AN ECONOMIC ANALYSIS OF THE SMALL-SCALE COFFEE-BANANA HOLDINGS IN MOSHI RURAL DISTRICT, TANZANIA.

BY

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This Thesis is my original work and has not been presented for a degree in any other University.

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ABSTRACT

This study was undertaken with the major objectives of assessing resource availability and resource use by small-scale farmers in Moshi rural district of Tanzania, with the view to identifying the critical constraints leading to low farm incomes in the area. In this respect, an attempt was made to find out whether the available resources could be re-allocated between alternative uses in order to maximize total farm gross margins.

A sample of 46 farms were surveyed from four villages in the district. The data were summarized and agregated to form a representative farm model for the area. The empirical analysis of the input-output data included gross margin calculations of the important farm enterprises, and linear programming analysis, under the existing and improved technologies.

The results of the survey showed that land was the most scarce resource. Farmers were also lacking important inputs and tools for most of their crop and livestock activities.

The empirical analysis indicated that under the existing technology, farmers in the district were efficiently utilizing the available farm resources and that there was little potential for increasing farm incomes through re-organization of the current farms set-up. However, under mixed and improved technology farmers could greatly improve their farm incomes through greater intensity in land use, improved methods of production, and raising productivity per unit area or animal. Under all technologies, excess labour supply was revealed to be available in most months of the year on the farms.

It was therefore, concluded and recommended that government in conjunction with other agricultural development institutions should strive to improve the quality and quantity of the extension staff. These institutions should also review the present heavy export tax on coffee in order to make the crop more profitable to farmers.

Research priority should be given to investigations on the coffee-banana inter-relationships as practiced by the small-scale farmers in the district.

The presence of excess labour supply on small-holder farms could also be profitably employed through establishment of small-scale industries in the villages.

CHAPTER I

INTRODUCTION

1.1 An Overview

The Tanzanian Government's objectives and policies towards rural development are well spelt out in the current Five year development plan, Tanzania (1976-81). Within the over-all strategy of improving the standard of living of people in the rural areas, the Government intends to achieve a target annual growth rate of 5.1 per cent in agricultural production by 1981. The methods stipulated in the plan for achieving this objective is to give agriculture a top priority in the Government's development expenditure. This sector will receive 22.32 per cent of all development expenditure, Tanzania (1976, p. 11); as compared to 5.9 per cent in the previous development plan. In the Government's view, the major constraints in the agricultural sector are: lack of proper production plans, inadequate investment finance, and high production costs caused by high prices for inputs.

Over 90 per cent of food and cash crops in the country are produced by small-scale farmers owning between 0.2 to 10 hectares of land, Tanzania, CBS (1972). In most developing countries, the major problems facing small-scale farmers is low productivity whether measured in yields per hectare, net income to farmers or rates of return on investments, Norman (1967, 1972) and De Boerf Welsch (1974). Many other authors and reports have given similar results. This study intends to contribute to the general question: "why is the productivity lower than one could expect?". The study will focus on the major constraints causing this general low performance. To eliminate severe environmental factors, this study will focus on Moshi Rural District, a district with very high agricultural potential, probably the highest potential in Tanzania mainland.

1.2 Background

1.2.1 Location

Moshi Rural District where this study was undertaken is one of the four Districts which comprise Kilimanjaro Region of Tanzania. Kilimanjaro Region is one of the eighteen Regions in Tanzania mainland. It is located in the Northern-Eastern part of the country and borders the Republic of Kenya to the north, Tanga Region to the south, and Arusha Region to the west. Moshi Rural District is located centrally in Kilimanjaro Region, on the southern slopes of Mt. Kilimanjaro. The District covers an area of 3083 square Kilometres which is 23 per cent of the Region's total area.

1.2.2 Rainfall and Altitude

The rainfall distribution pattern in the district can be divided into two major belts depending on altitude on the slopes of the mountain. The high potential Coffee-Bananas belt (altitude 1000-1800 metres), has an annual mean rainfall of 1663 millimetres, with a range of 1450-1850 millimetres, (Appendix A1.1). The second belt is the drier Maize/Beans belt (altitude 900-1000 metres), which has a mean annual rainfall of 852 millimetres with a range of 700-1000 millimetres (Appendices A1.2). In general, the combined altitude of the two belts varies from 900 metres to 1800 metres above sea-level. The Isohyets map (Appendix A1.3) indicates rainfall distribution throughout the District. Figure 1.1 shows that the district has a clear bimodal rainfall pattern with major rainfall peaks in the months of April and May (the long rains) and a second peak in the month of November (the short rains). The short rains are enough to grow a beans crop.

Figure 1.1 RAINFALL DISTRIBUTION
(COFFEE/BANANA BELT)
LYAMUNGU RESEARCH INSTITUTE

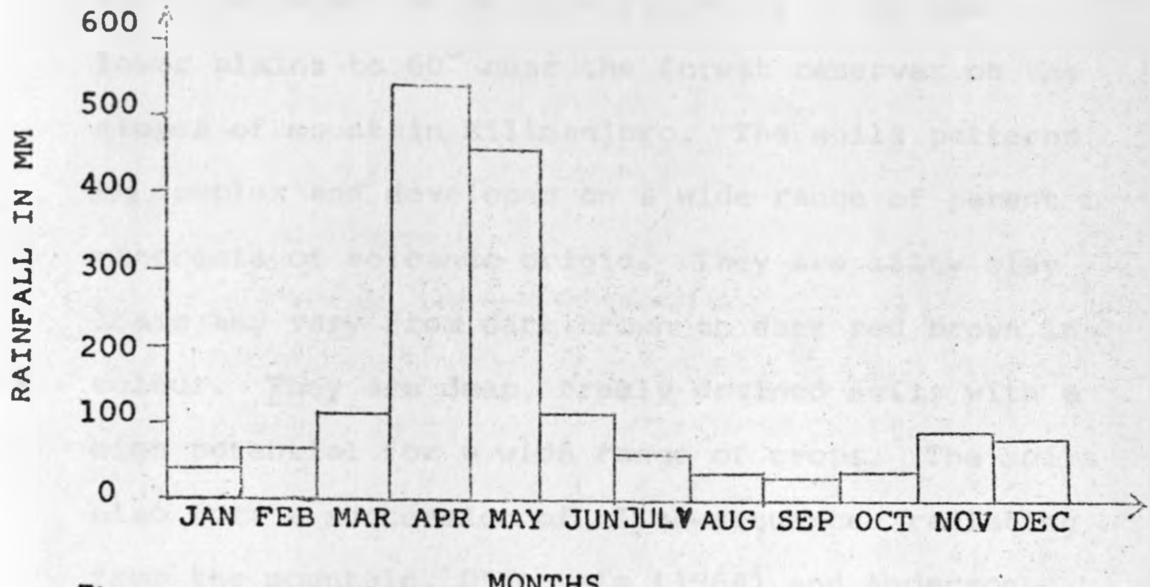
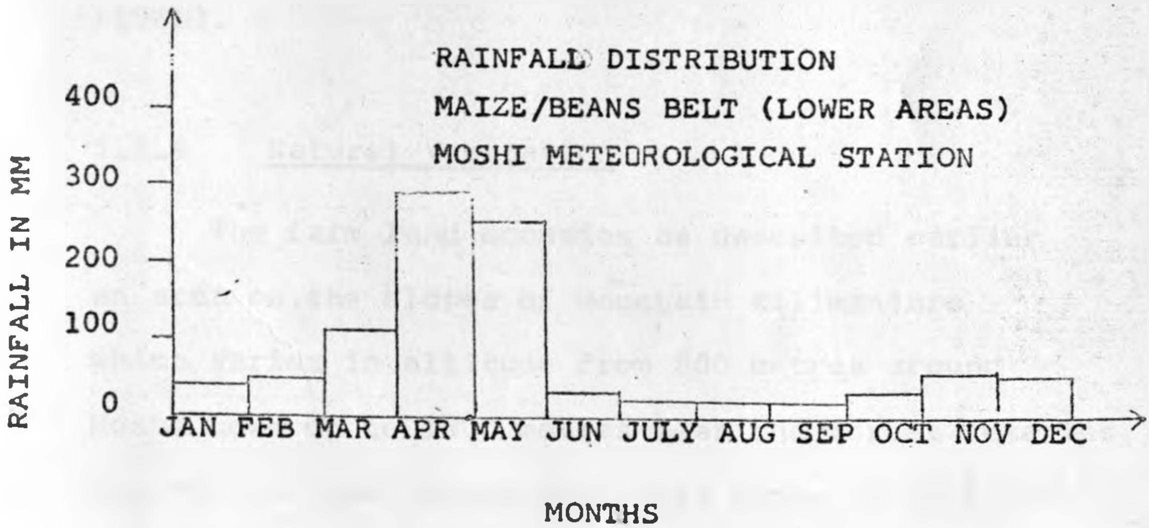


Figure 1.2



RAINFALL DISTRIBUTION
MAIZE/BEANS BELT (LOWER AREAS)
MOSHI METEOROLOGICAL STATION

1.2.3 Soils and Topography

The soils and topography of the district have been well described by Anderson (1968). Generally, the topography varies from slopes of 0^{o} in the lower plains to 60^{o} near the forest reserves on the slopes of mountain Kilimanjaro. The soils patterns are complex and developed on a wide range of parent materials of volcanic origin. They are silty clay loams and vary from dark brown to dark red brown in colour. They are deep, freely drained soils with a high potential for a wide range of crops. The soils also form a succession of climo-sequences radiating from the mountain, D'Hoore's (1964) and Anderson, (1968).

1.2.4 Natural Vegetation

The farm land occupies as described earlier an area on the slopes of mountain Kilimanjaro which varies in altitude from 800 metres around Moshi town up to 1800 metres near the forest reserves. The natural conditions over this range of altitude covers all vegetation segments from grasslands, scattered tree grasslands, woodlands, bushlands up to tropical rain forests (see Greenway, (1965)). However, due to the very intensive cultivation and growing of food and cash crops, the natural vegetation can hardly be found anymore in the district or even in Kilimanjaro region as a whole.

1.2.5 Demographic factors

The high potential Coffee-Bananas belt between altitudes of 1000 to 1500 metres is among the most densely populated areas in Tanzania mainland. It has a population density of about 600 persons per square kilometre. The 1967 population census shows a population growth rate for the district of 3.5 per cent per annum, (Table 1) as compared to a national average growth rate of 2.7 per cent per annum.

These simple figures do not show the real dynamics behind them. The 3.5% growth rate means that in a period of 20 years time, before the end of the century, the population in the district will have doubled. Such a situation is bound to bring tremendous pressure to the district as expansion to higher altitudes or to the lower drier plains is only possible on a limited scale. With already 600 persons per square kilometre, only maximum efforts can avaoid an "explosion".

1.2.6 The administrative system

The administrative history of the Chagga tribe which dominates the district has been described by Dundas (1924) and Stahl (1965). At the beginning

Table 1: POPULATION LEVELS AND RATES OF POPULATION GROWTH IN MOSHI DISTRICT

ITEM/YEAR	1948		1957		1967		1978
RECORDED POPULATION	POP.	GROWTH 1948-1957	POP.	GROWTH 1957-1967	POP.	GROWTH	ESTIMATED
KILIMANJARO REGION	353483	3.3%	473857	3.2%	652722	3.3%	3.7%
MOSHI DISTRICT	259648	3.4%	351255	3.7%	476223	3.2%	

Source: Tanzania. Ministry of Planning and Economic Affairs
Central Statistical Bureau
Dar-es-Salaam

NB: The above figures are bassed on a critical Review of Census Data by Demographers (Vol. 6. of Census Report). The rate of growth is natural increase only, there is no allowance for migration.

of the nineteenth century there were over 100 individual political units. By 1899 this number had been reduced to 37 and by 1961 to 15. The Chiefdoms under their hereditary chiefs remained the units of government on the mountain until 1962. The great change came in 1962 when the newly elected Kilimanjaro District Council absorbed the old Chagga council, abolished the hereditary chieftainship and became the single local authority. Further changes came in 1972 with the legislation of the Villages Registration Act, which set up elected village governments as the basis of the administrative system in the rural areas. The smallest administrative unit is the well known Tanzanian "ten cell unit" headed by an elected leader. These units are basically a political organization at "grass roots" level. In a village households are divided into groups of between 10 - 15 with one elected leader called a "Ten cell leader." These units facilitate the organization of self-help schemes and form the basis of party organization in the country. In farm management investigations, the units form an excellent sampling frame, also used for sampling and data collection in this study.

1.2.7 Infrastructure and Social Services

Moshi town which is the administrative centre for the district is situated on the lower slopes of the mountain. It is well connected to other parts of the country by a network of roads, railways, and an International airport. Radiating from the town to the villages is a number of feeder roads. Education is widely spread in the district and nearly all children are enrolled in primary schools. Health services include a network of hospitals, health centres and dispensaries. Medical care is a free service for all people. Generally, infrastructure and social services including a well organized banking service are quite adequate in the area as compared to other parts of the country.

1.2.8 Land Tenure System

Agriculture remains the major industry in the district with coffee production being the most important cash crop. Land ownership is still under the traditional customs of inheritance. There are no title deeds. We have to distinguish between two types of holdings owned by most families in the district.

(a) The "Kihamba" Land

This is a family holding found on the high potential highlands where permanent crops Coffee-Bananas are grown interplanted and permanent houses, both traditional and modern are built, (see figures 2 to 4). Livestock are also kept on the "Kihamba" land to supplement crops. One or two cattle (E.A. Zebu), few sheep and or goats are kept and stall-fed. Beck (1961) reported that an average size of a "Kihamba" plot per family was about 3.2 acres (1.3 hectares). This is contrary to the present survey results of 1.74 hectares (see chapter V).

(b) The "Shamba" land

To supplement the "Kahamba" plot families own a "Shamba" plot on the less potential drier lower areas of the mountain slopes.

Figure 2: Typical Coffee-Banana "Kihamba" holding with the two crops interplanted.

Figure 3: A Homestead on the "Kihamba" holding with "Chagga" traditional houses.

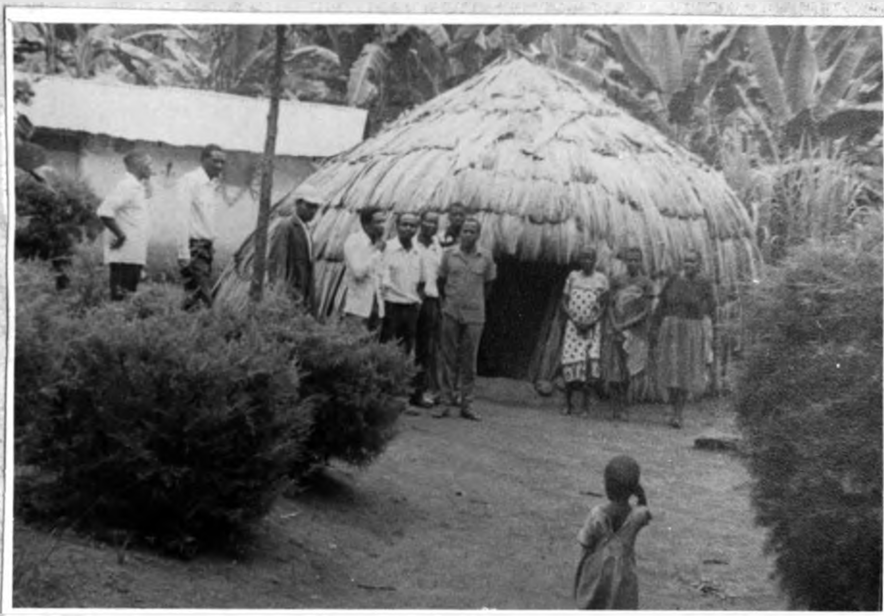


Figure 4: Modern permanent houses are also common on the "Kihamba" holdings instead of traditional houses.

This "shamba" holding is used in the long rains period (March - June) for growing annual crops mainly maize and beans. The plot also supplies grass as fodder for livestock. The average distance between the two types of holdings owned by a family could be up to 8 - 10 kilometres. Interested readers on Chagga land tenure system may refer to Hutchinson (1974).

1.3 The Agricultural Production System

The main crops in the area are coffee interplanted with bananas, maize and beans. Coffee was introduced by German missionaries at the beginning of this century. Real coffee expansion started after world war II, and since then, farmers have regarded coffee as an important enterprise in their farming system. Bananas and coffee are interplanted. The relationship between coffee and banana crops which are interplanted remains open to further research. The Coffee Research Station at Lyamungu, 20 kilometres from Moshi town, established in the early 1930s, has concentrated its research efforts on agronomy aspects of coffee production in pure stands. The important aspects of Coffee-Bananas intercropping on small-holder farms has received very little attention.

The few research reports in this direction by Mitchell (1963), Robinson (1961) and Menn (1967), show that bananas depress coffee potential yields due to competition for water and nutrients between the two crops. But this does not answer the question whether the total benefit of mixed cropping is not higher for the small-scale farmers, given the shortage of land in most of the small-holder farms. Theoretically it is thinkable that there is a level of interplanting where the small farmers maximize returns per unit of land avoiding also a too high risk. If a small-farmer has to have enough banana stools to satisfy subsistence requirements throughout the year, there is an urgent need for understanding the compromise level of Coffee-Banana mixtures on small farms before any prediction about coffee supply can be made.

It will be noted that yields per hectare for most crops on small-holder farms are low. For example coffee, as illustrated by table 2, shows that in small farms the coffee yields are only one third of the yields achieved on estates.

The data available for banana yields on small-farms are confusing and unreliable. The yields per hectare estimated by three studies in

Table 2: COFFEE PRODUCTION AND YIELDS IN KILOGRAMMES PER HECTARE ON SMALL-HOLDER FARMS AS COMPARED TO THOSE FROM ESTATES IN MOSHI RURAL DISTRICT (CLEAN COFFEE)

YEAR	SMALL-HOLDERS		COFFEE ESTATES	
	Total Prodn. (Tonnes)	Yield KG/Ha	Total Prodn. (Tonnes)	Yield KG/Ha
1966/67	8535	352	5282	1482
1967/68	8449	349	2403	674
1968/69	7804	322	5144	1443
1969/70	5626	232	2608	732
1970/71	5754	238	5847	1640
1971/72	11055	458	2967	832
1972/73	10818	447	4962	1392
1973/74	4420	183	2843	798
1974/75	10738	443	3587	1006
1975/76	12053	498	3770	1057

Source: Coffee Authority of Tanzania, <u>Work Plan for 1978/79</u> Moshi District Office.

