family.

Month	Total days available	Less rainy days	Less holidays sickess	Less sundays/ friday	Net days	Total mondays
		(a)				(b)
Jan	31	15	1	4	11	55
Feb	28	8	1	4	15	75
March	31	13	1	5	12	60
April	30	9	2	4	15	75
May	31	0	1	5	25	125
June	30	0	1	4	25	125
July	31	0	1	4	26	130
August	31	0	1	5	25	125
September	30	0	1	4	25	125
October	31	3	1	4	23	115
November	30	4	1	4	21	105
December	31	10	1	4	15	75
Total	365	62	13	51	238	1190

Source: Survey Data (1988)

Notes: (a) Calculated from table 4.2

(b) Calculated by multiplying number of persons in an average family of 6.8 (i.e 4 adults and 2 children = 5 persons) by number of net days in that month.

Table 4.16 Bereko Division: Available and Required Labour by Months and by Crops per ha.

Month	Available labour	Total labour required	Labour required by crops						
			Maize	Beans	Sorghum	Peas	F/Millet	S/flower	C/seed
	md	md	md	md	md	md	md	md	md
January	55	48	8	0	8	3	8	3	8
February	75	51	9	3	10	8	9	7	5
March	60	42	12	8	10	0	13	4	0
April	75	31	10	8	7	0	6	0	0
May	125	1	0	0	0	0	1	0	0
June	125	7	0	7	0	0	0	0	0
July	130	59	5	3	15	6	20	5	5
August	125	48	8	2	5	13	6	7	8
September	125	24	3	2	3	3	4	3	6
October	115	18	3	1	3	2	3	2	4
November	105	26	3	0	3	7	7	3	3
December	75	58	10	0	0	7	13	8	10
Total	1190	418	71	34	74	54	90	47	49

Source: Survey data (1988).

Table 4.16 shows the available and required labour by months and by crops. The table shows that fingermillet required the highest total amount of labour followed by sorghum and maize. On the other hand beans seem to require the lowest amount of labour.

The proceeding tabular and descriptive analyses have shown that the TFS in Bereko is being shaped by several factors including land, labour, technology in use and cropping patterns practised. Since the effect of each factor (variable) on output might differ. regression analysis has been employed to give an indication as to which factors do affect more the output in Bereko TFS. The multiple regression results are explained in 4.6 below.

4.6 Regression Analysis and Results

The aim was to identify the factors which had a strong effect on output in the study area. The question investigated is what factors are most significant in explaining the output of crops in the study area. The analysis was guided by the hypothesis (a) which seeks to find out if there is any significant relationship between agricultural output or productivity and technology used, available resources and cropping practice.

4.6.1 Definition of Regression Variables

The regression models used have been based on the Cobb-Douglas production function as explained in Chapter III. Three models have been estimated. The first models included weighted total output of the seven crops (maize, sorghum, beans, peas, fingermillet, sunflower and castor seeds) - as the dependent variable and total cultivated land, total labour and total capital (cash used) as the explanatory variables. Selection of variables was guided by hypothesis (a) of this study.

In the second model total output of maize was estimated as the dependent variable while land, labour, and capital were considered as independent variables. In addition two extra variables were added as independent variables viz technology in use (ox-plough and tractorization) and cropping pattern used. The two variables were introduced in the analysis as dummy variables. While maize was chosen as a food crop for analysis, fingermillet was chosen as a cash crop and formed regression model 3.

4.6.2 Regression Model 1

In this regression equation weighted total output of all crops was estimated as a dependent variable against three independent variables - namely land, labour, and capital. In its transformed form the equation was as follows:

$$\ln Y = \ln A + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + \ln U_o$$

where

Y = Weighted total output of all crops (maize, peas, sorghum beans, fingermillets, sunflower and castor seeds).

A = Constant term

$B_1..3$ = elasticities of response

X_1 = total land used

X_2 = total labour used

X_3 = total capital used

U_o = Error term

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The results for the least squares regression as suggested by the specified model are given in table 4.17

Table 4.17: Bercko division: Total output sample regression results: total output as a dependent variable

Variable	B	std Error	t-values
A	-2.4790477	1.5359959	-1.6139677
X_1	0.2401230	0.2994715	0.8018225
X_2	0.2301594	0.3136550	0.9367903

R^2 = 0.144027 F - Statistics = 6.393932

$\bar{R}^2$ = 0.121562 SE = 1.240451

NB: Value of A is in natural log its antilog value is 0.08382

From these results altogether the independent variables account for 12 per cent of the variations in weighted total output. This is a very low value which may imply that some factors (both exogenous or endogenous) have been omitted which explain strongly the dependent variables. There are no significant variables in this model at 5 per cent significance level. However the F - test have indicated that jointly the explanatory variables have a significant effect on total output.

It is observed that all variables relate to Y positively though not significantly at 5 per cent level as denoted by the B coefficients. The land and labour resources suggest that an increase in land will definitely lead to increased output and additional labour implies increased output.

The results indicate that a one per cent increase in land will increase output by 0.24 per cent while a one per cent increase in labour will increase output by 0.23 per cent. Capital though not very important implies that with a one per cent increase in capital, output will increase by 0.0S per cent. In this case it is profitable to increase more land or its productivity so as to realise higher output levels.

As regards input utilisation, Bereko farmers are employing the different inputs economically because for each input employed production is being carried out in Stage II (where diminishing returns are exhibited) since the direct elasticities of production are less than 1. For example, other inputs being held constant a one per cent increase in XI (land) would result in a 0.24 percent increase in output.

Returns to scale

The elasticities of production for the independent variables can be used to estimate returns to scale. When inputs of two or more variable factors are increased together the marginal physical product are unlikely to diminish as rapidly as when a single resource is increased alone (Upton 1973).

A summation of the elasticities of production of the inputs in the production equation 1 gives the scale coefficient of 0.55. This figure means that a simultaneous increase in all inputs by one per cent will increase total out put by 0.5 percent. This implies that farmers are producing where decreasing returns to scale are exhibited and hence producing economically.