NB: Coffee yields per hectare on small-farms are about 30% of the yields per hectare achieved on coffee estates.

the district, viz Sykes (1959), Beck (1961) and Bureau of Resource Assessment and Land Use Planning (BRALUP) (1969) differ by a very wide margin. These estimates range from 289 bunches per hectare per year to 1888 bunches, or 4 to 28 tons per hectare assuming an average weight of 15 kg per bunch. Unreliable as these figures are, the average yields are still comparable to those provided by Acland (1971) for pure banana stands in East Africa which range from 15-20 tons per hectare. He also estimates that given good husbandry, the yields are as high as 38-50 tons per hectare. As reported later in this survey, the banana yields per hectare average 9 tons.

Maize which is the second major food crop in the farming system is usually interplanted with other crops mainly beans. The estimated yields per hectare by the agricultural extension staff in the district is 14 bags (90 kg) per hectare as compared to potential yields of over 25 bags (90 kg) per hectare.

Livestock also plays an important role in the farming system. The livestock census carried out in 1978 (Table 3) indicates the number and types of livestock in the district.

Table 3: TYPE AND LIVESTOCK NUMBERS IN MOSHI RURAL DISTRICT.

TYPE	NUMBER
Cattle	90343
Goats	74721
Sheep	43334
Pigs	19575
Poultry	154049

Source: Tanzania, Ministry of Agriculture, Veterinary Department, Livestock Census, Moshi 1978.

The census indicated that the cattle population is composed of 25 per cent up graded dairy cattle, and 75 per cent local zebus kept in the coffee-banana belt of the district. Surveys done by Zalla (1972/73) indicated that 60 - 70 per cent of the coffee-banana small-holders owned cattle and 13 per cent of these were up graded breeds.

1.4 The Importance of the Coffee-Banana zone in the national economy

The coffee-banana zones includes among others, Arusha and Kilimanjaro regions in the northern parts of Tanzania. Tanzania's annual economic growth in real terms between 1971 - 1975 periods averaged 4.8 per cent per annum, Tanzania, (1976 p.5). During the same period monetary Gross Domestic Product grew at 4.5 per cent per annum, while subsistence Gross Domestic Product (i.e. non-monetary agriculture) grew at the rate of 3.5 per cent per annum. The importance of this zone lies in the fact that it is a major coffee producer in the country, and also a major banana producer which is a food crop. Over the last 14 years, coffee as a cash crop accounted for over 16 per cent of the country's export earnings, (Table 4). During the coffee boom periods of 1976 and 1977, coffee's contribution to the nation's export earnings rose to over 33 per cent and 40 per cent respectively. In terms of total coffee production, for the last 10 years, the small-holder farmers in Moshi District have contributed well over 10 per cent of the total national coffee output (see appendix A1.4).

Bananas on the other hand is an important food crop. It is consumed as a staple food for about 10 per cent of the total population in the country, Mbilinyi and Mascarenhas (1969). Banana as a fruit is also consumed while ripe by majority of the people in the country. Available figures both in the district and the nation are

Table 4: CONTRIBUTION OF COFFEE TO TANZANIA'S FOREIGN EXCHANGE EARNINGS.

(MILLIONS OF T. SHILLINGS).

(1) PERIOD	(2) TOTAL EXPORT RECEIPTS	(3) COFFEE EXPORT RECEIPTS	(4) (3) As A % OF (2)
1964	1506.5	221.0	14.66
1965	1358.6	171.8	12.64
1966	1797.1	302.7	16.84
1967	1715.8	238.8	13.91
1968	1628.1	265.1	16.28
1969	1652.1	257.1	15.56
1970	1649.5	312.2	18.92
1971	1711.4	227.4	13.28
1972	2179.5	383.0	17.58
1973	2410.8	495.3	20.54
1974	2643.2	375.1	14.19
1975	2589.3	483.0	18.65
1976	3852.9	1282.7	33.29
1977	4518.6	1857.2	41.10

Source: Tanzania, Bank of Tanzania, Economic Bulletin - Economic and Operations Report, June 1978, P. 77.

fairly inconsistent and differ from source to source in different ministries. The lack of reliable data on the crop is also caused by lack of a marketing organization for bananas. This problem is further aggravated by inadequate research both technical and economic on the banana crop. However, inspite of all these bottlenecks, Kilimanjaro area remains one of the major banana producing areas in the country. Besides being a staple food crop, bananas are used for brewing local beer "mbege" and also they form a source of cash income to the small-scale farmers. Mbilinyi and Mascarenhas (1969) showed that bananas from Kilimanjaro area are marketed by local traders in Dar-es-Salaam markets a distance of more than 600 kilometres away.

1.5 Framework of this study.

This introductory chapter has dwelt briefly on the physical and economic base of Moshi Rural District. The next two chapters will discuss the problems, objectives, and related literature review to this study. Chapter IV discusses research methodology employed and the theoretical base. The fifth and sixth chapters present the survey results and empirical analysis respectively. The last two chapters discuss the results and draw important conclusions and recommendations to policy.

CHAPTER II

THE PROBLEM AND OBJECTIVES OF THE STUDY

2.1 Problem formulation

From the introductory chapter, it is evident that Moshi Rural District has experienced two major problems which set a serious obstacle to growth in agricultural development. These are:

(a) High population pressure on land because of high population growth rates and limited land reserves leading to serious land shortages for further agricultural expansion.

(b) The crop yields on most of the small-scale farms are very low compared to those possible with improved practices, (table 5). For example, coffee yields on small farms are 25-50 per cent lower than the potential yields achieved on larger farms. Low outputs per unit of land are the main factors for low farm incomes and thus few (if any) farmers can accumulate savings to provide or increase their working capital to purchase seasonal farm inputs or equipment.

As yields are the main determinants for the economic performance in the farms, the question arises "what are the main causes responsible for this low

Table 5: AVERAGE YIELDS (TONNES PER HECTARE) OF CROPS ON SMALL-HOLDER FARMS - 4 YEARS AVERAGE 1974 - 78; COMPARED TO POTENTIAL YIELDS USING IMPROVED CROP HUSBANDRY PRACTICES.

CROP/CROP MIXTURES	OUTPUT UNDER EXISTING PRODUCTION METHODS (TONS/Ha.)		OUTPUT UNDER IMPROVED HUSBANDRY PRACTICES (PURE STANDS) (TONS/Ha.)	
COFFEE/BANANAS (INTERPLANTED)	COFFEE	0.35	COFFEE	1.2
	BANANAS	8-10	BANANAS	15-40
MAIZE/BEANS (INTERCROPPED)	MAIZE	0.75	MAIZE	2.7
	BEANS	0.58	BEANS	1.1
MAIZE/FINGERMILLETS (INTERPLANTED)	MAIZE	0.40		
	FINGERMILLETS	0.67	FINGERMILLETS	1.2

Source: Tanzania, Ministry of Agriculture Annual Reports, 1974 - 1978 Moshi District.

yields levels?" During the field work, extension officers questioned gave the following reasons:

(a) Inadequate use of fertilizers especially farm yard manure because of the work involved and expense in getting it to the farms.

(b) The crop husbandry is generally poor because of unorganized intercroppings, poor plant populations per unit of land, and inadequate soil conservation measures.

(c) Most of the coffee trees in the district are very old and unproductive due to improper husbandry.

(d) Lack of adequate control of crop pests and diseases particulary coffee berry disease (CBD) on coffee.

If these points are valid and no other constraints are given, then the main problem in this district during the next decade would be:

To improve with all possible efforts the crop and livestock husbandry simultaneously with an increase in the farming intensity.

However, small-scale farmers will only improve their methods of production, if the economic return is higher than the necessary efforts, and therefore a detailed analysis of the situation can help to find the right policy.

2.2 The objectives of the study

This study attempts to contribute to the understanding of the constraints facing the small-holders towards their efforts to raise agricultural production and hence standards of living. The study has been undertaken with the following broad objectives:

(a) To assess resource availability and resource use by small-scale farmers in Moshi district of Kilimanjaro region in Tanzania, and to identify the critical constraints forcing low farm incomes in the area.

(b) Attempt to find out whether the available resources on the farm viz: land, labour and working capital can be re-allocated between alternative uses to maximize total farm gross margins.

Within the above framework of objectives, an attempt will be made to answer the following three specific questions:

(a) Of what magnitude are the economic returns provided by the present enterprises?

(b) Are there specific enterprise inter-relationships that must be seriously considered?

(c) What economic inefficiencies, if any, in the allocation of farm resources suggest opportunities for increased farm incomes? Or in other words, are the farmers efficient but still poor?

2.3 The scope and limitations of the study

Kilimanjaro region is a large region spatially covering over 13,000 square kilometers. It is composed of four administrative districts, viz Rombo, Pare, Hai and Moshi districts respectively. In such a large area, the soils, rainfall, topography and types of crops grown differ in relation to climate. The highlands, high potential areas on the slopes of Kilimanjaro and Pare mountains specialize in the growing of coffee, bananas, vegetables, fruits and dairying. The drier and less potential lowland areas grow irrigated paddy, cotton, sorghum and maize. This study has been restricted to a sample of farmers in Moshi district only. It was not possible to cover all the coffee-bananas holders in all the four districts within the region due to limited resources, time and manpower. It is realized that such a complete study, covering the whole of Kilimanjaro region, would have been extremely useful to regional planners in formulating development plans. However, the data presented in the analysis was collected from a sample of four villages in Moshi rural district. It is hoped that this analysis as an example will indicate some general relationships which are valid in other districts and the region as a whole.

CHAPTER III

RELATED LITERATURE REVIEW

3.1 Farm management investigations on peasant farms in Tanzania.

The position as regards economics research on peasant farms in Tanzania is probably well summarised by the comments made by Livingstone (1971) when he said:

> Recent examination of annual reports of various Government research stations in Tanzania show that virtually no work is being done on crucial aspects such as farming systems, crop economics, rates of return on different crops, marketing bottlenecks and problems -------, and agricultural projects are not researched into integrated development schemes.
>
> Livingstone (1971, p. 1).

The earliest investigations on the economics of peasant agriculture in the country were undertaken through the cooperation of the ministry of agriculture and the then Tanganyika unit of the then East African Statistical Bureau in 1950. It was a joint survey in several districts. The data collected for the first time were on details of acreages, and yields of main crops grown and either sold or consumed by the African population, Brass (1957). The next effort in the second part of the 1950s tried to improve agricultural statistics through a series of pilot surveys. Three districts were chosen and one crop was examined in each district.

The first economic survey involving the collection of data geared to the development of farming systems was attempted by Beck (1960 - 61) on the slopes of mountain Kilimanjaro. His survey was an attempt to describe the existing farming system in the area, rather than a planning exercise for small-holder farm improvements. The survey was later followed by a series of Farm Management surveys carried out by a number of academic researchers in different parts of the country, Ruthenburg (1968). These academicians collected farm management data for ten case studies and made analyses using production functions.

Studies aimed at planning for peasant farm improvements in the country were pioneered by Collinson, (1962 - 65). He conducted a series of surveys in Sukumaland in Western Tanzania. The major interest in these investigations was to improve the quality of the extension advice over a wide area. He attempted to identify production constraints, gathering input/output data for the construction of simple farm models and formulating criteria for farmer's ability to use advice and credit. Programme planning analytical techniques were used on the data. His work was an excellent example of a well integrated approach to peasant farm improvements, using research station and peasant farm survey data, and forms the only example in the country of an attempt to improve general extension advice through farm management investigation techniques.

Feldman (1969) went a step further and applied a modified linear programming (separable programming) analytical approach when he was investigating scale effects on tobacco production on peasant farms in Iringa district of Tanzania. Both studies by Collinson and Feldman provided quantitative analyses on peasant agriculture farming systems.

A series of farm management studies carried out later have mainly concentrated on single enterprise approach to small-holder agricultural problems, for example Westergaard, (1968), Mbilinyi (1968) and many others. Additionally a number of theses and special projects carried by students and staff at the Faculty of Agriculture

Morogoro have provided extremely good information on various aspects. However, the main emphasis has been put on single enterprises, neglecting the factors forcing the peasants to run the present farming systems with a wide range of intercroppings and enterprise diversifications.

The present study is intended to follow a systems approach using Linear Programming as a tool in the economic analysis of the small-holder coffee-banana farming system in Moshi rural district of Tanzania.

3.2 Linear Programming Applications to Agriculture

Linear programming as a management tool to solve problems began with defence application in world war II and now it has progressed to a point where it is an essential tool in business planning including agriculture. The technique was applied to solve farm problems as early as 1950s. Heady, (1954) was the first break through in practical use, and since that time many models have been constructed to work out possible farm improvements in complex cases, see Weinschenk (1964) and Reisch (1970). In general, linear programming as a planning technique at research level has proved to be remarkably flexible when applied to a whole range of farming situations and problems.

In East Africa, the application of the technique to peasant agriculture has been quite recent. Clayton, (1961 - 62) pioneered the use of this tool in identifying the main constraints on small farms in Nyeri district of Kenya. He programmed small-farms of the sizes 4 - 9 acres (1.62 - 3.6 hectares). Clayton's findings are still valid and have shown how constraints in peasant agriculture can be identified by using the linear programming tool. He was able to show that labour bottlenecks in the Nyeri farms influenced the production of major cash crops which included coffee, tea and pyrethrum. Although the study was done under different objectives, the findings are also of interest in the context of the Moshi rural district farming situation. There are important similarities between these two districts. Both face the problems of high population pressure on land, farmers grow similar crops and the farm sizes are small. The optimal solutions obtained by Clayton, [although they have often been critized by his professional colleagues, Evans (1966)], provided useful guidance to extension officers in advising small-holder farmers in Nyeri district.

Heyer (1966) also applied the tool to small-farm problems in Machakos district of Kenya. She was interested in identifying farm operations distinctions, and the problems of uncertainty using variable resource programming. She showed that farmers were rational not to pay more attention to cotton growing in the area, which was contrary to the instructions of the Ministry of Agriculture extension officers. However, this study may not be quite relevant to the Moshi district situation because climatically and ecologically the two districts are very different.

Hall (1970) used a variant of the basic linear programming technique (Dynamic Linear Programming) to small-scale farms in the coffee-bananas zone of Buganda region in Uganda. Hall was attempting a regional planning exercise, though he included micro-models aimed at planning a representative small-holder farm in the zone. He was able to conclude that in areas where farmers grow permanent crops like coffee and bananas, optimal farm plans which suggest changes to a different system, may require a considerable span of time to achieve the suggested changes. Hall's study is of considerable interest in the context of Moshi rural district because the farming systems in both areas are identical. In both cases, small-holders interplant coffee with bananas. The author also attempted to compare the single period to multi-period L P technique approaches to planning the coffee-banana farming system, and concluded that the single period approach implicitly ignores establishment costs of the mature crops. The optimal plans obtained under such an approach may not be optimal when these costs are considered. Thus if the extension staff were to dessiminate advice to farmers based on the single period approach, such advice would be seriously misleading or at least sub-optimal. It is realised that the dynamic linear programming approach to planning farm improvements in the coffee-banana farming system provides more realistic and meaningful results. However, in the present study, the single period approach shall be employed in the analysis inspite of its weaknesses. The approach has been unavoidable in this context due to constraints of time, finance and manpower.

Various authors, Odero-Ogwel (1974), Norman (1973),Low (1974), Ateng (1977) have applied the L P technique in identifying various small-holder problems and constraints in many parts of Africa. All these evidence leads to the effect that L P as a tool for economic analysis in small-holder agriculture is becoming popular and gaining importance in planning for agricultural improvements in these farms both in Africa and elsewhere.

CHAPTER IV

METHODOLOGY

4.1 District survey

Farm level surveys were carried out in Moshi rural district of Kilimanjaro region in Tanzania. Two improtant criteria led to the selection of this particular district among the others in the region.

These were:

(a) Administratively, the district is the oldest among the other four and therefore past records were available.

(b) The area in this district is fairly homogeneous ecologically and the farmers have similar customs, traditions, experiences and production techniques.

4.2 Sample selection

A multistage random sampling method was employed in this study (two stage sampling method). Moshi rural district is composed of four divisions and a total of 114 registered villages. The first task was to sample one village randomly from a list of all the villages in every division. Therefore in total, four villages were sampled from the whole district. The list was taken to be accurate because all the villages have been registered with the Ministry of Cooperatives in the district as multi-purpose cooperative entities.

The second and final sampling stage was to sample randomly farmers from each of the four benchmark villages. Each of the four villages was visited, and a list of all the "Ten-cell leaders" was obtained and checked for accuracy. From each list, one "Ten cell unit" was randomly sampled and all the farmers in this particular unit were interviewed. The numbers of farmers contacted in the villages are given in table 6.

Table 6: FARMER'S PARTICIPATION IN THE SAMPLE AREA. MOSHI RURAL DISTRICT.

DIVISION	WARD	VILLAGE
HAI EAST	MBOKOMU	KORINI SOUTH
VUNJO EAST	MAMBA	KOKIRIE
VUNJO WEST	KILEMA	ROSHO
HAI CENTRAL	KIBOSHO	KINDI
		TOTAL

Source: Survey Data

4.3 Questionnaire design

The questionnaire was designed and tested in the sample area before the actual survey was started. Various ammendments were made where shortfalls in design were detected. The actual farm level survey was started towards the end of December, 1978 and completed at the end of February, 1979. It was a single visit survey carried out at the end of crop harvesting period. The data used in this study was collected from a sample size of 46 farmers in the district.

It should be noted that in the tables derived from the tabulations of the questionnaires as revealed in the next chapter, the percentages totals frequently do not add up to 100.00 due to rounding off of figures. The actual questionnaire used in the farm data collection is reproduced in appendices A2.1 to A2.21.

4.4 Limitations of the data

The data from the survey area was collected in a period of three months. The time spent interviewing a farmer varied from two to three hours including plot measurements. Data collected by this method should be treated with caution.

The reliability of such data is limited due to the fact that a researcher depends heavily on the farmer's memory. These weaknesses of data reliability and quality have been well documented by Massel and Johnson, (1968) and Moris (1970).

Surveying small-holder farms presents further problems of measurements, mainly farm sizes, farm outputs and farm inputs. These problems have also been cited by a number of authors for example Collinson, (1972), and Otim (1978). However, for the purpose of this study, some "crude" methods were employed. The data for farm outputs depended on farmer's memory, but were also counter-checked through discussions with the extension officers of the ministry of agriculture. Farm input data presented more problems. It was assumed that whenever a farmer purchases farm inputs he or she uses the purchased amounts on the appropriate enterprises. This assumption may not hold true because rarely do small-holder farmers apply recommended amounts of inputs on their farms. This could be due to problems of risks and uncertainty. One single visit survey cannot detect the use of farm inputs. Thus weak as this assumption was, it had to be used due to constraints of time. Further more, data collected in a single visit survey with single season under study, reflect specific climatic conditions prevailing during the particular season in question. Their use in planning as "data with the highest probability" for the next season is of-course limited since we know that climatic conditions change.

4.5 Definitions used in the study

The term "small-scale" farmers in the present context refers to peasant farmers in Tanzania mainland who own less than 10 hectares of land.

Existing technology was defined as the practice of mixed cropping and traditional livestock production under the indigeneous technological, sociological and economic conditions of the farmers in Moshi rural district. This is a suitable starting point for planning a farm since it is logically a purely short term situation presented by the existing pattern of fixed resources, enterprises and techniques. The data in this case was obtained from area farm sample surveys in the district.

On the other hand, improved technology was defined as the practice of monocropping and Livestock production which incorporates the adequate use of purchased agricultural inputs and animal husbandry in accordance with research recommendations for the particular area. This is an important consideration in peasant farm planning since it seeks to find out what happens when further developments are incorporated in the planning process by adding new resources or by cutting down on the existing ones through the incorporation of new techniques or by considering fresh lines of production. Data for this technology was obtained from a small number of large scale farmers and local research stations in the district. All monetary calculations presented in this study are in Tanzanian shillings, and the weights calculations are in kilogrammes and metric tons unless stated otherwise.

4.6 Theoretical framework of the study

4.6.1 Gross margin analysis

Farm planning and budgeting is a method of research for analysing the probable effects on costs and returns of the various alternative systems of enterprise combination or resource use, Yang, (1965). Its primary purpose is to improve the organization and operations of the farm. Other than the heuristic approach based on the farmer's own judgements, one basic approach to the farm planning problem has been the gross margin analysis. In calculations of gross margins, data were derived for yields, prices, and input-output quantities of the various competing enterprises. The gross margin (GM) is the difference between the revenue and the variable costs of inputs. In notation form, this can be

hwistic

presented as follows:

$$\overline{\Pi}_j = X_j P_j - U_{ij} \quad (j = 1,2,3,\ldots\ldots,m).$$

Where:

$\overline{\Pi}_j$ is the Gross margin per unit (hectares, dairy cow etc.) for the j^{th} enterprise.

m is the number of enterprises.

X_j is the yield in tons or kg per unit of enterprise.

P_j is the price of the product per ton or per kg.

U_{ij} is the input variable cost per unit of enterprise j; for i = 1,2,3, ...,n) where n is the number of inputs.

The results of the gross margin calculations for a representative farm model in the survey area are shown in Table 21 and 22 for two enterprises under the existing technology. The data for these calculations were computed from the survey data sheets.

For planning purposes, gross margin calculations were also made using secondary data for the enterprises in the farming system as shown in tables 23 and 24. The gross margins under this criteria were considered in the planning as being "Improved technology".

Since it was not convenient to include all the gross margins calculations for all the enterprises in this chapter, tables 21 to 24 for the enterprises under both technologies have been put as examples only. The rest of the gross margin calculations for the other enterprises in the farming system for both technologies are indicated in appendices A3.1 to A3.7.

Therefore the gross margin gives us a measurement of the contribution of each enterprise to the fixed costs and to the profit. Thus the gross margin analyses are used as guidelines to the selection of enterprises. When using this technique, gross margin figures for different enterprises are compared in order to substitute enterprises with high gross margins for those with low ones. It is an informal technique, in the sense that it analyses the financial position of the farm but does not take into account the constraints in the farms. Gross margins analyses make comparisons of enterprises to determine the weaknesses of the farm organization. The major drawbacks of this farm planning approach are:

(a) If three or more constraints, e.g. land, labour and working capital are limiting the possible production in a farm, the implications cannot anymore simply be taken into account in a gross margin planning.

(b) Peasent farms organizations are fairly complex, and this implicitly forces planners to take care of many constraints such as different work seasons, subsistence requirements etc., which as noted in section (a) above may not be possible.

(c) Data collected by peasant farm surveys as discussed earlier in this text, need to be taken with caution . Therefore, the stability of farm plans developed using such data has to be tested. This exercise may be possible with gross margin analysis, but requires greater efforts than would be the case when using any linear programming planning approach.

Therefore, gross margin analysis approach to farm planning has a limited use and serves only as a rough initial guide.

4.6.2 Linear programming model

While gross margin planning is an informal technique, linear programming technique is for many reasons more formal. It represents a systematic method of determining mathematically the most desirable course of action for optimum results. It is a valuable tool in solving problems of enterprise combinations for income maximization. The following brief descriptior is mostly based on Heady and Candler, (1958). The linear programming models of the following notations were used as analytical tool to explore the possibilities of optimizing farm organizations. The general form is:

(1) Maximize:

$$Z = \sum_{j=1}^{n} C_j X_j \quad (j = 1.2.3.....,n)$$

Subject to:

(2) $$\sum_{j=1}^{n} aij\, X_j \leqslant bi \quad (i = 1,2,3, ...,m)$$

(3) $$Xj \geqslant 0$$

Relation (1) is the criterion equation or objective function. In this case it is to maximize the value Z which is related by a linear function to C_j, and the level of activities Xj.

Relation (2) determines the feasability limits for each activity Xj as determined by each available resource bi. The linear input-output relations are aij's.

Relation (3) is to exclude the possibility of negative levels of activities Xj in the solution.

For the purpose of this analysis:

Z = Total Gross margin from the plan of the farm.

Xj= Crop or Livestock unit activities.

Cj= Gross margin, Unit price, or Variable costs from the j^{th} activity.

aij = The technical coefficients indicating the quantity of i^{th} resource needed for the production of one unit of the j^{th} activity.

bi = Resource supplies available on the farm.

$Xj \geq 0$ = Non-negativity restriction on the farm.

4.6.2.1 Resource restrictions and activities

In order to be able to use this analytical tool, four types of data are required:

(a) Resource constraints: These include land, labour, capital, and subsistence constraints. The working capital constraint was the amount of cash spent on inputs during the plan period. Land and labour constraints were the data for a representative or average farm in the sample area as discussed under section 4.6.3. Subsistence constraints were also included to cater for the reality in peasant farms.

(b) Activities: Most of the possible crops and livestock in the farming system were included in the present analysis.

(c) Production coefficients: These specified inputs required per unit of activity. They were the mean data from the surveyed farms. Similar coefficients were used for the outputs from various enterprises.

(d) The objective function: This was expressed in quantitative terms and for this analysis, it was the maximization of total farm gross margins from the representative farm in the sample area.

4.6.2.2 Major assumptions in the linear programming model.

Yang, (1971, p. 164) wrote that all linear programming studies suffer from the major weaknesses which are based on assumptions which are inherent in the technique itself. According to Yang, and other authors the following points are to be taken into account:

(1) That the physical requirements of each production factor per unit of farm enterprise is fixed. Thus if one hectare of maize production requires 10 man-days of labour, 10 hectares of the crop will require 100 man-days. In short, this assumption implies that the production function is linear with constant returns to scale and static production coefficients. The main criticism with this assumption is that constant returns to scale will not hold over wide ranges due to the concepts of diminishing marginal returns and economies of scale. However, in the case of this study, the farms are so small that the problems of economies of scale and diminishing returns does not arise.

(2) That farm resources such as land, labour, machinery and the farm enterprises are divisible and additive in order to achieve the goal of maximization. For example, 0.5 hectares of beans may be grown and 1000 litres of milk may be produced to achieve the highest possible income. Criticisms of this assumption are valid and in real life there are problems of indivisible units such as machinery, buildings and cows. But many researchers (e.g. Mukhebi, (1972)) have shown that an adjustment of the theoretical plan to the real situation (either one cow or none) can easily solve these problems.

(3) That each farm enterprise is independent of the others and the selection of one does not necessitate the selection of the other. For instance maize can be grown without requiring the simultaneous adoption of a legume, and maize can be grown without the raising of pigs. This assumption ignores the complimentarity and supplimentarity interrelationships of enterprises on the farm. This criticism is not fully justified because proper construction of the matrix can incorporate all these aspects easily, Boegemann, (1976). Furthermore, the new versions of computer programmes with the mixed integer versions (bound and branch techniques) allow a straight

incorporation of integer vectors, (ICL, 1975).

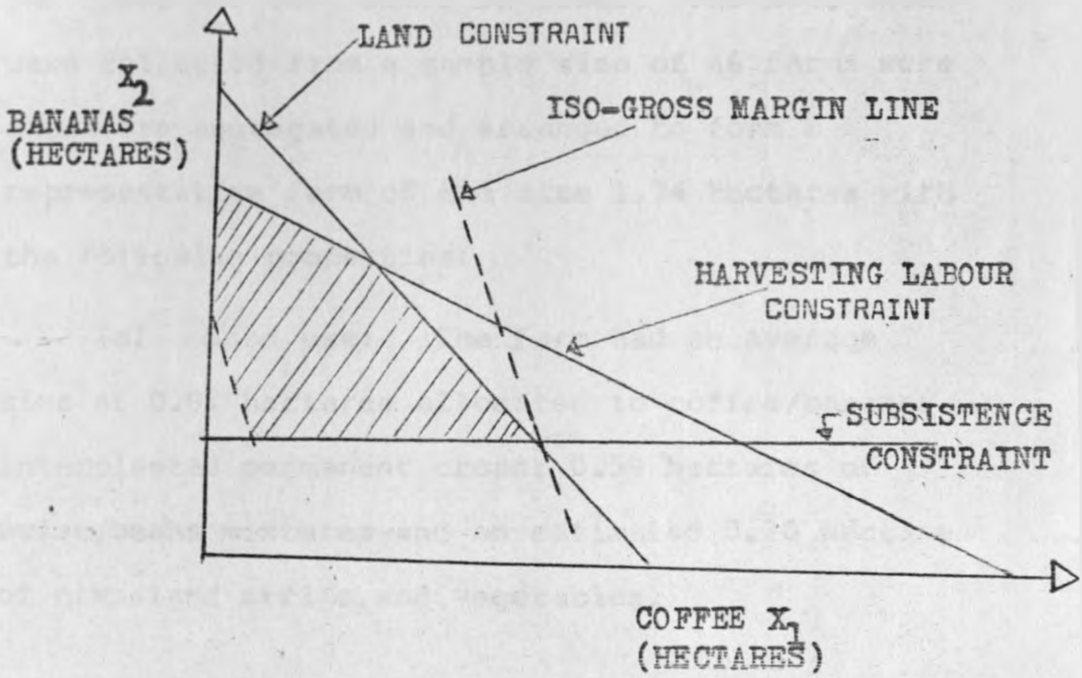
(4) That the number of enterprises is finite and consequently choices and combinations can be made only within this finite number of enterprises. This assumption does not violate our planning in this context because the possible enterprises are incorporated and the unknown alternatives are fixed in the reality.

(5) Factor substitution is ignored and single value objective function is assumed. Thus the model assumes that all the coefficients in the planning are known with certainty. In practice this assumption may not hold due to seasonal variations in inputs and outputs that occur in actual life and these are not actually accounted for in the model in any formal manner. However, the test of stability by parametrization of the objective function, the constraints and coefficients gives us the tool to overcome these short comings.

Much heavier than the problems discussed above as regards the weaknesses of the linear programming model, lies the question as to whether the assumptions of profit maximizations as the sole objective holds true in peasant farming. It does not need to be proved the fact that peasant farmer's first objective is to satisfy his or her family food supply which is determined by family food requirements. Besides this, cash is obviously the second. Thus their decision criteria or objectives are based on gross margins, security (i.e. minimizing risks and uncertainty) and family food supply. However, it is a fact that the food supply objective is also in line with the principle of profit maximization, and therefore, the linear programming assumptions may also be applicable in this context. In the present study the aspect of family food supply was incorporated into the linear programming matrices in the form of a constraint, i.e. minimum hectarage for annual food subsistence as illustrated in figure 4.1 and therefore the assumption of profit maximization is valid.

The elements of risks and uncertainty in peasant farms were not included in the model. One point to justify this procedure is the fact that in these high potential areas the variation of climate is not so great to the extent of forcing farmers to incorporate such measures in all their farming activities. Moreover, as pointed out

Figure 4.1: The theoretical geometric representation and solution to linear programming model with subsistence constraints incorporated.



earlier the interplanting of coffee with bananas gives quite a satisfactory security against high income variations.

4.6.3 The planning model

The objectives and specific questions to be answered in this study have been spelt out in chapter two of this text. In short, the study attempts to plan farm improvements of the small-holder coffee-banana farmers in the sample area. In this endeavour, a group farm planning approach was considered appropriate because these farmers operate in a similar ecological environment, have similar access to inputs and markets and generally the farms are very small in sizes. The data which were collected from a sample size of 46 farms were therefore aggregated and arranged to form a representative farm of the size 1.74 hectares with the following properties:

(a) Land use: The farm had an average size of 0.95 hectares allocated to coffee/bananas interplanted permanent crops; 0.59 hectares of maize/beans mixtures and an estimated 0.20 hectares of grassland strips and vegetables.

(b) Family size and available labour force: The household was composed of 8 members with an average of 2 children under the age of 7 years, 3 children of school going age (8-15 years), 3 adults - male and females (16-60 years of age) available for farm work.

(c) Labour constraints: Table 7; indicates the average labour available on the farm by months.

Table 7: AVERAGE FAMILY LABOUR AVAILABILITY ON THE REPRESENTATIVE FARM MODEL, SAMPLE AREA:

MONTHS	ASSUMED WORKING DAYS	AVAILABLE FAMILY LABOUR (MAN-DAYS)	ADJUSTMENTS FOR HOUSEHOLD WORK (MAN-DAYS)	NET FAMILY LABOUR AVAILABLE FOR FARM WORK (MAN-DAYS)
January	20	74.5	7.5	67.0
February	20	63.6	7.5	56.1
March	15	47.7	7.5	40.2
April	15	47.7	7.5	40.2
May	20	63.6	7.5	56.1
June	20	63.6	7.5	56.1
July	15	58.6	7.5	51.1
August	20	74.5	7.5	67.0
September	20	63.6	7.5	56.1
October	20	63.6	7.5	56.1
November	20	63.6	7.5	56.1
December	15	58.6	7.5	51.1

Assumptions:

1. One man-day = 6 working hours.
2. Children in school are not available for farm work except during holidays.
3. A farmer spends 20 days of the month on farm work.

(d) Enterprise alternatives: The possible enterprise alternatives in the area and their monthly labour requirements as employed in the respresentative farm model are illustrated on table 8.

Table 8: ALTERNATIVE ENTERPRISES AND THEIR MONTHLY LABOUR REQUIREMENTS IN THE SAMPLE AREA. (MAN-DAYS)

ENTERPRISE	COFFEE	BANANAS	MAIZE/ BEANS	MAIZE	BEANS	DAIRY
MONTH	1 hectare					1 cow
January	22	12.7	0	0	0	13.3
February	7	10	0.5	0.5	0.5	13.3
March	1	4	15	8	12.5	13.3
April	11	16.75	68	68	17	13.3
May	10	16.75	32	48	15	13.3
June	10	10	0	0	0	13.3
July	21	10	15	0	0	13.3
August	37	16.75	20	20	0	13.3
September	29	10	14	14	0	13.3
October	24.5	10	0	0	0	13.3
November	17.5	10	0	0	0	13.3
December	16	6	0	0	0	13.3
Total	206	132.45	164.5	158.5	45.0	159.6

Source: Survey Data

In addition to production activities, the planning model also defined the following constraints and activities in order to add more reality to the peasant farm situations in the area.

(i) Selling activities: These included the selling of bananas and milk at the prevailing local market prices, selling of maize and beans at official market prices.

(ii) Hiring labour at Shs. 15.00 per man-day during the labour peak requirements periods.

(iii) Credit acquisition to supplement cash needs on the farm at the on-going 8.0 per cent bank rate of interest.

(iv) Subsistence constraints: The following quantities of annual food requirements were identified and included. The data were calculated for the average family from figures given by farmers in the sample survey area, cross-checked with Extension workers and also discussions held with staff members of the Tanzania Nutritional Centre based in Dar-es-Salaam.

315 bunches of bananas @ 20 kg weight, 12 bags of maize @ 90 kg, and 3 bags of beans @ 90 kg weight.

The data for this representative farm were compiled, linear programming matrices designed, and data punched on cards for computer analysis using LP mark III package at the Institute of Computer Science, Chiromo. Fig. 4.2 shows an example of the matrices set up.

Figure 4.2: EXAMPLE OF A LINEAR PROGRAMMING MATRIX

LINEAR PROGRAMMING PROBLEM MATRIX :

PROBLEM LP01 PICTURE(1,1)

ROW SET :- ALL ROWS

		PRODCO	PRODBA	PRODMZ	PRODBN	PRODMZBN	PRODCW	SELBA	SELMZ	SELBN	MARHR	APRHR	MAYHR	JULHR	AUGHR	SEPHR	CRDTA	LIMITS
		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Z
PROFIT	Z	4	-3	-3	-3	-3	4	2	2	3	-2	-2	-2	-2	-2	-2	-1	
LAND	+	*	*	*	*	*	A											1
JANL	+	2	2				2	A										2
FEBL	+	1	1	A	A	A	2	A										2
MARL	+	*	1	1	2	2	2				-*							2
APRL	+	2	2	2	2	2	2					-*						2
MAYL	+	1	2	2		2	2	A					-*					2
JUNL	+	1	1				2	A										2
JULYL	+	2	1		2	2	2	A						-*				2
AUGL	+	2	2	2		2	2	A	B	B					-*			2
SEPL	+	2	1	2		2	2	A	B	B						-*		2
OCTL	+	2	1				2	A										2
NOVL	+	2	1				2	A										2
DECL	+	2	1				2	A										2
OPCR	+	4	3	3	3	3	4										-*	4
BANPRD	+		-3					*										
MZPRD	+			-2		-2			*									
BNPRD	+				-1	-1				*								
MARH	+										*							
APRH	+											*						
MAYH	+												*					
JULYH	+													*				
AUGH	+														*			
SEPH	*															*		
CRDT	*																*	

NB: Subsistence Constraints are indicated on the matrix by "BANPRD, MZPRD and BNPRD"

Source: Computer Print-outs

CHAPTER V

RESULTS OF THE SURVEY

5.1 The elements of the farming system as represented by the sample.

The data collected in this study were based on the questionnaire as illustrated in appendices A2.1 to A2.21. The resource base for the district survey area are indicated in the following general findings:

5.1.1 Farm sizes and land ownership.

Table 9 focuses on the farm sizes and land use pattern as revealed by data from the sample farms.