4.6.3 Regression Model 2

The second regression equation was executed with output of maize as a dependent variable against five independent variable. In its transformed form the model was as follows.

$$\ln Y = \ln A + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 X_4 + b_5 X_5 + \ln U_o.$$

where

Y = total physical output of maize

A = constant term

$b_{1...5}$ = elasticities of response

X_1 = total land used in the production of maize

X_2 = total labour used in the production of maize

X_3 = total capital used in the production of maize

X_4 = dummy variable - assigned a value of 1 if ox-plough/tractor and zero otherwise

X_5 = dummy variable - assigned a value of 1 if monocropping and zero otherwise

U_o = error term.

The results for the least squares regression as suggested by the specified model are given in table 4.18.

Table 4.18 Bereko Division: Total Output Sample Regression Results: Maize total output as Dependent Variable.

Variable	B	Std Error	t-value
A	3.2446605	3.1523410	1.0292860
X_1	0.4703511	0.7173376	0.6556900
X_2	-0.4944010	0.6427259	-0.7692252
X_3	0.7507749	0.1298138	5.7834758*
X_4	-0.1979878	0.9197215	-0.2152693
X_5	0.0756255	0.3241882	0.2332765

R^2 = 0.435320 SE = 1.510411
$\bar{R}^2$ = 0.416111 F - statistic = 17.26845

NB: Value of A is in its natural log- its antilog value is 25.65299939.

From the results, altogether the independent variables account for 41 per cent of the variation in the dependent variable (total output of maize). At 5 percent confidence level there is only one significant variable in the model namely amount of capital used in the production of maize. The F - test indicates that jointly the explanatory variables have a significant effect on total output of maize.

It is observed that all variables except X_2 (labour) relate to Y positively though not significantly as denoted by the B coeffficients. However, from the results in table 4.18, it is observed that the elasticity of production with respect to farm labour (X_2) bears a negative sign which is somewhat unusual although not statistically different from zero. One would expect that farm labour influences output positively. This suggests that farm labour has reached the level beyond the maximum total product in the production (response) curve. Here the marginal product per unit of labour is negative - hence extra units of labour actually decrease the total product so both the total product of the fixed input and the average product per unit of the variable input are falling at this stage. This means that it is uneconomical to continue employing more labour in maize production.

A summation of the elasticities of production of the inputs in the production equation 2 gives the scale coefficient of 0.73. This figure means that a simultaneous increase in all inputs by 1 per cent will increase total output by 0.73 percent. This means farmers are producing where decreasing returns to scale are exhibited.

The results have also shown that ox-plough and tractor technology do shift the production function to the right i.e. downwards while monocropping do shift the production function to the left i.e. upwards. The possible explanation may be that the use of ox-plough or tractor has reached a stage where it is uneconomical given the amount of land available per household of 7.0 ha or that use of these technologies should be in a packages. As Livingstone and Ord (1980) and UNESCO (1981) argue, mechanization can not automatically be regarded as the only solution to increased productivity. Some other factors may be of importance and disregard of them may result into failures with respect to mechanization.

In order to use tractors, physical conditions should permit the use of it. The ground should not be excessively hard, stony, hilly or under thick bush - otherwise the tractor may be very expensive especially for smallholder farmers. The physical conditions of Bereko do not allow tractorization to be adopted everywhere. As explained in section 1.2.6 above, almost half of Kondoa district is hilly land. Bereko division is highly affected by this physical feature constraint as far as tractor use is concerned. These factors may be some of reasons why technology variable bears a negative sign and hence shifting the production function downwards. On the other hand the results suggest that monocropping should be encouraged as it has a positive effect on total production function.

4.6.4 Regression Model 3

The third regression equation was executed with output of fingermillet as a dependent variable against the same five independent variables in model 2. In its transformed form the model is as follows:

$lnY = A + b_1lnX_1 + b_2lnX_2 + b_3lnX_3 + b4b_4 + b_5X_5 + lnU_o$

where

Y = total physical output of fingermillet

A = constant term

b1.. 5 = elasticities of response

$X^1..X_5$ = as in model 2

U_o = error term.

The results for the least squares regression as suggested by the specified model are given in table 4.19

Table 4.19 Bereko Division: Total Output Sample Regression Results: Fingermillet total output as a Dependent variable

Variable	B	Std Error	t - value
A	1.0360764	2.1228974	0.4880483
X_1	0.3263014	0.3674561	0.8880011
X_2	0.9126119	0.4095197	2.2282494
X_3	0.1954164	0.1352009	1.4453783
X_4	- 0.9171833	1.1536048	-0.7950586
X_5	0.0139639	0.4138347	0.0337427

R^2 = 0.328557 NB Value of A is in its

$\bar{R}^2$ = 0.268607 natural log - its

SE = 1.580101 antilog value is

F-stat = 5.480496 2.818138047

The results show that altogether the independent variables account for 27 per cent of the variations in the dependent variable (Y). There is no significant variable in the model. The F-test have indicated that jointly the explanatory variables have a significant effect on Y. It is observed that all variables relate to Y positively though not significantly at 5 per cent level. The result indicate that a one per cent increase in land will increase output by 0.32 per cent while a one per cent increase in labour will increase output by 0.91 percent. In this case it is profitable to increase labour or its productivity so as to get more output.

As regards input utilisation, Bereko farmers are employing the different inputs economically because for each input employed production is being carried out at Stage II - since the direct elasticities of production are less than 1 for each.

A summation of the elasticities of production of the inputs in the production equation 3 gives the scale coefficient of 1.43. This figure means that a simultaneous increase in all inputs by one per cent will increase total output by 1.43 per cent. This is an indication that farmers are producing where increasing returns to scale are exhibited hence there is room for expansion of production levels.

As in model 2 the technology (ox-plough or tractor) in use factor shifts the production function to the right while cropping pattern shifts it to the left (upwards).

4.6.5 Remarks on the Regression Results

Given the hypothesis postulated previously that: There is no significant relationship between agricultural output or productivity and technology use, available resources, and cropping practices.

The results suggest that there is a positive relationship though not significant between output and available resources and cropping practices. It also shows that there is a negative relationship in relation to technology used.