Table 9 shows that about 50% of the farms under permanent crops - viz. coffee/bananas varied in size from 0.81 to 1.2 hectares, with an average of 0.95 hectares per farm family. The sizes for the annual crops land in the less potential drier lower areas (shambas) varied from 0.41 hectares to 0.81 hectares with an average size of 0.59 hectares per farm family; and that over 47% of the farms in the sample fell under this category.

Table 9: FARM SIZES AND LAND USE FROM SAMPLE OF 46 FARMS.

FARM SIZES IN HECTARES	PERMANENT CROPS "KIHAMBA"		ANNUAL CROPS "SHAMBA"	
	NO. OF FARMS COFFEE/ BANANAS	PERCENTAGE OF OWNERS (%)	NO. OF FARMS MAIZE/ BEANS	PERCENTAGE OF OWNERS (%)
≤0.41[1]	NIL	NIL	14	30.43
0.42-0.81	17	36.95	22	47.83
0.82-1.2	23	50.00	8	17.39
1.3 -1.6	3	6.50	1	2.17
1.7 -2	1	2.17	NIL	NIL
>2	2	4.34	1	2.17
TOTAL	46	100.00	46	100.00

Source: Survey Data.

1) The strata boundaries were determined through conversion from acres to hectares.

Other estimated plots mainly strips of fodder grass, and vegetables was averaged to 0.2 hectares per family farm. Thus the average peasant farmer for the sample in the District had 1.74 hectares of total cropped land excluding areas for the homestead. Therefore, generally, farms are small in size.

Table 10: LAND ACQUISITION METHODS SAMPLE AREA.

CATEGORY/ VILLAGE	KINDI		KORINI		ROSHO		KOKIRIE	
	N	%	N	%	N	%	N	%
Inherited	12	100	8	88.88	13	100	10	83.33
Bought	—	—	1	11.11	—	—	2	16.66
Renting	-	-	-	-	-	-	-	-
TOTAL	12	100	9	100	13	100	12	100

Source: Survey Data.

More than 80% of the farmers in the sample had inherited their farms from their parents. There was no farmer who was renting land. The practice of inheritance in which each male child gets a piece of land (subdivisions) on the same family plot contributes heavily on farm sizes becoming progressively smaller and smaller. This is further intensified with the high population growth rate noted earlier in this text.

5.1.2 Family structure and available family labour.

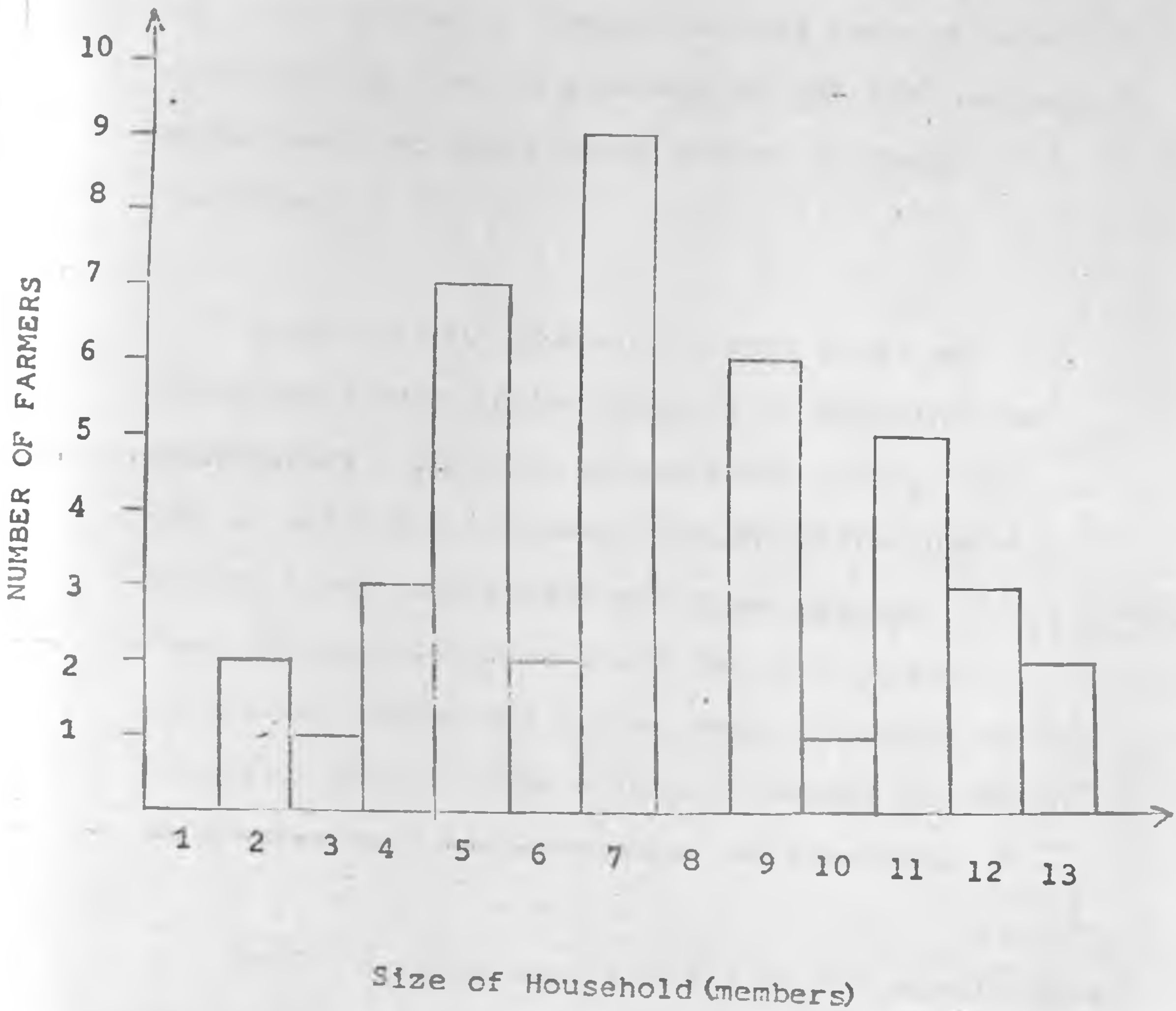
All the farms in the survey sample, had a total of 350 members, with an average household membership of 8 people (Appendix A5.2) Children under 15 years of age formed 30% of the total population in the sample. The frequency distribution of the family sizes are illustrated in figure 5.1. The ratio between household members under 15 years and over 60 years to those of the age between 15-60 years in the sample (i.e. Ratio of producers to consumers) on the farm was 1:2. This implies that one producer on the farm has to produce enough food and cash for two members of the family who are non-producers. The land/labour ratio which is an indicator of relative scarcity of the resources in the sample area was 0.2:1. This ratio indicates that land size is too small in relation to available labour. Therefore land is the most scarce resource in the area.

Table 11: <u>AGE DISTRIBUTION AND PERCENTAGE OF FARM OWNERS.</u>

YEARS OF AGE	KINDI		KORINI		ROSHO		KOKIRIE	
	N	%	N	%	N	%	N	%
15-25	-	-	-	-	-	-	-	-
26-36	2	16.66	1	11.11	2	15.38	-	-
37.47	5	41.66	1	11.11	1	7.69	4	33.33
48-58	2	16.66	6	66.66	7	53.84	3	25.00
59-60	3	25.00	1	11.11	3	23.07	5	41.66
Total	12	100.00	9	100.00	13	100.00	12	100.00

Source: Survey Data.

Figure 5.1 Frequency Distribution of size of Household(Members) in the sample area.



The age distribution of farm owners and the time in life they have actually spent on the farm is a good indicator of farming experience they have had in their locality both physically and climatically. Table 11 reveals that 40-50% of the farms are owned by farmers within the age range of 37 to 58 years. Therefore most farmers have lived in the area long enough to get the necessary experiences of the farming system in their locality.

Literacy with peasant farmers forms an important factor in the process of adopting new innovations. Literate farmers can easily make use of written mass communication media such as agricultural newsletters and farm magazine. They can also comprehend and put into practice programmes introduced in the area by agricultural extension agents. The extent of formal education in an area is a good indicator of literacy.

Table 12 shows that farmers in the sample area have quite a high rate of literacy. Over 33% of all the farmers in the sample have had primary school education level above standard four.

Table 12: FORMAL EDUCATION (LITERACY) AND PERCENTAGE OF FARM OWNERS IN THE SAMPLE AREA.

LEVEL OF EDUCATION [1]	KINDI		KORINI		ROSHO		KOKIRIE	
	N	%	N	%	N	%	N	%
None	4	33.33	-	-	1	7.69	1	8.33
Std. 1	-	-	-	-	-	-	-	-
" 2	-	-	-	-	-	-	-	-
" 3	-	-	-	-	-	-	-	-
" 4	4	33.33	5	55.55	5	38.48	7	58.33
" 5	-	-	-	-	-	-	1	8.33
" 6	1	8.33	-	-	-	-	-	-
" 7 - 8	3	25.00	4	44.44	5	38.46	3	25.00
Over Std. 8	-	-	-	-	2	15.38	-	-
Total	12	100.00	9	100.00	13	100.00	12	100.00

Source: Survey Data

(1) This refers to primary and post primary education levels attained by a farmer in sample area.

5.1.3 Farm assets and working capital

The word "capital" in traditional agriculture has a wide definition. It includes finance for farm business operations, land, cash crops, livestock farm implements and fertilizers. Farm implements used in farm operations is the dorminant type of capital in the surveyed area. Therefore in this study, capital has been restricted to implements, and livestock which supplements the coffee/ bananas farming system. Land was not valued and hence was excluded from the calculation, as land value would have dominated the "capital figures" without contributing to our problems.

Hand and Fork Hoes

These implements are used for preparing land by hand and also for planting and weeding crops.

Table 13: NUMBER AND PERCENTAGE OF FARMERS POSSESSING HAND AND FORK HOES EQUIPMENT SAMPLE AREA.

VILLAGE/ NUMBER HOES	1		2		3		4		5+		TOTAL FARMS
	N	%	N	%	N	%	N	%	N	%	
KINDI	-	-	1	8.3	2	16.6	1	8.3.	8	66.6	12
KORINI	-	-	-	-	-	-	2	22.2	7	77.7	9
ROSHO	1	7.6	2	15.4	5	38.4	2	15.4	3	25.0	13
KOKIRIE	1	8.3	3	25.0	2	16.6	4	33.3	2	16.6	12
SAMPLE Total	2	4.3	6	13.0	9	19.5	9	19.5	20	43.5	46

Source: Survey Data.

Over 43% of the farmers in the sample had five or more hand or fork hoes. Less than 5% of these farmers had at least one hand or fork hoes. This high number of hoes per farm family indicates that this implement is very important in farm operations.

Pangas

This implement is used for prunning bananas and cutting grass and crop residues as fodder for livestock.

Table 14: NUMBER AND PERCENTAGE OF FARMERS POSSESSING PANGAS.

VILLAGE/ NUMBER OF PANGAS	1		2		3		4		5+		TOTAL
	N	%	N	%	N	%	N	%	N	%	FARMS
KINDI	3	25.00	5	41.60	1	8.30	1	8.30	2	16.60	12
KORINI	1	11.11	2	22.22	4	44.40	2	22.22	-	-	9
ROSHO	8	61.50	4	30.70	1	7.60	-	-	-	-	13
KOKIRIE	7	58.30	3	25.00	2	16.60	-	-	-	-	12
SAMPLE TOTAL	19	41.30	14	30.40	8	17.40	3	6.50	2	7.10	46

Source: Survey Data.

Majority of the farmers (30 - 40%) possess up to two pangas. Very few (7%) possess five or more pangas. The implement is used for performing fewer farm operations and thus a farm family needs to possees at least one or two only.

Coffee Prunning and Spraying Equipment

These include items such as hand saws, secateurs and hand spraying pumps. These equipment are essential for improved coffee husbandry practices such as prunning and spraying pesticides for controlling pests and diseases in the crop.

Table 15: NUMBER AND PERCENTAGE OF FARMERS POSSESSING PRUNNING AND SPRAYING EQUIPMENT.

VILLAGE	NUMBER WITHOUT ANY OF THE EQUIPMENT		SAWS		SECATEURS		HAND SPRAYING PUMPS		TOTAL FARMS
	N	%	N	%	N	%	N	%	
KINDI	12	100.00	-	-	-	-	-	-	12
KORINI	6	66.60	3	33.30	-	-	-	-	9
ROSHO	5	38.50	-	-	7	53.80	1	7.70	13
KOKIRIE	4	33.30	-	-	-	-	8	66.60	12
SAMPLE TOTAL	27	58.70	3	6.50	7	15.20	9	19.6	46

Source: Survey Data.

Table 15 reveals that majority of farmers (58%) in the sample area do not possess any of the important coffee prunning and spraying equipment. It is obvious that most of the farmers do not carry out these important coffee husbandry practices. This discrepancy may be the cause of low coffee yields and quality in the district. The problem revealed above also may cause a vicious cycle whereby the important coffee husbandry practices are not carried out, thus leading to poor yields. The poor coffee yields leads to less cash available for purchasing the equipment, and hence coffee yields deteriorates further and further, and the process continues year after year.

Coffee Processing Equipment

Small-holder coffee farmers in the district process harvested coffee on their farms using hand operated pulping machines. Ripe coffee cherries after picking are thus hand pulped, fermented in wooden boxes and dried on wire trays after washings. The efficiency with which this processing is carried out determines the quality of coffee sold in the cooperative societies.

Table 16: NUMBER AND PERCENTAGE OF HOUSEHOLDS POSSESSING COFFEE PROCESSING EQUIPMENT IN THE SAMPLE.

VILLAGE	FARMS WITHOUT EQUIPMENT		HAND PULPERS		WIRE TRAYS		BOXES		TINS	
	N	%	N	%	N	%	N	%	N	%
KINDI	6	50.00	6	50.00	-	-	-	-	-	-
KORINI	4	44.40	5	55.50	4	44.40	4	44.40	-	44.40
ROSHO	6	46.10	2	15.40	6	46.10	6	46.10	6	46.10
KOKIRIE	-	-	11	91.60	11	91.60	11	91.60	11	91.60

Source: Survey Data.

A high percentage of farmers (about 35%) do not possess coffee processing equipment. These large number of farmers without such important equipment may be the contributing factor towards the low quality of coffee from small farms as compared to those from estates.

Cattle ownership

Cattle keeping forms a complementary part in the district's coffee-bananas farming system. These provide manure for the crops and milk for home consumption. Table 17 illustrates the average cattle herd size per farm in the sample area.

Table 17: NUMBER AND PERCENTAGE OF FARMS OWNING CATTLE IN THE SAMPLE AREA.

VILLAGE/ NUMBER	NONE		1-2 HEAD		3-4 HEAD		5+ HEAD		TOTAL FARMS
	N	%	N	%	N	%	N	%	
KINDI	2	16.6	5	41.6	3	25.0	2	16.6	12
KORINI	-	-	2	22.2	5	55.5	2	22.2	9
ROSHO	5	38.5	5	38.5	3	23.1	-	-	13
KOKIRIE	-	-	8	66.6	3	25.0	1	8.3	12
SAMPLE TOTAL	7	15.2	20	43.5	14	30.4	5	10.8	46

Source: Survey Data

About 30-40% of the farmers own cattle ranging from 1 to 4 cattle per farm. Only 10% own five or more cattle. Farmers keep the small- East African Zebu type of cattle. The introduction of grade dairy cattle was a relatively new innovation in the area. This has been the result of Government's diversification programme as a measure against the reliance on coffee as the only source of cash income for farmers in the area. Table 18 indicates the extent of dairy cattle ownership in the district survey area.

Table 18: NUMBER AND PERCENTAGE OF FARMERS OWNING BOTH GRADE AND INDIGENEOUS CATTLE.

VILLAGE	FARMER WITHOUT ANY TYPE OF CATTLE		GRADE 1 + HEAD		INDIGENEOUS 1 + HEAD		TOTAL FARMS
	N	%	N	%	N	%	
KINDI	2	16.66	1	8.3	9	75.0	12
KORINI	-	-	2	22.2	7	77.7	9
ROSHO	5	38.50	2	15.4	6	46.2	12
KOKIRIE	-	-	4	33.3	8	66.6	13
SAMPLE TOTAL	7	15.20	9	19.5	30	65.2	46

Source: Survey Data

Only about 20% of the farmers own grade dairy cattle, as opposed to 65% owning indigeneous cattle. This indicates that the programme has not been quite successful.

5.2 Resource utilization in the survey area.

5.2.1 Land use.

Figures 5.2 and 5.3 illustrate the frequency distribution of hectares under permanent and annual crops respectively. From these figures it is clear that over 60% of total hectares in the area are under permanent crops such as coffee/bananas while 37% of the land is allocated for annual crops such as maize and beans. This criteria of land use illustrates the importance of coffee and bananas in the farming system.

5.2.2 Labour supply to crops and livestock.

Appendix A5.2 shows that the average number of farm workers is 3.2 adults (over 15 years of age). Children below the age of 15 years are 2.2 per household on average. In order to obtain the amount of family labour available on an average farm, male equivalent weighting coefficients were assigned under three major assumptions:

(a) That labour productivity of a woman over 15 years of age, was the same as that of a man of the same age. This assumption is contrary

Figure 5.2 FREQUENCY DISTRIBUTION OF FARM SIZES (HECTARES) UNDER COFFEE/ BANANAS PERMANENT CROPS.

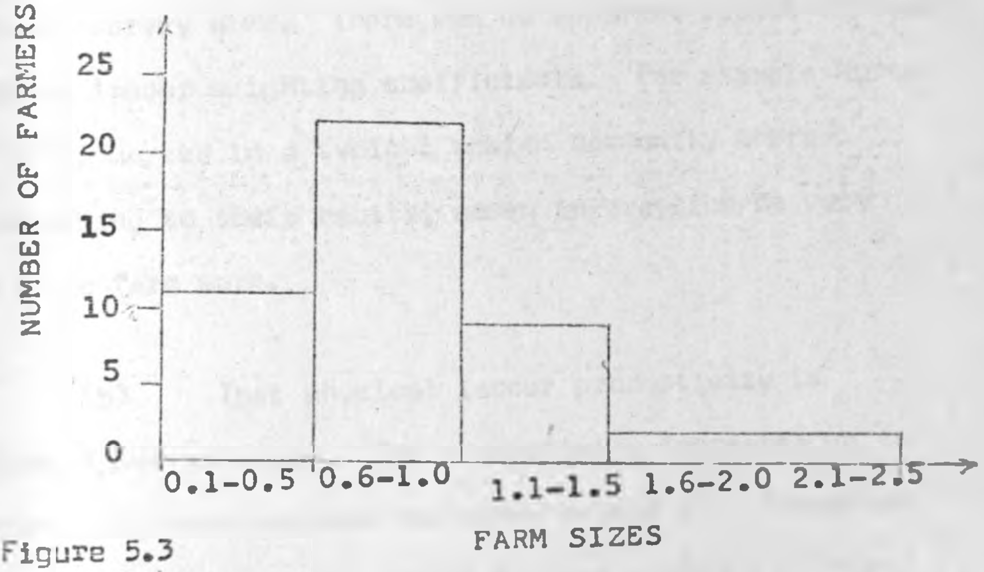
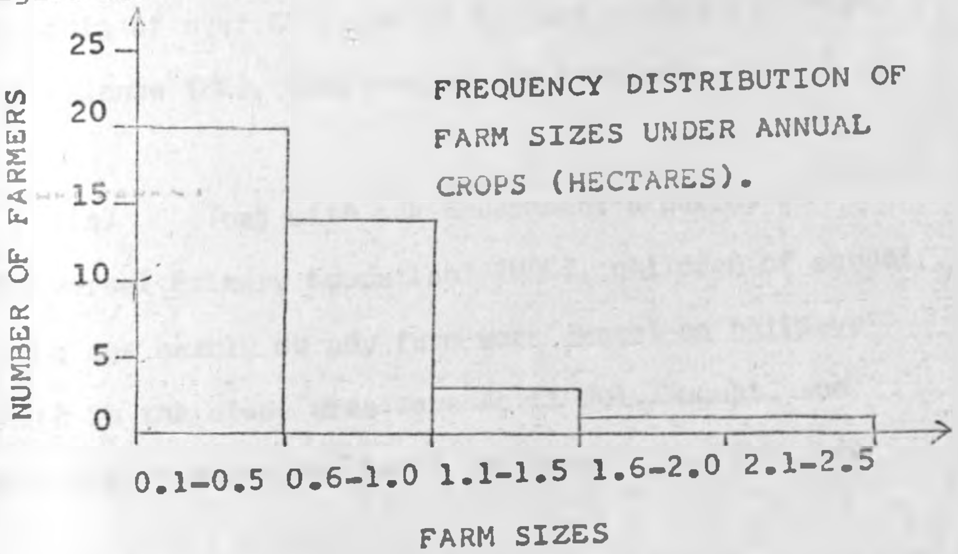


Figure 5.3



FREQUENCY DISTRIBUTION OF FARM SIZES UNDER ANNUAL CROPS (HECTARES).

to the labour weighting coefficients adopted by various farm management researchers, Collinson (1962 - 65) and Norman (1973). These researchers worked in different environments where the norms, cultures and traditions of the areas were quite different from those existing in Moshi survey area. There was no apparent reason to adopt their labour weighting coefficients. For example Norman (1973) worked in a typical moslem community where according to their habits, women in practice do very little farm work.

(b) That physical labour productivity is correlated with age. The productivity increases up to the early twenties and decreases beyond 60. Therefore an adult of over 60 years of age was assigned 0.5 man-equivalents (ME), (both males and females).

(c) That with the Government's policy of "Universal Primary Education" (UPE), children of school going age hardly do any farm work except on holidays which in the study area were April July/August, and November/December months of the year.

Their contribution to farm work during these specific months were consequently assigned 0.5 man equivalents, (both male and females). Thus for the purpose of this study, the following labour weighting coefficients on Table 19, were adopted.

Table 19: LABOUR WEIGHTING COEFFICIENTS.

LABOUR CLASS	AGE	WEIGHTING COEFFICIENTS (MAN-EQUIVALENTS)
Children	7 years and below	0.00
School age children	8 - 15 years	0.50
Male and Female Adults	16 - 60 years	1.00
Male and Female Adults	Over 60 years	0.50

(These figures are valid for the times the persons are actually working on the farms. For example, if a male (16 - 60 years) was only ½ year available, he was calculated as 1 x 0.5 = 0.5).

(d) That a farm family worked for 20 days on the farm, and a working day was assumed to be 6 hours of farm work. Adjustments were made to cater for major holidays during the year such as Easter, Christmas and "Saba Saba" celebrations. Similar adjustments were made to cater for availability of children labour during school holidays.

Figure 5.4 illustrates the pattern of average family labour available in man-days during the different months of year. The same figure also illustrates the pattern of total labour requirements by all enterprises on a representative farm in the sample area. Figures 5.5. and 5.6 illustrates the monthly labour requirements by the major crops in the district. It is obvious on the figure 5.4 that in some months of the year, the average family labour available does not match with total labour requirements by enterprises on the farm. This situation inevitably creates the need for hired labour during these months. The extent of labour hiring in the sample area is indicated on table 20.

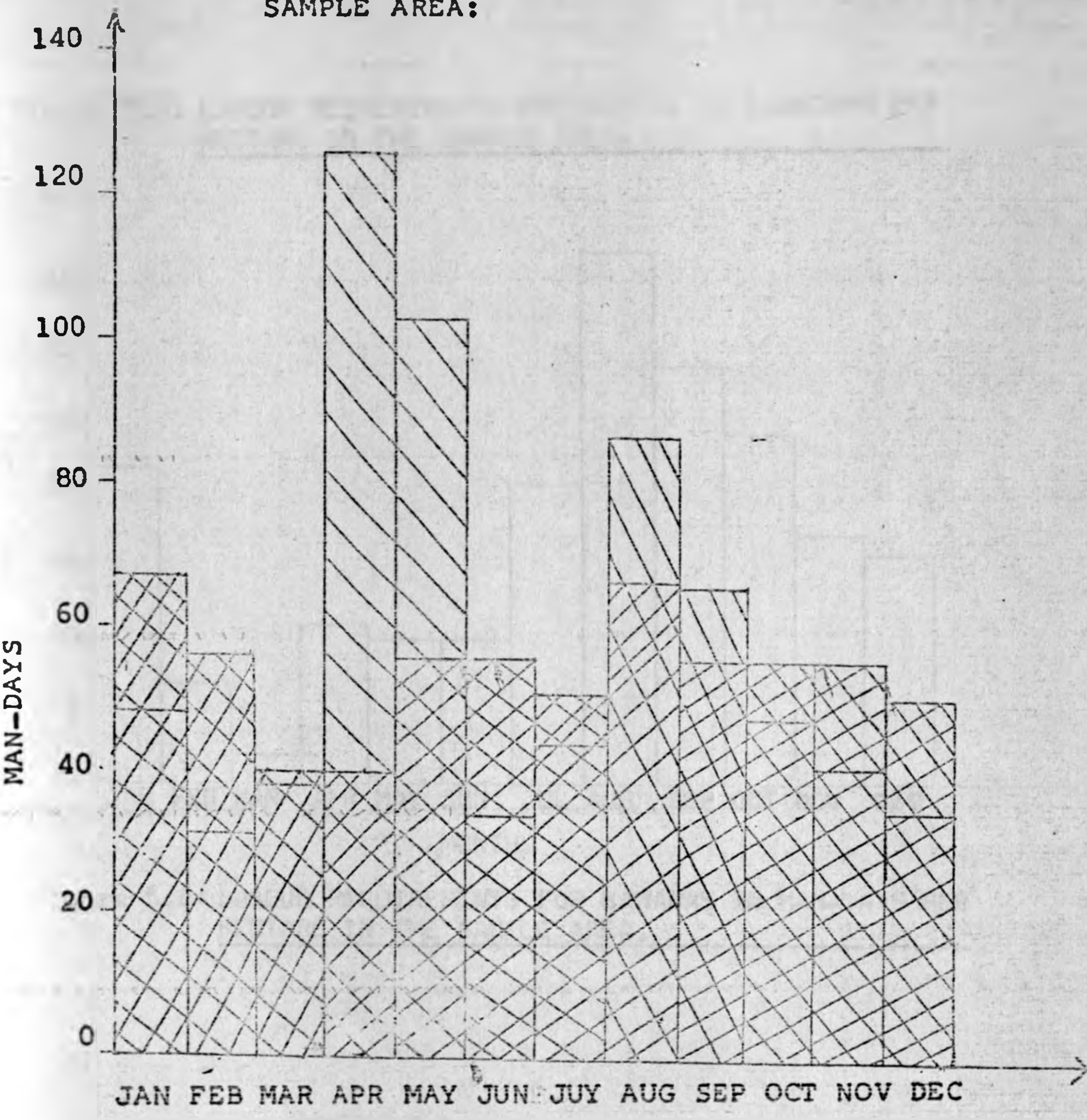
Table 20: NUMBER OF HIRED LABOUR AND PERCENTAGE OF FARMERS HIRING 1977/78 SEASON.

NUMBER OF HIRED LABOUR	KINDI		KORINI		ROSHO		KOKIRIE	
	N	%	N	%	N	%	N	%
NONE	2	16.6	6	66.66	10	76.92	1	8.33
1	-	-	2	22.22	-	-	1	8.33
2	-	-	-	-	1	7.69	-	-
3	-	-	-	-	1	7.69	2	16.66
4	-	-	-	-	-	-	1	8.33
5	-	-	-	-	-	-	1	8.33
6	1	8.33	-	-	-	-	2	16.66
7	-	-	-	-	1	7.69	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	1	8.33
10 and More	9	75.00	1	11.11	-	-	3	25.00
TOTAL	12	100.00	9	100.00	13	100.00	12	100.00

Source: Survey Data.

Table 20 also indicates that there was a wide variation as regards the number of labour hired from one farm to another. For example, during the 77/78 season, 75% of the farmers in Kindi Village hired well over 10 labourers, while only 10% of the farmers in Korini village did so. At Rosho village, the survey shows that 75% of the farmers did not hire any labour at all. Observations in the area, reveal that most labour is hired for picking coffee. In good years, when coffee production is high, more labour is hired and vice versa. In the gross margin calculations on the coffee enterprise, for the representative farm model in the district, the survey data indicated that on average the average farm had hired about 29 man-days, during the season, maily for harvesting coffee.

Figure 5.4: TOTAL LABOUR REQUIREMENTS AND LABOUR AVAILABILITY IN MAN-DAYS FOR ALL FARM ENTERPRISES ON THE REPRENTATIVE FARM-SAMPLE AREA:



KEY

1 Man-day = 6 farm working Hours.

→Total labour requirements by all enterprises

→Total available family labour on the farm

Figure 5.5: LABOUR REQUIREMENTS FOR COFFEE IN MAN-DAYS PER HECTARE IN THE SAMPLE AREA.

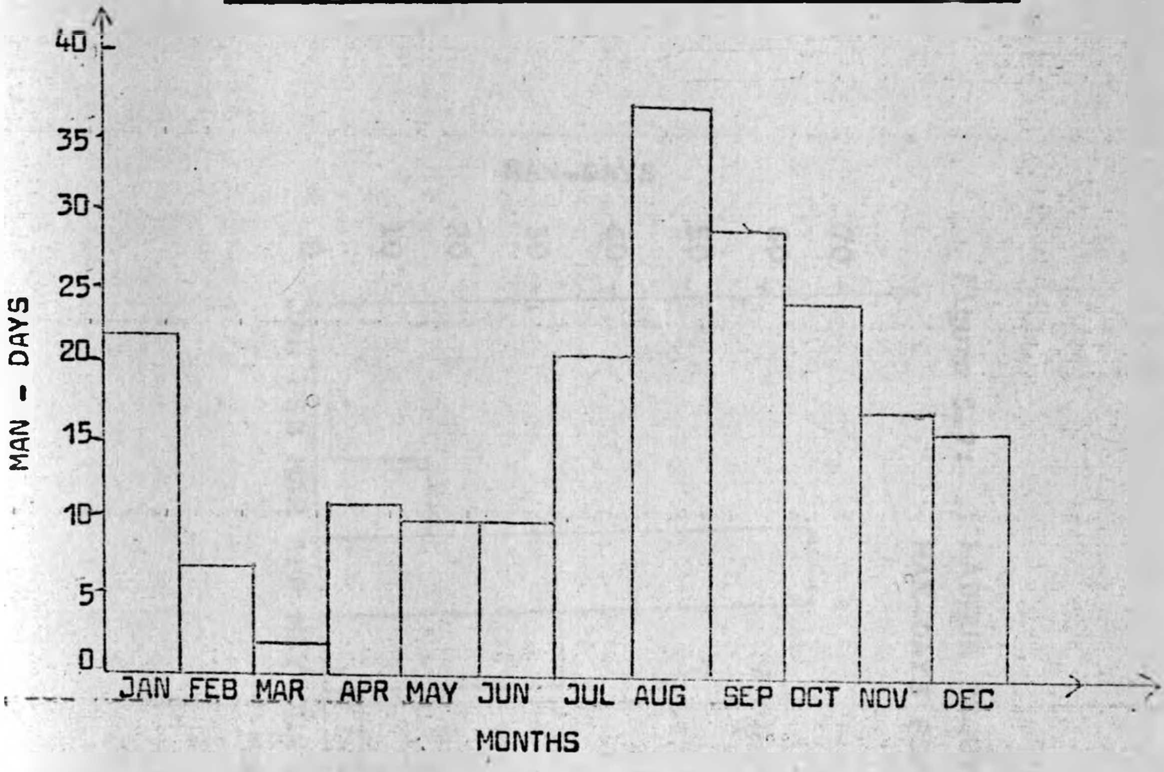


Figure 5.6: LABOUR REQUIREMENTS FOR BANANAS IN MAN-DAYS PER HECTARE IN THE SAMPLE AREA.

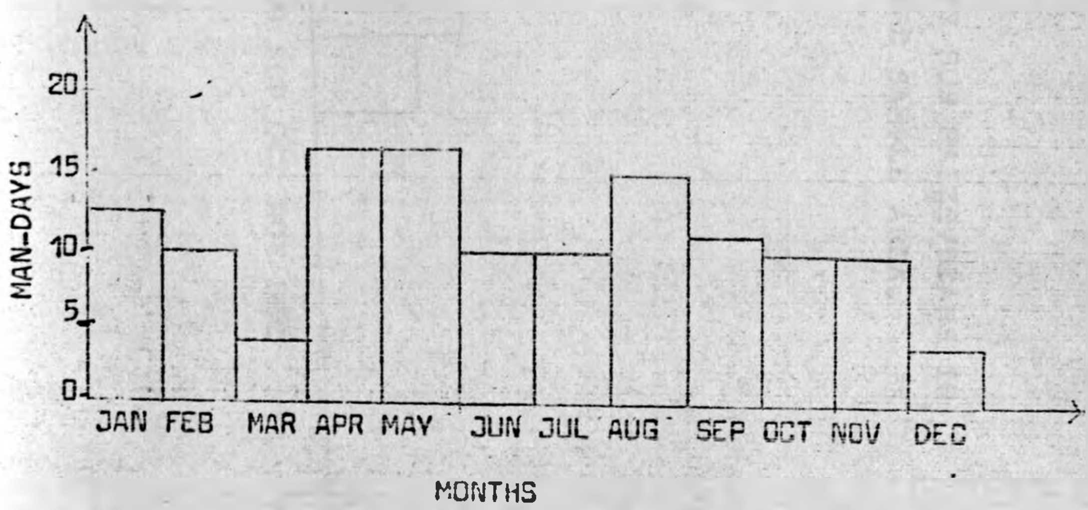
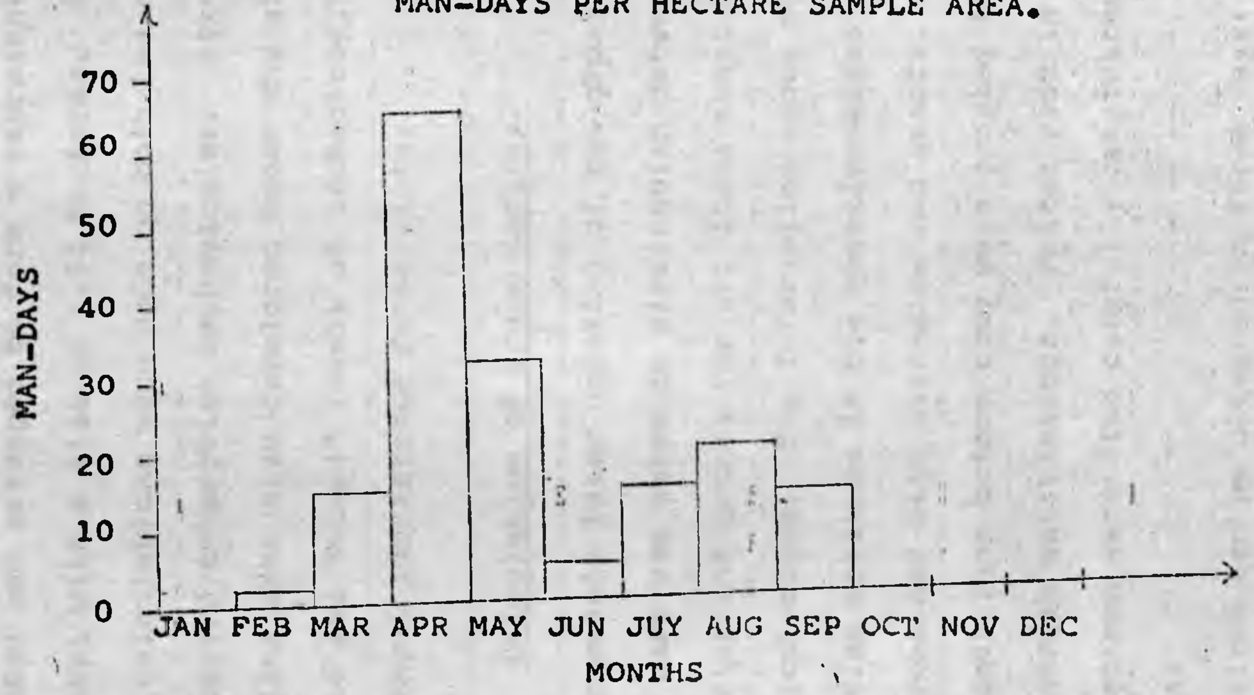


Figure 5.7: LABOUR REQUIREMENTS FOR MAIZE/BEANS IN MAN-DAYS PER HECTARE SAMPLE AREA.



CHAPTER VI

EMPIRICAL ANALYSIS OF THE DATA

The data from the sampled farms were aggregated and arranged to form a representative farm model with a size of 1.74 hectares. Gross margin calculations were made on both the existing and improved enterprise technologies. Six optimum farm plans were also developed under the existing, improved and "mixed" levels of technology, with and without subsistence constraints.