The general conclusion is that the results do confirm to the postulated hypothesis. In the TFS these results seem to be logical (with regards to their positiveness). For example if acreage is held constant them more use of labour and capital as models 1 and 3 suggest, tend to increase total output. The analysis cannot, however, determine whether it is better to increase hectares (less intensive) or to hold hectares constant and increase input per hectare (more intensive). Benefit/Cost or related analyses are needed to do this. Also the results are logical because more output would demand more land, more labour and more capital. The low magnitude of the coefficients of response may mean that some factors (both exogenous and endogenous) might have contributed to total output levels. This fact is common in small holder farming which is characterised by several socio-economic, socio-cultural factors in their production processes (Upton 1973).

The results from regression equations 2 and 3 suggest that output may be increased by reallocation of resources. The percentage increase on output caused by variable land is more in the production of maize than fingermillet and hence for increased output more land should be allocated to maize. On the other hand labour brings negative effect in maize and hence reallocation in favour of fingermillet may be more economical. In other words in maize production labour is not the main constraint while in fingermillet it is. Also more capital should be invested into maize as it produces more output compared to investment in fingermillet.

However, the resulting gain in output may be different to farmers desire because they may decide to have more maize or more fingermillet other factors withstanding. The viable suggestion is that it might be economical to reallocate resources.

It should be noted, however, that the survey results has shown that land is scarce in the study area (see 1.2.6;4.2.1.1). In that case increased acreage, is not possible in the study area. The possible solution is to apply proper enterprise combination and proper farm management and planning such as improved farming practices) so as to increase productivity of the area.

The proceeding tabular and regression analysis has indicated that land, labour, capital, technology in use and cropping pattern and other factors do help to shape the TFs of Bereko. It has also been shown that land is the most important factor in determining the output levels of the area. Pricing has also been indicated as another factor which help to decide which crops to be grown. It remains important to see what will happen if some of these factors are changed as will be indicated by the LP analysis.

4.7 LP Analysis and Results

In normal situations, farmers will tend to produce what they think is profitable to them. As such the limited resources are distributed to those crops most preferred before turning to other crops. Hence the rationalization of these resources for optimal production becomes a problem to be considered.

The aim of the LP analysis was to find out what will happen to the TFS if some changes were effected on factors identified by the regression analysis that is land, capital and technological change. A linear programming analysis has been used on one of the common crop mix in the study area as shown in appendix C (i.e. maize, sorghum, peas, and fingermillet); and taking monocropping as the dominant cropping pattern as explained in section 4.2.2.

A basic LP model which closely reproduces the TFS was first built and its results analysed. The activities, constraints, and coefficients are explained in Chapter III and the tableau is shown in table 4.20.a

The second model tested the effect of changes in technology. Assuming other factors do not change, the model tests what will happen if the system adopted an improved technology. This is a technological package that has a high chance of being adopted by Bereko farmers and comprises of an improved husbandry (through ridging, use of ox-plough or tractor, weeding twice, planting in rows rather than broadcasting) and use of improved seeds. This technological package will lead to increased demand for labour (table 4.13a and 4.13b) in table 4.20b. The tableau is shown in table 4.20b. In constructing this model the yield levels obtained from district authorities (DADO - Kondoa) are used. Prices of inputs used are shown in table 4.21.

Table 4.20a Bereko Division: Basic LP Model of the Traditional Farming Practice

Constraints	Row.	Constraint	Sign	Production Activities				Consumption Activities				Selling activities		
Column No.	No.	level (0)		Maize (1)	Sorghum (2)	F/Millet (3)	Peas (4)	Maize (5)	Sorghum (6)	Peas (7)	Maize (8)	Sorghum (9)	F/Mill (10)	Peas (11)
Objective Function	(0)			-1900	-1100	-1300	-1700	0	0	0	9.00	6.60	37.50	21.00
Available land	(1)	Ha 5.9	≥	1	1	1	1							
Labour Jan	(2)	md 55	≥	8	8	8	8							
Feb	(3)	75	≥	9	10	9	8							
Mar.	(4)	60	≥	12	10	13	0							
Apr.	(5)	75	≥	10	7	6	0							
May	(6)	125	≥	0	0	1	0							
Jun	(7)	125	≥	0	0	0	0							
Jul	(8)	130	≥	5	15	20	6							
Aug	(9)	125	≥	8	5	6	13							
Sep	(10)	125	≥	3	3	4	3							
Oct.	(11)	115	≥	3	3	3	2							
Nov	(12)	105	≥	3	3	7	7							
Dec.	(13)	75	≥	10	10	13	7							
Available capital	(14)	Tshs.8500	≥	1900	1100	1300	1700							
Yields per ha														
of maize	(15)	Kg. 0	≥	-110				1			1			
Sorghum	(16)	0	≥		-800				1			1		
F/Millet	(17)	0	≥			-900							1	
Peas	(18)	0	≥				-1500			1				1
Nutrient levels														
from maize	(19)	kg 1338.3	=					1						
Sorghum	(20	669.2	=						1					
Peas	(21)	140.5	=							1				

Table 4.20(b) Bereko Division Basic LP Model of the improved farming practice

Constraints colum no.	Row No.	Constraint level (0)	sign	Production activities: Maize (1)	Production activities: Sorghum (2)	Production activities: F/Millet (3)	Production activities: Peas (4)	Consumption activities: Maize (5)	Consumption activities: Sorghum (6)	Consumption activities: Peas (7)	Maize (8)	Selling activities: Sorghum (9)	Selling activities: F/Millet (10)	Selling activities: Peas (11)
Objective Function	(0)			-13272.5	-9785	-8095	-7875	0	0	0	9.00	6.60	37.50	21.00
Available Land	(1)	Ha. 5.9	≥	1	1	1	1							
Labour Jan	(2)	md 55	≥	14	14	16	-12							
Feb	(3)	75	≥	13	13	18	13							
Mar.	(4)	60	≥	15	15	13	8							
Apr.	(5)	75	≥	13	15	5	6							
May	(6)	125	≥	0	0	0	0							
Jun.	(7)	125	≥	0	0	0	0							
Jul.	(8)	130	≥	5	10	18	0							
Aug.	(9)	125	≥	7	3	6	8							
Sep.	(10)	125	≥	3	2	3	5							
Oct.	(11)	115	≥	2	2	2	3							
Nov.	(12)	105	≥	1	2	1	2							
Dec.	(13)	75	≥	3	3	10	5							
Available capital	(14)	Tshs.35000	≥	-13272.5	9785	8095	7875							
Yields per ha of														
maize	(15)	kg 0	≥	-3900				1						
Sorghum	(16)	0	≥		-2500						1			
F/Millet	(17)	0	≥			-1800			1			1		
Peas	(18)	0	≥				-2000			1			1	
Nutrient level														
from Maize	(19)	kg.1338.3	=					1						
Sorghum	(20)	669.2	=						1					
Peas	(21)	140.5	=							1				

The third test concerns price changes. Since maize is the only crop with controlled price in the region and most preferred crop, a stepwise change in prices was tested starting with the controlled price of Tshs. 9.00 as in the basic model.