6.1 Calculation of gross margins.

To enable later updating of the gross margins proper care was taken to distinguish between quantities and prices for all items considered in the calculations. The information about the quantities obtained in the questionnaires were counterchecked with extension and general agronomy recommendations before they were adopted for the gross margin calculations. Prices used in the calculations were also carefully considered as follows:

Prices can be obtained in three ways:

(a) By asking the farmers the total amount of cash income received from sales of various farm products, and cash expenditure spent on purchasing various farm inputs. Calculations of prices per unit of product can then be made from the yield or inputs figures.

(b) By conducting market research in the sample area, check prices per unit of product and substract transport and marketing costs from it to obtain actual cash received by farmers.

(c) By taking the official products and inputs prices prepared annually by the Ministry of Agriculture

The first two methods were not used in the gross margin calculations because with the first method, farmers are mostly not willing to reveal their incomes.

The second method requires a fairly detailed study on transportation methods available in the area. This kind of study was not within the scope of the present problem and therefore, it was not carried out.

The third method was used in obtaining prices for gross margin calculations in this study. For crops like bananas which do not have an organized marketing system, an attempt was made to obtain the average local market prices prevailing in the area. In both ways, there was no allowance attempted to substract transportation and marketing costs from the prices.

Family labour in the gross margin calculations was treated as a fixed resource because of its variable opportunity costs during different periods of the year, coupled with the fact that women who contribute considerably to farm work, also perform domestic activities.

6.1.1 Gross margin based on existing technology

6.1.1.1 Crop activities

Table 21: shows the gross margin calculations for coffee crop enterprise taken as an example of how the crop activities gross margins were calculated. The gross margin for bananas, maize and beans mixtures, and maize and beans as pure stands are illustrated in appendices A3.1 to A3.6. The coffee average output in the sample farms was 425 kg of clean coffee per hectare. Based on the 1977/78 coffee prices of Tshs. 10.50 per kg, this gives a gross output of Tshs. 4462.50. Majority of the farmers did not use purchased fertilizers on their farms during the season. The major input costs was on pesticides for spraying against coffee berry disease, leaf rust and other diseases and pests. These purchased inputs accounted for about 34 percent of the total variable costs of the enterprise. The

Table 21: GROSS MARGIN CALCULATIONS UNDER EXISTING TECHNOLOGY - MATURE COFFEE TREES

FORM I:

FARM NO. REPRESENTATIVE FARM SAMPLE AREA.

GROSS MARGIN CALCULATIONS.

AREA: MOSHI (RURAL) DISTRICT

MATURE PERENNIALS, CROP: COFFEE SEASON: 1977/78

INPUT-OUTPUT DATA PER HECTARE (UNDER EXISTING CROP HUSBANDRY PRACTICES)

ITEM	Unit	Unit per Hectare	Unit Price	Value per Hectare
(A) OUTPUT 1. YIELD (CLEAN COFFEE)	Kilograms	425	TShs. 10.50	
2. GROSS OUTPUT	-	-		TShs. 4462.50
(B) VARIABLE INPUTS 3. Sprays (i) Copper 50% Oxychloride	Kilograms	5.5 x 5 = 27.5	TShs. 15.00	TShs. 412.00
(ii) Fenitrothion 50%	Litres	2 x 3 = 6	TShs. 35.00	TShs. 210.00
(iii) Ensosulfan 35%	Litres	2 x 3 = 6	TShs. 35.00	TShs. 210.00
4. Tools Secateurs, Pulpers, Wire, Trays	Repairs and maintainance per year			TShs. 290.00

Table 21 continued:

ITEM	Unit	Unit per Hectare	Unit Price	Value per Hectare
5. <u>Depreciation</u>[1]				
(i) 25% per annum on spraying pumps - 5 years life.			TShs. 837.00	TShs. 136.00
(ii) 25% per annum on coffee - pulpers - 5 years life.			TShs. 420.00	TShs. 64.00
(iii) Depreciation per hectare[1]			-	TShs. 244.00
6. <u>Others</u>				
(i) Hired labour	Man-days	30	TShs. 15.00	TShs. 454.00
(ii) Transport				TShs. 432.00
(iii) Miscellaneous costs				TShs. 440.00
(C) TOTAL VARIABLE COSTS				TShs. 2892.00
(D) GORSS MARGIN				1570.00
(E) <u>LABOUR INPUTS IN MAN-DAYS</u>				
7. Weeding & Mulching:		60		
8. Fertilizers/Manure:		3		
9. Prunning:		20		
10. Spraying:		10		
11. Harvesting, Processing and Marketing:		113		
(F) TOTAL LABOUR INPUT (MD)		206		

1 Depreciation allowance on coffee crop has been included in the GM calculations to cover spraying pumps and coffee pulpers which are used exclusively on the coffee crop and these items vary with hectarage. Also depreciation per hectare was considered to cover capital expenditure used on re-planting diseased coffee trees and filling ins in the farm in case shade trees are removed or banana stems are decreased. The expected useful life of a coffee tree was taken as 30 years.

TOTAL HIRED LABOUR: 3 MAN-DAYS @ 15/= per MAN-DAY FOR 10 DAYS ON AVERAGE

WAGES: TShs. 454.00

(G) GROSS MARGIN PER MAN-DAY FAMILY LABOUR = TShs. 7.60

(I) MONTHLY LABOUR REQUIREMENTS PER HECTARE

JANUARY	-	22	FEBRUARY	-	7
MARCH	-	1	APRIL	-	11
MAY	-	10	JUNE	-	10
JULY	-	21	AUGUST	-	37
SEPTEMBER	-	29	OCTOBER	-	24.5
NOVEMBER	-	17.5	DECEMBER	-	16

major crop production operations which required a lot of labour were weeding, mulching, picking and processing. These operations utilized well over 80 per cent of the total labour requirements of the coffee enterprise. The gross margin per hectare during the season was TShs. 1570.00 per hectare, and the gross margin per man-day of labour was TShs. 7.60. The gross margins for the other crop enterprises in the appendices A3.1 to A3.5 could be explained on a similar basis.

6.1.1.2 Livestock activities

Table 22 indicates the gross margin calculations for a dairy cow. The average output of a graded cow in the sample area was 1800 litres of milk per lactation. The 1977/78 season milk prices were TShs. 2.50 per litre. Purchased inputs for the animal were mainly few concentrates and salt. The major item cost was the transportation costs of fodder grass mainly hay from the low land areas. This item accounted for well over 70 per cent of the total variable costs. This was to be expected because the animal is stall-fed and hay is not easily available within the coffee-bananas belt areas. The total gross margin per cow was Tshs. 2.916.00 and the gross margin per man-day was TShs. 18.00.

Table 22:

form III:

FARM NO: REPRESENTATIVE FARM

GROSS MARGIN CALCULATIONS FROM A DAIRY COW - EXISTING TECHNOLOGY

AREA: MOSHI (RURAL) DISTRICT: SAMPLE VILLAGES:

ITEM	Unit	Total Units	Unit Price	Total Value
			TSHS.	
(A) OUTPUT				
1. YIELD (Sales Of) Products:				
(a) Milk	Litres	1800	2.50	4500.00
(b) Cull cow	Kg	300	1500.00	1500.00
(c) Value of Calf	Tshs.	No Market For IT.		
2. GROSS OUTPUT (a+b+c)				6000.00
(B) VARIABLE COSTS:		Per Diary Cow		Per Dairy Cow
3. Concentrates Salt	Kg Kg	150 5	1.00 2.00	150.00 10.00
4. Veterinary Charges	Tshs.	-	-	40.00

............../2

Table 22: Continued

FORM III:

ITEM	Unit	per dairy cow	Unit Price Tshs.	Per Dairy Cow
5. Depreciation on cow Equipment and Building:	10% Depreciated for 7 years			223.00
6. Transport Costs (Fodder for cattle)	Lorry Trips	12 Trips	200.00 per trip	2400.00
7. Cow stall-Repair and mainatenance:				260.00
8. TOTAL VARIABLE COSTS:				3083.00
9. GROSS MARGIN:				2916.00
LABOUR INPUTS IN MAN-DAYS: 9. Collecting Hay:		123.6		
10. Cleaning Stall:		6		
11. Collecting water:		12		
12. Milking:		18		
13. TOTAL LABOUR INPUT (MAN-DAYS)		159.6		

(D) GROSS MARGIN PER MAN-DAY = TShs. 18.27

(E) MONTHLY LABOUR REQUIREMENTS: PER COW:

JANUARY	13.3
FEBRUARY	13.3
MARCH	13.3
APRIL	13.3
MAY	13.3
JUNE	13.3
JULY	13.3
AUGUST	13.3
SEPTEMBER	13.3
OCTOBER	13.3
NOVEMBER	13.3
DECEMBER	13.3

NB: The value of the cull-cow was included in the gross output of the Dairy Cow on the assumption that a useful life of a productive dairy cow bought while in calf is 10 years and hence when eventually sold the price shall be TShs. 10,000/- according to the 1980 Livestock market prices. Hence each year the farmer is saving an income of TShs. 1,500/-.

Depreciation on Cow Equipment and building include the cow-shed, milking cans, the cattle sprayer etc., items which are specifically utilized for that enterprise, after taking into account their useful lives. Obviously the size or number of these items will vary with the size of the herd.

6.1.1.3 Establishment costs for mature perennial crops.

Gross margin for mature perennial crops do not show any indication of their establishment costs. These important costs were calculated with data based on estimates from the agronomy section of the coffee research station at Lyamungu[1]. These calculations were done for coffee and banana crops in the area.

(a) Establishment costs for one hectare of coffee plantation.

The establishment costs of coffee consists mainly of labour costs. On small-scale farms, this labour is normally provided by the family. However, in order to be able to comprehend the nature of costs achieved only, the national labour wage rate of Tshs. 12.00 per man-day in rural areas has been used arbitrarily to potray the opportunity cost of family labour. The details of labour costs per hectare of coffee plantation from seedling beds to first production (3 years after planting) are given below:

1. Seedling beds (for 1372 plants necessary for 1 hectare).

1.1	Establishment	15	man-days
1.2	Watering	15	man-days
1.3	Weeding	6	man-days

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[1] Personal communication with Mr. Swai of the Coffee Agronomy Dept. Lyamungu Research Institute, 1977/78

1.4	Shading	2 man-days
1.5	Spraying	7 man-days
1.6	Prunning	2 man-days
		14 man-days

2 Establishment of plantation (at least 6 months before planting).

2.1 Land preparation

Land clearing	280 man-days
Planting holes	40 man-days

2.2 Planting

Preparation of seedlings	12 man-days
Planting	20 man-days

3. Production labour requirements (1-4 years)

3.1	Weeding, irrigation	70 man-days
3.2	Prunning	15 man-days
3.3	Spraying 3 x year	6 man-days
3.4	Replanting (10%)	12 man-days
		103 man-days

Therefore, a total of 496 man-days are required for the establishment of one hectare of coffee plantation.

Other additional costs include. manure, shading material, fertilizers, pesticides, and spraying equipment. It was estimated that these could take an additional cost of Tshs. 4000.00[1].

1 According to personal communication with Mr. Swai of the agronomy section (coffee) Lyamungu Research Institute.

Therefore the total establishment cost was:

Labour:	496 x 12.00	= Tshs. 5952.00
Purchased inputs:		= Tshs. 4000.00
	Total	Tshs. 9952.00

The depreciation of total costs over 30 years (from year 10 to 40) at 8 per cent interests amounts to Tshs. 1000.00 (to the nearest figure) per year. (Gittinger (1972), p. 214-215).

6.1.1.4 Establishment costs for one hectare of bananas plantation.

On a similar basis to coffee, establishment costs for one hectare of bananas plantation were calculated as follows:

1. Establishment of Planation

1.1 Land preparation

Land clearing	280 man-days
Holing	40 man-days
Planting	20 man-days
Total	340 man-days

2. Production labour requirements

2.1 Weeding	40 man-days
2.2 Prunning and mulching	7 man-days
2.3 Replanting (10%)	6 man-days
Total	53 man-days

3. Annual estimated costs of maintaining one hectare.

3.1 The purchase, transport and application of mulching materials - TShs. 1000.00

3.2 Manure - biannual application
- estimated costs of purchase and transport Tshs. 3000.00

4. Pesticides - mainly (Dieldrin) Tshs. 200.00

5. A total of 393 man-days are required to establish one hectare. Therefore, the total cost was:

Labour	393 x 12.00 =	Tshs. 4716.00
Inputs (purchased)		Tshs. 4200.00
	Total	Tshs. 8916.00

The depreciation of total costs over 5 years (from 5th to 10th) at 8 per cent rate of interest amounts to Tshs. 600.00.

6.1.2 Gross margin based on improved technology

Gross margin calculations were also done on the major enterprises to determine their possible economic returns under improved crop and livestock husbandry practices. The figures taken into account for the improved technology were based on secondary data from Lyamungu Agricultural Research Institute for all crop enterprises. The dairy enterprise figures were obtained from the Livestock Development division of the ministry of Agriculture, Kilimanjaro Region, Office at Moshi.

6.1.2.1 Crop activities.

Table 23 illustrates, as an example, the gross margin calculation for coffee enterprise. Compared to calculations given in table 21, coffee under improved technology has a gross margin of Tshs. 6449.00 as compared to Tshs. 1570.00 under the existing technology. The gross margin per man-day is Tshs. 16.40 which is more than that under the existing technology of Tshs. 7.60. This increase in gross margin per man-day may be due to the increase in crop yields under improved production methods. The calculations of gross margins for the other crop enterprises are shown in the appendices A3.6 to A3.7 and their main differences with similar enterprises under existing technology can be clearly noted.

6.1.2.2 Livestock activities.

Table 24 shows the gross margin from a graded cow kept under improved methods of production . The gross margin per cow is Tshs. 3973.00 as compared

Table 23:

FORM I:

FARM NO: REPRESENTATIVE FARM

GROSS MARGIN CALCULATIONS.

AREA: MOSHI (RURAL) DISTRICT

MATURE PERENNIALS

CROP: COFFEE (ARABICA), SEASON: 1977/78 UNDER IMPROVED TECHNOLOGY

INPUT-OUTPUT DATA PER HECTARE

ITEM	Unit	Unit per Hectare	Unit Price	Value per Hectare
(A) OUTPUT				
1. YIELD (CLEAN COFFEE)	Kg	1200	10.50	
2. GROSS OUTPUT				12600.00
(B) VARIABLE INPUTS				
3. Fertilizers:				
(i) S/A or ASN	Kg	680	2.80	1904.00
4. Pesticides				
(i) Copper 50%	Kg	27.50	15.00	413.00
(ii) Fenitrothion 50%	Litres	6	35.00	210.00
(iii) Endosulfan	Litres	6	32.00	192.00

................/2

Table 23: Continued

Form I

ITEM	Unit	Unit per Hectare	Unit price	Value per Hectare
5. Others eg. Transport.	-	-	-	1295.00
6. Depreciation				136.00
7. Prunning and Harvesting (Hired Labour)	Man-days	133	15.00	2000.00
(C) TOTAL VARIABLE COSTS				6150.00
(D) GROSS MARGIN				6449.00
(E) LABOUR INPUTS IN MAN-DAYS Weeding & Mulching:		85		
Fertilizers/Manure:		10		
Prunning:		30		
Spraying:		14		
Harvesting and Marketing:		255		
(F) TOTAL LABOUR INPUT (MD)		394		

(G) GROSS MARGIN PER MAN-DAY

= TSHS. 16.40

(I) <u>MONTHLY LABOUR REQUIREMENTS PER HECTARE</u>

JANUARY	22.8
FEBRUARY	11.6
MARCH	12
APRIL	13.3
MAY	22
JUNE	22.6
JULY	25
AUGUST	26
SEPTEMBER	22.8
OCTOBER	21
NOVEMBER	15.2
DECEMBER	13.6

Table 24:

FORM III:

FARM NO: REPRESENTATIVE FARM

GROSS MARGIN CALCULATIONS FROM A DAIRY COW: - IMPROVED TECHNOLOGY

AREA: MOSHI (RURAL) DISTRICT: SAMPLE VILLAGES:

ITEM	Unit	Total Units	Unit Price TSHS.	Total Value TSHS.
(A) OUTPUT				
1. YIELD (SALES OF) Products:				
(a) Milk Yield	Kg	3000	2.50	7500.00
(b) Cull Cow	Kg	500	4.00	2000.00
2. GROSS OUTPUT				9500.00
(B) VARIABLE COSTS:		Per Diary Cow		Per dairy cow
3. Concentrates and Salt:	Kg/YR KG/YR	1460.00 45.60	1.00 2.00	1460.00 91.20
4. Dipping/Spraying:	TSHS			50.00
5. Veterinary Charges:	TSHS			40.00

............./2

Table 24: Continued

FORM III:

ITEM	Unit	per dairy cow	Unit price Tshs.	per dairy cow
6. Hay and Pastures:	Kg Kg	7300 1825	0.10 0.30	182.50 730.00
7. Depreciation on cow/ Equipment and Building	cow Eqpt. & Building			222.93 150.00
8. Transport Costs (Feeds)	T.SHS.	12 months	200.00 p.m.	2400.00
9. Cow stall-Repairs and maintainance:	T.Shs			200.00
10. TOTAL VARIABLE COSTS				5526.00
11. GROSS MARGIN:				3973.00
LABOUR INPUTS IN MAN-DAYS				
12. Collecting Hay:		130		
13. Cleaning Stall:		26		
14. Collecting water:		15		
15. Spraying/Dipping:		7		
16. Milking:		28		
17. TOTAL LABOUR INPUT (MANDAYS)		206		

(D) GROSS MARGIN PER MAN-DAY = 19.28

(E) MONTHLY LABOUR REQUIREMENTS PER COW:

JUNAURY..............................8

FEBRUARY.............................5.6

MARCH................................5.8

APRIL................................5.5

MAY..................................6

JUNE.................................7

JULY.................................7.6

AUGUST 7.3

SEPTMBER.............................7.6

OCTOBER 7.8

NOVEMBER.............................8.2

DECEMBER 7.8

to Tshs. 2916 under the existing technology (tabl 22). Again, the gross margin per man-day increased to Tshs. 19.00 compared to Tshs. 18.00 under the previous technology. Variable costs and labour demands are also higher under improved than under the existing technology.

6.2 The formulation of activities, constraints, and production coefficients for the linear programming models.

The data used for the formulation of the linear programming matrix models included specified constraints, alternative activities, production coefficients and gross margin per unit of activities. The constraints and production activities for the representative farm model were discussed in the chapter on methodology. In addition the following activity definitions were specified in the matrices of the planning model.