The fourth model tested the effect of institutional changes in the form of access to credit facilities. The last plan tested the combined effect whereby all the above changes were put together (viz improved technology, incentive prices and credit facilities).

4.7.1 Results from Model 1 (The Basic LP Model) for Bereko Division

In this basic model which reproduces main features of the existing farming system, official farmgate prices for maize and sorghum were used while parallel prices for fingermillet were used and average prices between official prices and parallel prices were adopted for peas. This is in conformity with table 4.8 and 4.9. The average farm size was calculated to be 5.9 ha for the four crops (maize, fingermillet, sorghum and peas) as table 4.4 shows.

The LP problem was solved using LP - WYE computer package and results of basic LP model gives a gross margin (GM) of Tshs.113 692. The optimal plan incorporates 2.85 ha of fingermillet; 1.22 ha of maize, 0.8 ha of sorghum; and 0.92 ha of peas. The plan also suggests that 2563 kg of fingermillet and 1240 kg of peas be sold. The level of consumption is restricted at 13338.3 kg for maize; 669.2 kg for sorghum; and 140.5 kg for peas.

Since household food security is of high priority, the LP model incorporates an allowance for food for the family. The plan reveals that only that level of maize, sorghum, and peas required for subsistence should be grown. In order for maize and sorghum to be produced above subsistence requirements prices should rise to at least Tshs.40.11 and Tshs.34.77 respectively.

Two resources - March labour and capital have been shown as limiting with a Marginal Value Product (MVP) of Tshs 743 and Tshs 17.5 respectively. Land has been almost exhausted by the plan because 0.91 ha only are remaining. This implies that increased output cannot be expected from increased acreage. Again the plan reveals that although March labour and capital are limiting their upper limits are 64.3 md for March labour and Tshs 8631.88 for capital otherwise land resource will be binding. This implies that increased output cannot be expected from increase in acreage alone; and therefore, leads to the question of technological change as tested in model 2.

4.7.2 Results from LP model 2 for Bereko division: Improved farming practice

The improved farming practice hold land constant in the study area and tries to increase productivity and output per ha. In this model the most probable technological package was tested. This is a package ich can easily be adopted by Bereko farmers and involves improved husbandry (through ridging, use of ox-plough or tractor, weeding twice, planting in rows rather than broadcasting and timely harvest); and use of improved seeds. In constructing the model the yield levels obtained from the district authorities (DADO) - Kondoa) for the package were used as shown in table 4.10 However, the researcher has a strong feeling that yield levels for maize and sorghum have been a bit exaggerated and proposes for double the levels obtained through TFS as the reasonable levels (i.e 2200 kg for maize, and 1600 kg for sorghum). All the same, unless explained otherwise, yield levels recommended by the district are used for all models. Prices of inputs used are shown in table 14.21. The implication of this plan is that more labour is demanded to perform the planned jobs. Also extra funds/capital is required to pay for the inputs (improved seeds, ox-plough or tractor hire, labour hiring and other costs). In this model two scenarios were tested. Scenario 1 used the district recommended yield levels while scenario 2 used researcher recommended levels i.e. 2200 kg for maize and 1600 kg for sorghum instead of 3900 kg and 2500 kg respectively. Yield levels for fingermillet and peas were as recommended by the district authorities. Results from LP plan 2 scenario one gives a GM of Tshs 161 597. This amount is higher compared to that indicated by the basic model of Tshs 113 692 (see table 4.23). This implies that with an improvement in technology GM rises from Tshs 113 692 to Tshs 161 597 an increase of Tshs 47 905 which is an increase of 42%

The plan incorporates 2.85 ha of fingermillet (the same as in the basic plan -table 4.23: 0.34 ha of maize; 0.27 ha of sorghum: and 0.07 ha of peas. All GM is accrued from the sale of 5131 kg of fingermillet. As in the basic plan consumption levels remain as recommended. The binding constraint is January labour with a MVP of Tshs 3713. This is expected since more labour is needed to perform the added job when increased productivity and output is to be achieved. On the other hand, land, capital and labour (except January labour) are not exhausted by the optimal plan.

The results indicate, therefore, that with an improved technology output is increased and hence GM is also increased. However the plan indicate that in order to produce maize beyond subsistence needs prices should rise to at least Tshs 16.80 otherwise farmers are advised to grow maize at the level enough for subsistence only.

Results from scenario two shows little difference to that of scenario one. GM goes down to Tshs 134996 from Tshs 161 597 while amount of land allocated to fingermillet goes down to 2.49 ha from 2.85 ha: maize 0.61 ha: sorghum 0.42 ha, and peas 0.07 ha. (compared to 0.34 ha for maize: 0.27 ha for sorghum and 0.07 ha for peas). Apart from these small changes the results in scenario two show that with improved technology (output levels withstanding), GM increase as compared to the TFS.

Table 4.21 Recommended prices of inputs by DADO - Kondoa 1988:

Input	Price/kg Tshs.	kg/ha
Maize seeds		
. ICW	64.00	25
. Staha C.while	64.00	25
. *Katumani	85.50	25
Sorghum seeds		
. Lulu)		
. Serena)		
. Bulrush millet)	5.00	30
.Others)		
Finger millet	n.a	30
Beans	n.a	25
Peas	n.a	20
Sunflower	12.00	15
Castor seeds	6.00	20
Fertilisers		
. NPK 6:20:8	11.00	300
. CAN 26%	9.00	300
. TSP	11.00	125
Insecticides		
. Actelic	100.00	10

Source: DADO - Kondoa (1988)

*Recommended type for Kondoa district
n.a not available.

Table 4.22 Bereko division: Realised total GMs for different LP Plans

Type of Farming Practice	Remarks	Realised GM Tshs
1. Traditional Farming Practice	Basic plan of the existing farming system	[illegible]
2. Improved Farming Practice	Increased output levels Increased overhead costs Price of Maize at 9.00 per kg	161,597
3. Traditional Farming Practice	Basic plant with price of maize raised to Tshs 40.12	[illegible]
4. Traditional Farming Practice	Basic plan with price of maize raised to Tshs 47.00	[illegible]
5. Traditional Farming Practice	Basic plan with price of maize raised to Tshs 45.00	124,603
6. Traditional Farming Practice	Basic Plan including hired labour and credit with price of maize at 9.00	117,731
7. Traditional Farming Practice	Basic plan including hired labour and credit with price of maize at 4012	154,000
8. Improved farming	Price of maize at 9.00 with hired labour	189,903
9. Improved Farming Practice	Price of maize at 9.00 with hired labour and credit facilities	209,303
10. Combined plan	Improved technology with incentive prices and including hiring of labour and credit facilities	212,109

Source: Survey results (1988).

4.7.3 Results from LP Model 3 for Bereko division. TFS with an increase in prices of maize

In order to test the effect of price changes three scenarios were tested. The results from the basic LP model indicated that the optimal plan would remain constant as long as price of maize remained below Tshs.40.11 per kg. Scenario one, therefore, tests what will happen when price of maize is raised to Tshs 40.12 per kg.

Results from scenario one shows that the GM rises from Tshs 113 682 to Tshs 113 707 an increase of Tshs 15.00. The plan also shows that maize now takes the biggest share of land as 3.22 ha are allocated to maize while fingermillet is allocated 0.99 ha: sorghum 0.84 ha; and peas 0.09 ha. In order to get the above GM, 2208.6 kg of maize and 895.9 kg of fingermillet should be sold. Sorghum and peas are not to be grown for sale unless prices rise to Tshs 34.80 and Tshs 21.00 respectively. March labour and capital are the two binding resources with MVP of Tshs 742 and Tshs 17.5 respectively.

Scenario two tested the effect of raising the price of maize to Tshs 47.00 per kg. This is because scenario one indicated that GM would not change as far as price of maize remained between Tshs 40.11 and 44.84. The results of scenario two indicate that GM will rise to Tshs 130 519. This level will remain unchanged so long as price of maize remain above Tshs 44.84. No upper limit is set for this GM. In scenario three the price of maize was reduced from Tshs 47.00 per kg to Tshs 45.00. This resulted in the reduction of GM from Tshs 130 159 to Tshs 124 003. Again no upper limit is set for this plan.

The results indicated that the price of maize can be set anywhere above Tshs 44.80 in the TFS and for a unit increase in price GN will rise accordingly. However, as price of maize is increased more land is needed for maize production while capital and March labour become limiting. For example the MVP for capital when price of maize is raised to Tshs 40.12 is Tshs 17.50 and rises to Tshs 25.05 and Tshs 26.20 when price of maize goes up to Tshs 45.00 and Tshs 47.00 respectively (see table 4.24). This result implies that as higher prices are set for maize more land is allocated to maize rise leading to increased demand for capital to pay the overhead costs. Alternatively the capital constraint could be solved by the provision of credit. However as credit required added cost in terms of interest payment a thorough study is needed before credit facilities are recommended.

4.7.4 Results from LP model 4 for Bereko Division: TFS with a provision of credit and hired labour

The tests above both for TFS and improved practice have indicated that January, March labour and capital are limiting. Model 4, therefore, tests the effect of incorporating credit facilities and hiring labour in the models. Two scenarios are tested. Scenario one incorporates credit and hired labour in the basic model. Scenario two tests the effect of raising price of maize to Tshs 40.12 per kg.

Table 4.23: Bereko division:Comparison between TFS and improved practice LP results

1.Type of farming Practice	T F S	Improved Practice
2.Total hectares available (ha	5.9	5.9
3.Gross Margin obtained (Tshs.)	11369	161397
4.Amount (ha.) allocated for		
. Maize	1.22	0.34
. sorghum	0.84	0.27
. Fingermillet	2.83	2.85
. Peas	0.92	0.70
5.Amount (kg)sold of		
. Maize	0.0	0.0
. Sorghum	0.0	0.0
. Fingermillet	2564	5131
. Peas	1240	0.0
6. Binding Resources (MVP)		
. January labour	0.0	3712.81
. March Labour	743.21	0.0
. Capital	17.53	0.0
. Land	0.0	0.0
7.Surplus Resources		
. Land	0.08	2.37
. January labour	8.49	0.0
. February "	22.68	14.84
. March "	0.0	13.22
. April "	39.89	51.85
. May "	122.15	125.00
. June "	125.00	125.00
. July "	48.87	74.30
. August "	82.03	104.13
. September "	104.684	114.53
. October "	97.24	107.87
. November "	72.46	101.13
. December "	10.99	44.31
. Capital "	0.0	4199.58

Source: Survey data (1988)

Results from scenario one indicates that GM goes up from Tshs 113 692 to Tshs 117732. The plan also raises hectares under fingermillet from 2.85 ha in the basic plan to 3.75 ha. The level of maize, sorghum and peas remain the same as in the basic plan (i.e. at 1.22 ha, 0.84 ha. and 0.92 ha respectively). The plan also allows the hiring of March labour at the level of 11.76 md. Credit facilities accommodated by the optimal plan is Tshs 337.39. Maize is included for sale only when price per kg rises to Tshs 31.33. Land is now the most binding resource with a MVP of Tshs 31 244.88.

The results indicated that credit will help raise GM because the funds will be used to hire more labour which was constraining. However, land becomes a limiting resource for more production.