Activity	Unit of Activity
1. Produce coffee (PRODCO)	1 hectare
2. Produce bananas(PRODBA)	1 hectare
3. Produce maize/beans(Intercrop)(PRODMZBN)	1 hectare
4. Produce Maize(pure stand)(PRODMZ)	1 hectare
5. Produce beans (pure stand)(PRODBN)	1 hectare
6. Produce one dairy cow (PRODCW)	1 cow
7. Selling bananas (SELBA)	1 bunch weighing 20 kg
8. Selling maize(SELMZ)	1 90kg bag
9. Selling beans (SWLBN)	1 90kg bag
10. Selling milk (SELMLK)	1 kg.

The production coefficients were defined in terms of the amount of input required or physical yield per unit of activity. For example, the production coefficients for coffee production activity were the amount of land, monthly labour needs, and working capital required to produce one hectare of coffee during the planning season - 1977/78. The data used were those from the survey questionnaire which were averaged to form data for the representative farm in the sample area.

The production and selling activities in the model were stated separately to impart more clarity to the formulation of the model. The margins in the matrices for the production activities were stated at the variable cost level per unit of activity with negative signs; while those for the selling activities were in terms of anticipated official market prices with positive signs. These negative and positive signs in the objective function of the matrices indicate substraction and addition respectively to the total gross margins of the resulting optimal plan.

6.3 Results of the linear programming optimization.

6.3.1 Model 1: Existing technology with incorporation of subsistence requirements.

This plan was developed to examine the potential increase or decrease in total farm income through optimization with subsistence constraints incorporated into the model. The subsistence constraints considered in this model were the quantities of food crops adequate to supply enough food for the average family in the sample area for a year. These included 315 bunches of bananas each weighing 20 kilogrammes, 12 bags of maize each weighing 90 kilogrammes. Table 25 illustrates the results of the model as compiled from the computer outprints of the optimum solutions.

The results show that no coffee was produced while bananas (pure stands), maize/beans mixtures took up more than 80% of the total available land. Land for livestock was reduced by 50% as compared to the current farm organization. The total gross margins after the family food requirements were satisfied in the optimal plan

Table 25: Present and optimal organization of the model farm with the incorporation of subsistence needs (Model 1).

Details Land under Production	Current Organization		Optimal Plan	
	Hectares	Percent	Hectares	Percent
Coffee/Bananas	0.95	54.59	-	-
Coffee	-	-	-	-
Bananas	-	-	0.7711	44.32
Maize/Beans	0.59	33.90	0.8310	47.75
Maize	-	-	0.0222	1.28
Beans	-	-	-	-
Dairy	0.20	11.49	0.1159	6.65
IDLE Land	-	-	-	-
Total Farm Size (Hectares)	1.74	100.00	1.74	100.00
Total Gross margin (without subsistence constraints)	Quantities and real total gross margin of current organization		Quantities and real total gross margin of optimal plan	
Produce Sold	Amounts (Kg)	Gross margin (Tshs)	Amount (Kg)	Gross margin (Tshs)
Coffee	404	1926.00	-	-
Bananas	2120	478.00	1676.26	1089.60
Maize	180	-	187.06	158.95
Beans	15	-	-	-
Milk	1350	291.00	2000.00	1772.70
Real Gross Margin (with subsistence constraints) (Tshs)		2692.00		3021.25
Change over Current Plan	-		329.25 (12.23%)	

(Figure in parentheses shows the change in percentage)

Source: On compilation from the optimum solution as in Appendix A6.1

were compared to the total gross margin under the same conditions in the current farm organization. The total gross margin in the optimal farm plan increased by about 12% from Tsh. 2692.00 to Tshs. 3020.00 approximately.

6.3.2 Model 2: Existing technology without the incorporation of subsistence requirements.

In this plan, farm income was optimized by relaxing the subsistence constraints while keeping all other constraints constant. The optimal solution was shown on table 26:

The results of the model show that, no coffee production appeared in the optimal plan. Banana production occupied more than 90% of land while dairy took 5% of the farm land. The predominance of bananas in this plan was mainly due to its high gross margin per hectare i.e. T.shs 6500 against Tshs. 1500.00 approximately, which was about four times higher than that of coffee. This may be an indication of a development path in the farming system towards bananas as an economic crop enterprise. With dairy in the optimal plan, banana residues and wastes could profitably be utilized since the cows in this

Table 26: Current and optimal organization of the model farm under existing technology without incorporation of subsistence needs (Model 2).

Details Land Under Production	Current Organization		Optimal Plan	
	Hectares	Percent	Hectares	Percent
Coffee/Bananas	0.95	54.59	-	-
Coffee			-	-
Bananas			1.6449	94.53
Maize/Beans	0.59	33.90	-	-
Maize			-	-
Beans			-	-
Diary	0.20	11.49	0.1000	5.75
Idle Land	-	-	-	-
Total Farm Size(Ha.)	1.74	100.00	1.74	100.00
Production and Sales	Quantities and Total gross margin of Current Farm Organization		Quantities sold and Total Gross margin of optimal plan	
Product	Quantity sold (Kg)	Gross margin	Quantity sold(Kg) (Tshs)	Gross margin (Tshs)
Coffee	404	1900.00	-	-
Bananas	9120	5000.00	850.7439	11059.60
Maize	867	-	-	-
Beans	188	-	-	-
Milk	1800	1400.00	1109.40	2444.50
Total Gross Margin(without subsistence) constraints)(Tshs)	-	8300.00	TSHS 13504.10	
Change over current Plan(TShs)	-	-	5204.10 (62.7).	

Figure in parethese indicate change in percentage

Source: On compilation of computer printout solutions as indicated on appendix A6.2

respect are stall-fed.

It will be noticed that under both models 1 and 2, and the existing technology, coffee, which occupies about 50% of the available land in the current farm organization, did not appear in the optimal farm plans mainly due to the above mentioned reasons of high gross margins from bananas. The question is "why is the gross margin on coffee low?" An attempt was made to answer this question as follows;-

(a) The current coffee prices paid to a farmer is low both in relative and absolute terms, when compared to the prices of other crops in the area. The coffee prices received by farmers for the last five years, (1973/74 to 1977/78)have fluctuated between Tshs 4.00 per kg to Tshs 10.00 of clean coffee, inspite of the recent coffee price booms on the world market particularly during the 1976 and 1977 periods. The major reason for these relatively low prices has been the very heavy export tax of over 30% on clean coffee exported per unit imposed on the coffee industry through Government policy. This fact, coupled with the low coffee yields achieved on small-holder farms in practice, and under the existing technology, has made coffee economically unprofitable and thus unable to compete with the other enterprises in the optimal plans. This is clearly evident in optimal farm plan model 2, where the penalty price on coffee was extremely high, Tsh 3800.00.

(b) The second reason why coffee is not competative with other enterprises under the existing technology is the fact, that during the same period when coffee prices to farmers were low, production costs for the crop rose appreciably both in terms of cost of inputs and hired labour. Although government has utilized part of the coffee tax to subsidize coffee inputs, the subsidy has not been adequate to stabilize the poor price-cost structure on the crop.

These two main reasons, coupled with the problems of high incidences of pests and diseases particularly coffee berry disease (CBD), have largely contributed to the reduction of gross margin on the coffee enterprise. Subsequently, farmers have been unable to accumulate savings for purchase of coffee inputs and essential implements. Furthermore the incentive to tend the crop adequately might also have been reduced. Inspite of all these problems, farmers still expect higher coffee prices in future, and therefore, they do not uproot the crop as such.

The results of the two optimal farm plan models 1 and 2, under the existing technology, also reveal that there is little potential for increasing net farm revenue. When subsistence constraints were incorporated into farm model1, the emerging optimal plan showed an increase in "real" net farm revenue of only 12% over the current farm organization. On relaxing the subsistence constraints, model 2, the optimal farm plan indicated an increase in total net farm revenue of about 62%. However, this increase was mainly from bananas which is a major staple food crop in the area. Such a plan, although attractive in money terms, may not be acceptable to farmers mainly because bananas are quite perishable and their prices fluctuate widely on the local markets depending on periods of ample supply and scarcities in a year. Increasing bananas intensity in the area, through the adoption of such a plan, also increases risks.

In practice therefore, it seems that under the current farm organization, socially, economically and under the existing technology, farmers are efficiently utilizing their available farm resources. There is little gain to be achieved by trying to re-organize their current farms set up.

The above results and conclusion of these two models under the existing technology have been obtained under the assumption that "Whenever a farmer purchases farm inputs he or she uses the purchased amount on the appropriate enterprise" p.36. This assumption could have influenced the results of the two models under the existing technology in the sense that by changing this assumption it is possible that some other results could have emerged from the model plans. However, the assumption can only be changed if a detailed study of the farmer's activities were carried out throughout the year. This was not possible in this case due to constraints of time and finance.

All in all it can be conluded that the results of the models and the conclusions drawn from them are the best that can be attained for the data used.

6.3.2 Model 3A: Improved technology with the incorporation of subsistence requirements:

This plan was developed through the introduction of improved technology (see chapter VI, section 6.1.2), and the farmer was allowed to incorporate subsistence contraints as in model 1 discussed previously. The results of the model were as shown on table 27.

The emerging results showed that in the optimal farm plan, coffee occupied over 50% of the total farm land, bananas 18%, maize/beans intercropped 23% and dairy enterprise was so insignificant in the optimal plan, it was decided to exclude it from the plan and transfer the land so released plus its net farm revenue of TShs. 75.00 from milk sales, to the maize/beans enterprise. This

Table 27: Present and optimal organization of the model farm under improved technology with the incorporation of subsistence needs (Model 3A)

DETAILS I Land under Production	PRESENT ORGANIZATION		OPTIMAL PLAN	
	Hectares	Percent	Hectares	Percent
COFFEE/BANANAS	0.95	54.59	-	-
COFFEE	-	-	1.0159	58.40
BANANAS	-	-	0.3165	18.19
MAIZE/BEANS	0.59	33.90	0.4000	23.00
MAIZE	-	-	-	-
BEANS	-	-	-	-
DAIRY	0.20	11.49	0.0076	0.44
IDLE LAND	-	-	-	-
TOTAL FARM SIZE (HA.)	1.74	100.00	1.74	100.00
SALES	Quantities and Real total Gross margin of current orgn.		Quantity and real gross margin of optimal plan	
PRODUCE SOLD	Quantity (kg)	Gross margin (Tshs)	Quantity(kg)	Gross margin (Tshs)
COFFEE	404	1926.00	1219	3869.65
BANANAS	2120	478.00	30	-
MAIZE	180	-	-	-
BEANS	15	-	90	283.00
MILK	1250	291.00	113.50	74.75
REAL TOTAL GROSS MARGIN AFTER SUBSISTENCE CONSTRAINTS(TSHS)	-	2692.00	Tshs	4227.40
CHANGE OVER PRESENT PLAN	-		TShs. 1535.40 (57%)	

(The figure in parenthesis indicate change in percentage).

Source: On compilation of computer outprint results as in appendices A6.3

transfer would make the enterprise occupy 0.4076 hectares, which would be 23.43% of the total farm land. Such a transfer would still raise TShs. 75.00 in cash in the plan, and therefore does not change the net total gross margin. The optimum farm plan model 3A showed an increase in "real" total net farm revenue, from TShs. 2692.00 to TShs. 4227.40. This evidence clearly indicates that improved technology is worthwhile.

6.3.3 Model 3B: Improved and existing technologies with the incorporation of subsistence constraints.

An attempt was made to devise an optimal farm plan which involves optimization under both technologies with subsistence constraints incorporated into the model. This was important because improved technology essentially requires greater intensity in resources use. Theoretically n optimal farm plan could be evolved which utilizes improved technology in an enterprise and the existing technology in some other enterprises. The results of this optimal farm plan were as shown on table 28.

The results of optimal farm plan indicated that, coffee was not competitive, while bananas production under existing technology occupied well over 60% of the farm land. This was followed by maize/beans production under improved technology, 22% of land, and finally dairy enterprise occupying 10%

Table 28: Present and Optimal Farm organization Of the model farm under both the existing and Improved technologies with the incorporation of subsistence requirements Model 3B.

DETAILS LAND UNDER PRODUCTION	PRESENT ORGANIZATION		OPTIMAL PLAN	
	Hectares	Percent	Hectares	Percent
COFFEE/BANANAS	0.95	54.59	-	-
COFFEE 1 (IMPROVED)	-	-	-	-
COFFEE 2(EXISTING)	-	-	-	-
BANANAS 1 (IMPROVED)	-	-	-	-
BANANAS 2 (EXISTING)	-	-	1.1555	66.40
MAIZE/BEAN 1 (IMPROVED)	-	-	0.4000	22.98
MAIZE/BEAN 2 (EXISTING)	0.95	33.90	-	-
DAIRY(IMPROVED)	0.20	11.49	0.1845	10.60
IDLE LAND	-	-	-	-
TOTAL FARM SIZE (HA)	1.74	100.00	1.74	100.00
SALES	Quantities and "Real" Gross margin of current orgn.		Quanties and "Real" Gross margin of optimal plan	
PRODUCE SOLD	Quantity (KG)	Gross Margin (Tshs)	Quantity (Kg)	Gross Margin (Tshs)
COFFEE	404	1926.00	-	-
BANANAS	2120	478.00	282.6261 (Bunch)	3443.05
MAIZE	180	-	-	
BEANS	15	-	90	-
MILK	1350	291.00	5534.9150	2481.65
TOTAL "REAL" GROSS MARGIN AFTER SUBSISTENCE CONSTRAINTS(TSHS)	-	2692.00	-	5924.50
CHANGE OVER PRESENT PLAN(TSH)	-	-	-	3232.50 (120%)

(The figure in parenthesis indicate change in percentage)

Source: On compilation of Computer outprints results as in appendices A6.4

of farm land. The optimum farm plan model 3B resulted into an increase in "real" net farm revenue of about 120% over and above the "real" total net farm revenue achieved in the current farm organization; i.e. from TShs. 2692.00 to TShs. 5924.50.

This evidence indicates that for small-holder agriculture in the study area, farm incomes could be increased by practicing a mixture of technologies. While improved technology was worthwhile on maize/bean and dairy enterprises, existing technology was also found to be worthwhile on bananas enterprise. The explanation to this evidence was shown in the gross margins of bananas under the two technologies (Tables 34 and 35). While under the existing technology the gross margin on bananas is TShs. 6400.00, which requires a minimum amount of inputs and labour, the gross margin increases to only TShs. 7049.00 under improved technology.

6.3.4 Model 4A: Improved technology without considering subsistence requirements.

This farm plan was evolved with the introduction of improved technology, but relaxing the subsistence constraints in order to ascertain the increase or decrease in total net farm revenues after optimization. The results of this optimum farm plan model were shown on table 29.

Table 29: Current and Optimal organization of the model farm under improved technology without considering subsistence needs. (Model 4A)

DETAILS 1. Land under Production	CURRENT ORGANIZATION		OPTIMAL PLAN	
	Hectares	%	Hectares	%
COFFEE/BANANAS	0.95	54.59		
COFFEE	-	-	1.2503	71.85
BANANAS	-	-	0.3346	19.22
MAIZE/BEANS	0.59	33.90	-	-
MAIZE	-	-	-	-
BEANS	-	-	-	-
DIARY	0.20	11.49	0.1551	8.91
IDLE LAND	-	-	-	-
TOTAL FARM SIZE (Ha.)	1.74	100.00	1.74	100.00
PRODUCTION AND SALES	Quantities and Total Gross Margin of current Organization		Quantities and Total Gross Margin of Optimal Plan	
PRODUCT	Quantities (Kg)	Gross Margin (Tshs)	Quantities (kg)	Gross Margin (Tshs)
COFFEE	404	1900.00	1500.36	8063.45
BANANAS	9120	5000.00	334.6094	1530.40
MAIZE	867	-	-	-
BEANS	188	-	-	-
MILK	1800 (Litres)	1400.00	2326.5506	1530.40
TOTAL GROSS MARGIN WITHOUT SUBSISTENCE CONSTRAINTS (TSHS)	-	8300.00	Tsh 11,350.40	
CHANGE OVER CURRENT PLAN	-		Tshs 3050.40 (36.75%)	

Figures in parenthesis indicate changes in percentage

Source: On compilation of computer print-out solution results as in appendix A6.5

The optimum farm plan model 4A, which emerged, indicated that, like model 3A results, coffee again was quite competetive and appeared in the plan occupying more that 70% of the total cropped land. Bananas enterprise occupied about 20%, while dairy took about 10% of the land. The total net farm revenue increased from TShs. 8300.00 to TShs. 11,350.00 which was an increase of more than 36%. Again this model shows that improved technology has the scope of increasing farmers' net farm revenues.

6.3.5 Model 4B: Improved and existing technology without considering subsistence constraints.

The model was developed to involve optimization under both technologies without the incorporation of subsistence needs. The results of the emerging optimal farm plan were indicated on table 30.

The optimal farm plan showed that bananas production under the existing technology was worthwhile, occupying about 88% of the land, while dairy production under improved technology occupied 11% of the farm land. The resulting total net farm revenue increased by about 55% from TShs. 8300.00 to TShs. 12860.95. Interestingly, this optimal plan indicates development path towards bananas and dairy similar to that encountered in optimal farm model 2.

Table 30: Present and optimal farm organization under both the existing and improved technologies without the incorporation of subsistence needs (Model 4B).

DETAILS Land under Production	PRESENT ORGANIZATION		OPTIMAL	PLAN
	Hectares	%	Hectares	%
COFFEE/BANANAS	0.95	54.59	-	-
COFFEE 1 (IMPROVED)	-	-	-	-
COFFEE 2 (EXISTING)	-	-	-	-
BANANAS 1 (IMPRODED)	-	-	-	-
BANANAS 2 (EXISTING)	-	-	1.5465	88.87
MAIZE/BEAN 1 (IMPROVED)	-	-	-	-
MAIZE/BEAN 2 (EXISTING)	0.59	33.90	-	-
DAIRY	0.20	11.49	0.1935	11.12
IDLE LAND	-	-	-	-
TOTAL FARM SIZE (HA.)	1.74	100.00	1.74	100.00
SALES	Quantities and Total Gross margin of current organization		Quantities and total Gross margin of optimal plan	
PRODUCE SOLD	Quantity (kg)	Gross Margin (Tshs)	Quantity (kg)	Gross margin (Tshs)
COFFEE	404	1900.00		
BANANAS	9120	5000.00	799.8528 (Bunch)	10088.80
MAIZE	867	-		
BEANS	188	-		
MILK	1800	1400.00	5804.8279	2772.17
TOTAL GROSS MARGIN WITHOUT CONSIDERING SUBSISTENCE CONSTRAINTS(TSHS)	-	8300.00	-	12860.95
CHANGE OVER CURRENT FARM ORGANIZATION (TSHS)	-	-	-	4560.95 (54.95%)

Figures in parenthesis indicate changes in percentage

Source: On compilation of computer print-out solution results as in appendix A6.6

6.4 Comparisons of current farm organization with the emerging optimal farm plans and their total gross margins.

The comparisons of the results of the present empirical analysis were based on the existing farm enterprise organization, the emerging optimal farm plan models under various constraints and technologies, the pattern of resource utilization and comparative farm returns. Table 31 shows these comparisons under the current and the six optimal plans developed in the models 1 to 49.