Table 4.24: Bereko division: Comparison of LP Results among different price levels of maize

		Tshs/kg	Tshs/kg	Tshs/kg	Tshs/kg
Price level		9.00	40.12	45.00	47.00
Total hectares available		5.9	5.9	5.9	5.9
Gross margin obtained (Tshs)		113692	113707	124603	1130519
Amount of hectares allocated for					
.Maize		1.22	3.22	3.91	3.91
. Sorghum		0.84	0.84	0.84	0.84
. Fingermillet		2.85	0.99	0.0	0.0
. Peas		0.92	0.09	0.09	0.09
Amount (kg) sold of					
. Maize		0.0	2208	2958	2958
. Sorghum		0.0	0.0	0.0	0.0
. Fingermillet		2564	896	0.0	0.0
. Peas		1240	0.0	0.0	0.0
Binding resource (MVP)					
. January	Labour	0.0	0.0	0.0	0.0
. March	"	743.21	742.13	0.0	0.0
. Capital		17.50	17.54	25.10	26.21
. Land		0.0	0.0	0.0	0.0

Source: Survey results (1988).

Similar results are obtained from scenario two where price of maize is raised to Tshs 40.12 per kg. Maximum level of GM goes up to Tshs 154 005 from 113 707. The optimal plan incorporates 0.0 ha of fingermillet, 4.97 ha of maize, 0.84 ha of sorghum. and 0.09 ha of peas. The plan allows March labour hiring to the level of 8.0 md and credit facilities to the level of Tshs 2408.21.

The results, again, imply that credit facilities will increase GM but land is the binding resource with a MVP of Tshs 40909.30.

4.7.5 Results from LP Model 5 for Bereko division: Improved Farming Practice with a provision of Credit and Hired Labour

Plan 2 (improved technology) has shown that January labour was limiting. To test the effect of including labour hiring in the model, an activity allowing hiring of labour was included in model 2. This resulted to an increase of GM from Tshs 161597 to Tshs 189367 (i.e. an increase of Tshs 27770 or 17.2%). Hectares of fingermillet were increased from 2.85 ha to 3.32 ha while hectares for maize remained at 0.34 ha, sorghum at 0.27 ha and peas at 0.07 ha. Again fingermillet sold increased from 5130.6 kg to 5983 kg while hiring of labour is allowed up to 7.8 md. Capital is now the limiting resource. This shows that with capital resource not limiting, hiring of extra labour will help the smallholder farmers increase their incomes.

Since capital has been identified as limiting, another model was run incorporating credit facilities apart from labour hiring. The result was that GM increased from Tshs 189367 to 209003 an increase of 10.4%. Hectares under fingermillet also increased from 3.32 ha to 3.68 ha and fingermillet sold also increased to 6614.6 kg from 5933 kg. Labour hiring was allowed up to 13.2 md and credit facilities up to the level of Tshs 3110.70.

The above tests show that with credit facilities more labour could be hired and hence increase incomes to the farmers although at some levels other resources (especially land) become limiting.

The above test were performed on one change at a time. There is need to see the effect of incorporating all changes together as shown in model 6 below.

4.7.6 Results from LP Model 6 for Bereko division: Combined effect of improved technology, incentive price, credit facilities, and hiring of labour

The aim of this test was to see the total effect when all changes were combined-namely improved technology, incentive price (of Tshs 16.80 as indicated by the improved technology plan of model 2), credit facilities, and labour hiring.

The results show that maximum GM goes up to Tshs 212109 Tshs 113692 in the TFS or from Tshs 161597 in the improved technology. Most of the land is allocated to fingermillet production (3.35 ha). This implies that GM is accrued from sale of fingermillet. Credit is allowed in the plan at the level of Tshs 647650 and labour hire at the level of 27.58 md. Land is not exhausted by the optimal plan.

The results again show that credit facilities will help employ more labour and hence increase income.

4.7.7 Remarks on the LP results

Given the hypothesis postulated previously that Smallholder agricultural output and productivity and hence income cannot be changed through changes in production technology, institutional and policy reforms the results suggest that there is a possibility of increasing agricultural output and productivity and hence income by effecting some changes in technology, and other institutional factors. By applying improved technology GM rises and by effecting changes in output prices GM also rises. Credit facilities have also got a positive effect on incomes. The results, therefore, suggest that with some reforms on the TFS in Bereko division, there will occur changes on the output and incomes positively or negatively.

4.8 Summary of The Chapter

Tabular analysis has shown that factors shaping the Bereko TFS include land (availability, fertility, use etc); labour, capital, technology in use and cropping pattern and other institutional factors like pricing.

Regression analysis indicated that land is the most important single factor which is important in explaining the output of crops in the area. Others are labour and capital and cropping pattern. Based on R square, variables in this analysis explain less than 50% of the variations in output. However although t-test has shown that individually the explanatory variables do not affect output (dependent variable) significantly, the F - test suggests that jointly the independent variables do affect the dependent variable significantly.

LP analysis has indicated that the improved farming practice and higher prices affect net revenue positively, the LP results suggests that proper farm management and planning is needed in the area. The proper farm management envisaged here includes comprehensive farm plans for every farmer, proper information (especially data on prices, farming activities, marketing etc). Due to present policy of villagization farmers may need to be advised on allocation and utilization of their limited resources such as land (in the case of the study area).

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Purpose

The purpose of this study was to examine the TFS in Bereko division so as to study the economics of resource use in the division. In pursuit of the general purpose, the following specific objectives were set: (a) to identify the various physical, technological and policy factors that shape the TFS of Bereko division; (b) to determine the likely adjustments of the system given some changes in factors identified in (a); and (c) to make recommendations on transformation possibilities to improve agricultural productivity. The objectives were achieved by evaluating the extent to which the hypotheses presented hold. Data for the evaluation were obtained from a farm survey conducted among smallholder farmers in Bereko division. The farm survey data were supplemented by secondary information from RDD, RADO, CRCU in Dodoma.

A typical cropping pattern (crop mix) reflecting a typical smallholder farmer of Bereko was used to construct the LP models used for analysis. For the regression models a weighted total output (using prices as index) was used to estimate the regression equation against the major resource inputs of land, labour and capital. Two individual crops (maize and fingermillet) were estimated separately to allow better discussion and analysis of the system.

The theory and justification for selecting regression and LP as appropriate techniques have been presented in chapter three.

5.1.2 Findings

Several principal findings emerged from the analyses in relation to hypotheses designed to adhere the objectives of the study.

Through tabular analysis and descriptive statistics the results have shown that the Bereko farmers are smallscale (smallholder) farmers with an average farm size of 7.0 ha and 6.8 persons per family. The lower limit and upper limit of the farms are 4.7 ha and 9.1 ha respectively (appendix A). It has also been shown that on the average about 36.4 per cent of total land is under cultivation whereby the cropped area is about 85 per cent of the cultivated land. About 78 percent of total cropped area is under monocrop, 13 percent under intercrop and 9.0 per cent under mixed crops. Maize is the dominant and most preferred crop and occupies 64.0 per cent of the total cropped area while fingermillet is the dominant cash crop and occupies 11.4 per cent of total cropped area. The two crops (maize and fingermillet) are labour intensive although sorghum also requires a higher amount of labour.

The mostly used technology in land preparation is ox-plough while hand-hoe is the common technology in weeding and gardening. Population density is 82 persons per km2 i.e 0.4 ha of arable land per head. An average farm family for the sampled area has about 6.8 persons, 74 per cent of them being adults with 3.45 males and 3.35 females. This implies that the number of workers comes to about 5 per farm family or 2.2 persons per ha.

Average rainfall is 740 mm per annum with average rainy days of 57 per annum.

The gross output of the average farm in TFS is Tshs 62233.9 with total VC of Tshs 6000, gross margin of Tshs 56233.9. The net income can be calculated at Tshs 51133.9 (Appendix B2). The net income equals Tshs 937.2 per family member as compared to the minimum wage of Tshs 1440.5 per month.

Fertiliser, insecticides and improved seed are hardly used in the division.

Further results show that land and labour are the main factors of production in the study area. Land preparation and weeding are the more labour intensive operations while sowing is the least labour intensive operation.

Assuming 263 workdays in a year one worker is working for 181 days which means 31 per cent of his capacity is not properly utilised.

Regression results have shown that a positive relationship, though not significant, exists between output and these factors/resources land, labour and capital. While technology tends to shift the production function to the right (down), cropping pattern shifts it to the left (up). As regards returns to scale, Bereko farmers are producing where decreasing returns to scale are exhibited hence producing economically. Although individually the explanatory variables have no significant effect on output, jointly they have a significant effect on output. However, over 50 per cent of the variations in output are not explained by the explanatory variables.

The LP models used for analysis showed that the proposed improved farming practice in Bereko produced higher net revenue than the TFS. The results have also shown that incentive prices and credit facilities will help raise incomes of the smallholder farmers of Bereko considerably. Abundant surplus labour is also realised almost throughout the year. There is possibility of increasing net revenue in both the TFS and the improved farming practice through effective policy changes.

5.2 Recommendations

5.2.1 Pricing System: There is need to identify proper means of setting output prices because the controlled farmgate prices have forced farmers to resort to parallel market which means that public institutions like CRCU can hardly compete effectively in the marketing system.

5.2.2 Credit facilities: Credit facilities should be made available to farmers so that they can employ more of the limiting resources whenever capital becomes scarce. This will help farmers to increase their incomes. Since most farmers are not aware of the credit facilities, proper means should be encouraged to educate the farmers about it. Extension staff should be used for the purpose.

5.2.3 Off-farm activities: The government should encourage the establishment of small-scale industries in the rural areas where excess labour could be utilised. The Party's (CCM) programme of "Ushirika wa Uzalishaji Mali Vijijini" (Village Production Co-operatives) should also be encouraged. This is so because analysis has shown that there is abundant underutilised labour in Bereko division.

5.2.4 Other recommendations

<u>Farming practices:</u> Farmers and administrators should keep data on farming activities. The information can be used to:-

(a) build farm data bank in the villages and village managers can be used effectively for the purpose:

(b) secure assistance from government or other institutions like banks;

(c) deal with farmers who lag behind in improving their living standards/conditions;

(d) determine strategies when it is required in the village.

5.3 Limitations of the Study and suggestions for Further Studies

First. Limited data were available during the farm survey to the extent of necessitating the use of supplementary data from village governments, DADO etc - which in most cases do not reflect the true situation of Bereko farmers.

Second. The study included only crop enterprises. There is need to integrate livestock and crops.

Third. The study looked at improvement of technology without incorporating a study on the economics of commercial production in the whole. Improvement of technology can lead to increased output of crops (cereals) above the domestic needs which implies excess food should be sold outside. There is need to look into transportation, storage, and the economics of production as a whole. A study should be done to look at the matter in depth.

Fourth. Labour resource. A permanent source of labour comes from family labour which includes relatives. During peak labour demands such as land preparation and weeding (as the case with improved practice), most farmers do seek help from relatives or neighbours who work communally with local brew, lunch/dinner as payment. This poses a problem when it comes to valuing this labour as a cost of production. It is always not possible for farmers to recall exactly what cost was incurred in the form of local brew: lunch/dinner. The supply and demand of labour in traditional agriculture is also affected by rainfall. season of the year, public holidays and leisure preference. This seasonality of labour is very important when it comes to effective labour available for formwork. Other limitations as regards labour include homogeneity of labour. The assumption that labour is homogenous in respect to duration of work and labour efficiency cannot be taken strictly as true. Some jobs have not been properly investigated such as collection of water, firewood, building and repairs. These do affect available farm labour on one hand and do provide facilities and amenities critical to family life and welfare. These factors need consideration in further studies.

However, the data is believed to have produced viable source of information on smallholder production practices in Bereko division for use to planners and other policy makers in making proper decisions. Despite the problems of inadequate data and limitations of the study presented above, the information obtained from the regression and LP exercises is believed to be representation of the situation in Bereko division. The analytical models used are flexible enough to be modified or used as they are to suit other geographical locations with similar agricultural environment. The models offer good guide to policy makers in managing the limited resources in order to increase overall agricultural production.

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APPENDIX A1

Bereko division: Frequency distribution of farm sizes for group B farmers[1]

Class Internal ha	Central value x_i	x_i^2	f_i	Frequency $f_i x_i$	$f_i x_i^2$
0.5 - 3.5	2	4.0	35	70	140
3.5 - 6.5	5	25.0	28	140	700
6.5 - 9.5	8	64.0	26	208	1664
9.5 - 12.5	11	121.0	9	99	1089
12.5 - 15.5	14	196.0	2	28	392
15.5 - 18.5	17	289.0	2	34	578
18.5 - 21.5	20	400.0	2	40	800
21.5 - 24.5	23	529.0	2	46	1058
24.5 - 27.5	26	676.0	1	26	676
27.5 - 30.5	29	841.0	2	58	1682
Σ			109	749	8779

(i) Mean Farm Size $\bar{X}_i$ $= \dfrac{\Sigma f_i x_i}{\Sigma f_i} = \dfrac{749}{109} = 6.8715596$

(ii) Std Deviation S_i $= \sqrt{\dfrac{\Sigma f_i x_i^2}{\Sigma f_i} - \left[\dfrac{\Sigma f_i x_i}{\Sigma f_i}\right]^2}$

1 The farmers were divided into two groups. Group A comprised all farmers who had farms ≤ 30 ha and group B farmers with farms ≥ 30 ha.

$$\sqrt{\frac{8779}{109} - \left|\frac{749}{109}\right|^2}$$

$= 5.7726036$

(iii) Std Error $= \frac{\pm 2S_1}{\sqrt{n}}$ where $n = \Sigma f_i = 109$

SE_1

$= \frac{\pm 2S_1 \; X \; 5.7726036}{10.440306}$

$= \pm 1.1097895$

(iv) Confidence Interval of mean farm

$CI_1 = \bar{X}_1 \pm SE_{t.05}$ where to.05 $= 1.982$

At 95% probability level, the CI of the mean farm

is

$= \bar{X}_1 \pm 1.1097895(1.982)$

$= \bar{X}_1 \pm 2.1996027$

$= 6.8715596 \pm 2.2996027$

Therefore, it can asserted that with 95% CI that the farms in group A lie between 4.6719569 and 9.0711623 ha.

(iv) Confidence Interval of the mean farm

$CI_2 = \bar{X}_2 \pm SE_{t.05}$ where t.05 = 2.365

At 95% probability level, the CI of the mean farm is

$= \bar{X}_2 \pm 11.589694(2.365)$

$= 61.83 \pm 27.409626$

Therefore it can be asserted that with 95% CI that the farms in group B lie between 34.426374 and 89.239626 ha.

APPENDIX B1

Gross Output, gross margin and net income for representative farm model for Bereko division. Existing situation: 1977/88

Item	Unit	Maize	Sorghum	Beans	B/millet	Peas	Sunflower	Castor Seed	Total
		CROPS							
1. Farm Size	ha	4.48	0.54	0.29	0.08	0.35	0.20	0.01	7.0
.Cropped area	ha								
.Fallow area	ha								
2. Land use	(a)	4.48	0.54	0.29	0.08	0.35	0.20	0.01	7.0
3. Output									
.Total Pr.	kg	4928	432	348	720	525	120	7	
.Losses (30%)		1478	130	104	216	157.5	35	2	
.Net Prod.		3450	302	244	504	367.5	84	5	
.Farmgate Price	Tsh	31050	1993.2	5063.4	3326.4	4410	1157.6	8.15	49051.4
4. Gross Output	Tsh	31050	1993.2	6063.4	3326.4	4410	1167.6	40.8	49051.4
5. Variable Costs									
.Seeds	Tsh								
.Fertilizer	"								
.Insecticides	"								
.Maintanance /Repair	"	300	200	0	100	0	0	0	
.Field/Operations	"	1000	500	0	500	0	0	0	
.Packing/ Material	"	3000	300	200	500	300	0	0	
Sub Total	Tshs	4300	1000	200	1100	300	0	0	6900
6 .Gross Margin	Tshs	26750	1093.2	5863.4	226.4	4110	1167.6	40.8	41251.4

7. Overhead Cost	
.Depreciation (b) Tshs	4500
.Medicine (Oxen)	200
.Livestock levy	400
Sub total	5100
8. Net Income	36151.4

(a) To get 7.0 ha 0.33 should be added which are used for other (see table 4.4)

* Losses in the field, transportation, storage etc.

(b) Depreciation on ox-plough and oxen (6 years for oxen and 5 years for plough)

APPENDIX B2

Gross output and Gross Margin for Bereko division for the preferred crop mix and using existing prices.

Item	Unit	Crops				Total
		Maize	Sorghum	P/millet	Peas	
1. Farm Size	ha	3.89	0.57	0.90	0.54	5.9
. Cropped area	"					
. Fallow area	"					
2. Land Use	ha	3.89	0.57	[illegible]	[illegible]	[illegible]
3. Output						
.Total	kg	4279	456	810	810	
. Losses (30%)	kg	1283.7	136.8	243	243	
. Net Production	kg	2995.3	319.2	567	567	
. Farmgate Price	Tshs	9.0	6.6	37.5	21	
4. Gross Output	Tshs/kg	26957	2106.7	21262.5	11902	62233
5. Variable Costs						
.Maintanance	Tshs	300	300	300	300	
.Farm Operation	Tshs	800	500	500	400	
.Packing materials	Tshs	800	300	500	1000	
Sub Total	Tshs	1900	1100	1300	1700	6000
6. Gross Margin	Tshs	25057.7	1006.7	19962.5	10207	56233.9

APPENDIX C

Bereko division: Farm enterprise combination - 1987/88 season

Crop combination (mix)	No. of farmers	% of total	No. of ha	Average ha	Household members
1. Maize alone	18	15.3	57.1	3.2	3.1
2. Maize + Fingermillet	20	16.9	125.9	6.3	3.3
3. Maize + Fingermillet & Sorghum	13	11.0	67.2	5.2	3.5
4. Maize + Fingermillet & Sorghum & Peas	14	11.9	114.4	8.2	3.9
5. Maize + Peas	10	8.5	58.3	5.8	2.8
6. Maize & Sorghum	10	8.5	58.3	5.8	3.4
7. Maize + beans	3	2.5	37.2	12.4	4.0
8. Maize + Peas + beans	5	4.2	28.3	5.7	2.6
9. Maize + Peas + Fingermillet	7	5.9	40.5	5.8	3.3
10. Maize + Sorghum + Fingermillet Sunflower	5	4.2	34.4	6.9	4.0
11. Maize + Sorghum + Peas	1	0.8	8.1	8.1	5.0
12. Maize + Sorghum + beans	3	2.3	15.4	5.1	2.3
13. Maize + peas + sunflower	1	0.8	4.0	4.0	3.0
14. Others	8	6.8	73.4	9.2	4.3