6.4.1 Farm enterprises under the current and optimal plans.

The table shows comparisons of both land size used for the production of the various enterprises under the current and optimal farm plan models. It also indicates the magnitude of total net farm revenues derived under those farm plans.

The current farm organization indicates that the most important crops in the farming system are coffee/bananas interplanted, and maize/beans interplanted. These crops taken together occupy more than 80% of crop farm land. Livestock kept averages of 2 cows utilizing a small portion of the holding (0.20 hectares) in form of strips of grassland portions along contours and boundaries of

Table 31: COMPARISONS OF THE CURRENT FARM ORGANIZATION WITH THE EMERGING OPTIMAL FARM PLANS AND THEIR GROSS MARGINS.

DETAILS	CURRENT FARM ORG.	OPTIMAL FARM PLANS MODEL 1	MODEL 2	MODEL 3A	MODEL 3B	MODEL 4A	MODEL 4B
ENTERPRISES	Hectares	Hectares	Hectares	Hectares	Hectares	Hectares	Hectares
COFFEE/BANANAS	0.95	-	-	-	-	-	-
COFFEE 1 (IMPROVED)	-	-	-	1.0159	-	1.2503	-
COFFEE 2 (EXISTING)	-	-	-	-	-	-	-
BANANAS 1 (IMPROVED)	-	-	-	0.3165	-	0.3346	-
BANANAS 2 (EXISTING)	-	0.7711	1.6449	-	1.1555	-	1.5465
MAIZE/BEANS 1(IMPROVED)	-	-	-	0.4000	0.4000	-	-
MAIZE (IMPROVED)	-	-	-	-	-	-	-
BEANS (IMPROVED)	-	-	-	-	-	-	-
MAIZE/BEANS 2(EXISTING)	0.59	0.8310	-	-	-	-	-
MAIZE (EXISTING)	-	0.0222	-	-	-	-	-
BEANS (EXISTING)	-	-	-	-	-	-	-
DAIRY	0.20	0.1159	0.1000	0.0076	0.1845	0.1555	0.1935
IDLE LAND	-	-	-	-	-	-	-
TOTAL FARM SIZE (Ha)	1.74	1.74	1.74	1.74	1.74	1.74	1.74
TOTAL GROSS MARGIN(TSHS)	8300.00	-	13504.00			11350.40	12860.95
CHANGE OVER CURRENT PLAN (TSHS)	-	-	5204.00 (62.2%)	-	-	3050.40 (36.75%)	4560.95 (54.95%)
TOTAL "REAL" GROSS MARGIN AFTER SUBSISTENCE CONSTRAINTS (TSHS)	2692.00	3021.25	-	4227.40	5924.50	-	-
CHANGE OVER THE CURRENT PLAN (TSHS)	-	329.25 (12.23%)	-	1535.40 (57%)	3232.50 (120%)	-	-

(Figures in parenthesis shows change in percentages)

Source: On compilation from tables 25 - 30 the farm plots. The animals are stall-fed.

The optimum plan developed under the existing technology with subsistence constraints incorporated (model 1) showed that land area devoted to food crops increased by over 30% over the current farm organization. Land for livestock activities was reduced by about 50% probably in order to give more land to food crops production. With the relaxation of subsistence constraints (model 2), the crop with the highest gross margin under the existing technology, and less purchased inputs, bananas, entered the plan occupying about 95% of available land. The area of land devoted to livestock remained the same as in model 1. However, as discussed earlier in this chapter the plan though attractive in the total gross margin, seems risky because it is a single crop enterprise plan.

When improved technology was introduced model 3A, and subsistence constraints incorporated, coffee entered the plan occupying more than 50% of farm land. Maize/beans intercropped also featured prominently in the plan. The dairy enterprise could be ignored since it appeared very insignificant. In model 3B where both improved and existing technologies were considered together with the incorporation of subsistence needs, the plan showed that bananas production under the existing technology were worthwhile, when maize/beans enterprise and dairy could profitably be produced under improved technology to increase net farm revenues. In model 4A, where family subsistence constraints were relaxed under improved technology, coffee, bananas and dairy featured distinctly into the optimal farm plan.

6.4.2 Total Net Farm Revenue

The total net gross margins occuring from the optimal farm plans as indicated on table 31 could be compared to the total gross margins of the current farm organization under three criteria:

(a) Under the existing technology, the results show that when subsistence constraints were considered, as in model 1, the emerging optimal farm plan showed an increase in "real" net farm revenue of about 12% over the current "real" net farm revenue. Such an increase clearly shows that, it may not be economic to change the present farm set up towards the optimal plan. When the subsistence constraints were relaxed (model 2) the total net gross margin was increased by over 60%. Such a plan based on a single crop seems risky and therefore may not be practically acceptable.

(b) Under the improved technology, taking into account subsistence constraints, model 3A, the optimal plan showed an increase in "real" total net farm revenue of 57% over the "real" total farm revenue obtained from the present farm organization. When subsistence constraints were relaxed (model 4A) the increase in total net farm revenue was about 36%. The results of these two optimal farm plans under improved technology indicates superiority over those obtained under the existing technology both in terms of resemblance to the enterprise which farmers are familiar with, lack of riskness and the total net farm revenues.

(c) When the two technologies were considered together taking into account subsistence needs, the resulting optimal plan (model 3B) showed quite a substantial increase in "real" net farm revenue of about 120% over the current farm organization. However, the total net farm revenue increased by about 55% when the subsistence constraints were relaxed, (model 4B) under the two technologies.

If farmers were to be advised on the type of optimal farm plan to adopt, it seems that model 3B is very promising in terms of increase to be achieved in "real" net farm revenue. The model clearly shows that farmers' revenue could be appreciably raised through combination of technologies. Bananas seem to be fairly profitable under the existing technology, while maize/beans are economic under improved technology. However, the question is, "should farmers then uproot coffee which is already on their farms in favour of bananas, maize/beans and dairy?" The answer could be yes if the present relatively low coffee prices paid to farmers continue. However, on a national point of view, such a plan would not be acceptable to government since coffee is a major national foreign exchange earner. Therefore on a national basis, optimal farm plan model 3A could be acceptable. Farmers also may not be in favour of plan 3B since they still expect coffee prices to improve in future and hence would not be ready to uproot the existing coffee trees. All in all, these points tend to favour optimal farm plan 3A, and one could suggest that the bananas in this optimal plan be produced under the existing technology while with the other enterprises, emphasis should be on improved technology.

6.4.3 Employment.

The optimum farm plans developed under the existing and improved technologies, with and without subsistence constraints resulted into an overall decrease in labour employment ranging from 19% to 37%, Table 32. The decrease was however small (2.5%) in model 3B when the two technologies were taken into account. Model 4B showed a 4% increase in labour demand.

These decreased labour demands may be an indication that inevitably there exists excess

Table 32: LABOUR UTILIZATION PER YEAR UNDER DIFFERENT OPTIMAL FARM PLAN MODELS COMPARED TO THE CURRENT FARM ORGANIZATION (MAN-DAYS).

PERIOD	CURRENT FARM ORGANI-ZATION	OPTIMAL FARM PLANS					
		MODEL 1	MODEL 2	MODEL 3A	MODEL 3B	MODEL 4A	MODEL 4B
PERIOD 1(JAN-MARCH)	109	114	108	91	134	73	163
PERIOD 2(APR-JUNE)	227	136	135	138	161	125	188
PERIOD 3 (JULY-SEPT.)	209	165	137	123	226	158	178
PERIOD 4 (OCT - DEC)	117	117	120	72	124	60	161
TOTAL (MAN-DAYS)	662	532	500	424	645	414	690
CHANGE OVER THE CURRENT FARM ORGANIZATION		-130 (19.63%)	-162 (24.4%)	-238 (35.95%)	-17 (2.56%)	-248 (37.46%)	+28 (4.23%)

(Figures in parentheses shows change in percentages)

<u>Source:</u> On compilation from optimum farm plan solution as in appendix A6.1 to A6.6

labour force on the farms in the sample area. This evidence creates the need for the establishment of off-farm activities such as small-scale industries which shall absorb the ever-increasing population.

6.4.4 Information on the scarcity of resources.

The marginal value product of exhausted resources for the six optimum farm plans models were shown on table 33. The marginal value product of land, under all the optimal farm plans were fairly high, ranging from Tshs 2600.00 in model 1 to Tshs 5400.00 under model 4. This evidence together with the low land labour ratio discussed in chapter V were clear indications to the effect that land was the most scarce resource in the area. The marginal value product of labour was not potentially high and in most cases the MVP for labour was the same as the on-going rural labour wage.

Although working capital was also a limiting resource in most of the optimal farm plan models, its MVP was similar to the present rates of interest of 8% charged by the Tanzania rural development bank.

Table 33: MARGINAL VALUE PRODUCT OF EXHAUSTED RESOURCES UNDER VARIOUS CONSTRAINTS CONDITIONS OF FARM RESOURCES IN THE OPTIMUM FARM PLAN MODELS.

RESOURCE	MARGINAL VALUE PRODUCTS (TSHS)					
	MODEL 1	MODEL 2	MODEL 3A	MODEL 3B	MODEL 4A	MODEL 4B
LAND	2600.00	3261.40	5400.00	5179.20	5449.00	5179.20
MARL	-	-	-	15.00	4.80	15.00
APRL	15.00	190.00	2.60	15.00	15.00	15.00
MAYL	15.00	3.58	-	15.00	-	15.00
JUNL	15.00	-	-	-	-	-
JULYL	-	-	-	8.50	10.00	15.00
AUGL	-	-	-	-	-	-
SEPL	-	-	-	15.00	-	8.50
WORKING CAPITL (INTEREST RATE)	0.079	0.079	-	0.08	0.08	0.08

Source: On compilation from optimum farm plan solutions appendix A6.1 to A6.6

CHAPTER VII

DISCUSSIONS OF THE OBJECTIVES IN THE LIGHT OF THE EMPIRICAL RESULTS

7.1 The magnitude of the present economic returns of different enterprises.

In the previous chapter, gross margin calculations were made for all enterprises in the current farm organization under the existing technology. It was realised that the major input cost on most enterprises was family labour. There was little use of purchased inputs such as fertilizers, pesticides, and improved seeds. Contrary to the situation found on large scale farms, family labour in peasant agriculture could not be realistically assigned a salary, (such as minimum wages). This was inevitable because the opportunity cost for family labour varies throughout the year, and depends on whether it is a peak labour demand period or a slack one as clearly indicated on figure 5.4. In these circumstances, the economic return to the small-scale farmer from various enterprises could be considered as that residue which is left over after deducting all the purchased input costs from his or her crop and livestock products' realizations or sales. It was therefore, considered more appropriate to determine the magnitude of economic returns to the farmer in terms of farmer's family labour income per man-day for the different enterprises on the farm, this was indicated on table 34 which was obtained from summary of the gross margin calculation for the present enterprises. The calculations of the average margins per man-day of family labour indicate that bananas have the highest return per man-day of labour of TShs. 48.30 and coffee, has the lowest average margin per man-day of TShs. 7.60 under the current farm organization and present technology. The calculations also show that, with the exception of bananas enterprise, the return to the farmer for one day labour utilized for farm work in the present enterprises fluctuate between TShs. 7.00 and TShs. 10.00. It means that if a farmer in the study area works on these enterprises, the equivalent of one full month, the net monthly cash income to family labour does not exceed TShs. 300.00. It should be remembered that although bananas have the highest return per man-day of labour, it is a staple food in the area and therefore real income per man-day may be lower when the amounts consumed are taken into consideration. On the other hand, it seems that coffee which is an important cash crop in the area, is of little advantage as regards its economic returns under the

Table 34: AVERAGE MARGIN PER MAN-DAY OF FAMILY LABOUR CALCULATION OF INDIVIDUAL FARM ENTERPRISES UNDER EXISTING TECHNOLOGY ON THE REPRESENTATIVE FARM MODEL IN THE SAMPLE AREA.

ENTERPRISE		MEAN YIELD Kg/Ha	AVERAGE PRICE TShs./Kg	AVERAGE GROSS-OUTPUT TShs./Ha	AVERAGE SPECIFIC COSTS TShs./Ha	MEAN GROSS MARGIN TShs./Ha	AVERAGE MAN-DAY PER Ha.	AVERAGE MARGIN PER MAN-DAY (TShs.)
COFFEE		425	10.50	4462.00	2438.00	1570.00	206	7.60
BANANAS		10343	0.65	6723.00	200.00	6523.00	133	48.30
MAIZE/BEANS:	(MAIZE)	1260	0.85	1071.00	397.00	1697.00	164.5	10.30
	(BEANS)	324	3.15	1023.00				
MAIZE		1485	0.85	1262.00	340.00	922.00	158.5	5.80
BEANS		324	3.15	1023.00	419.00	604.00	74.8	8.10
DAIRY		1800	2.50	4500.00	3083.00	1417.00[1]	159.6	8.90

[1] per cow

Source: On compilation of Gross Margin calculations table 21, 22 and appendices A3.1 to A3.5

existing technology probably due to the same reasons discussed earlier in the previous chapter.

For comparative purposes only, average margins per man-day of family labour were calculated for individual farm enterprises assumming that farmers adopted improved methods of production as shown on table 35.

The average margin per man-day of family labour under improved technology shows that the farmer's efforts could be increased from the existing technology, and this increase may vary from 115 per cent on coffee enterprise to over 180 per cent on dairy enterprises. It is therefore evident that even under the 1977/78 farm gate prices in the district, farmers could get higher economic returns through the adoption of more intensive methods of production for almost all the existing enterprises in the area.

7.2 The interrelationship between enterprises

Coffee/bananas mixed croppings, and maize/beans interplanted are predominant in the farming system of the study area. The interrelationships

Table 35: AVERAGE MARGIN PER MAN-DAY OF FAMILY LABOUR CALCULATION OF INDIVIDUAL FARM ENTERPRISES UNDER IMPROVED TECHNOLOGY ON THE REPRESENTATIVE FARM MODEL.

ENTERPRISE		MEAN YIELD Kg/ha	AVERAGE PRICE TSHS/Kg	AVERAGE GROSS OUTPUT TSHS/ha	AVERAGE SPECIFIC COSTS TSHS/ha	MEAN GROSS MARGIN TSHS/Ha	AVERAGE MAN-DAY PER HA.	AVERAGE MARGIN PER MAN-DAY TSHS.
COFFEE		1200	10.50	12600.00	6150.00	6449.00	394	16.40
BANANAS		20000	0.65	13000.00	5950.00	7049.00	330	21.40
MAIZE/BEANS:	MAIZE	2700	0.85	2295.00	1646.00	3483.00	140.5	24.80
	BEANS	900	3.15	2835.00				
DAIRY		3000	2.50	9500.00	5526.00	3973.00	159.6	24.90

Source: On compilation from Gross margin calculation tables 23, 24 and Appendices A3.6 to A3.7 under improved technology.

between coffee and bananas interplanted has been discussed earlier in this text. It was however concluded that more technical and economic research on this issue was urgently required. There was no empirical evidence established in this particular study as regards interrelationship between these two crops because the input/output data for these crops were considered separately. Theoretically, it could be hypothesized that such intercroppings were essential to maximize returns in terms of cash and food requirements on these small plots owned by the peasants in the district. This assumption needs careful economic research in order to establish optimum farm sizes for a given level of a determined farm incomes in the study area. Such investigations were outside the scope of the present analysis.

The interrelationship between maize/beans interplanted as a single enterprise was evident in the empiral analysis. The return in terms of average margin per man-day of family labour under the existing technology, was higher than when the two crops were grown pure stands, as shown on table 34. This evidence is further intensified by the optimal farm plan models where maize/beans mixed cropping as an enterprise appeared in most of the plans. Technically, the interrelationship between the two crops grown in mixtures has been proved to be beneficial and highly productive, CIAT,[1] (1977) and many other agronomic researches in East Africa. Therefore in case of Moshi district, there was a strong interrelationship of the two crops when grown as mixed crop and this important relationship need to be seriously considered when the problem of land shortage in the area is also taken into account.

The interrelationships between dairy and crop enterprises were also evident in this study in terms of average margins per man-day of family labour and also in the emerging optimum farm plan models. Besides this aspect, observations indicate that since the livestock are stall-fed, there could be a lot of gains through integration of the two enterprises because the animals could utilize a lot of crop residues such as bananas and maize/beans crops. These residues could be otherwise wasted or used for mulching. It may be an interesting topic for further research to compare the two uses of these crop residues with the view to finding out the best alternative use both agronomically and economically, bearing in mind the

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1 CIAT = The International Centre of Tropical Agriculture.

manure obtained from the livestock as well.

7.3 The economic efficiency of the present farm organization and possible improvements

The major question encountered in this study is the question "what are the economic inefficiencies evident in the farming system as regards the allocation of farm resources, which in event could suggest opportunities for increasing farm incomes? or are the peasant farmers in Moshi rural district efficient but still poor?" This question could be answered by examining the results of the linear programming models both under the existing and improved technology.

It was observed in the optimum farm plan model 1, under the existing technology, that with a reallocation of resource, excluding the cost of family labour, but considering subsistence constraints, the programming results indicate that "real" net farm revenue might have been increased by 12% from the present TShs. 2692.00 to TShs. 3021.00. This move is accomplished by concentrating efforts on the production of bananas, maize and dairy enterprises. This change appears to be a trade-off between an increase in income, and uprooting coffee which is a long time established crop in the area. Such a move would hardly be acceptable to the farmers because the potential increase in "real" total gross margin is not economically or sociologically high enough. It could probably be acceptable if such a move could probably increase farm incomes to say more than 50%.

On relaxing the subsistence constraints model 2, under existing technology, there was a potential increase in total gross margin of about 62% from TShs. 8300.00 to TShs. 13500.00. The objections to the adoption of this relative attractive optimal plan lies in the fact that it is a risky plan. Economically, farmers would not accept putting all their "eggs in one basket." These two empirical results confirm the fact that the peasant farmers in Moshi district under the existing technology, were doing the best they could and in general they are allocating their resources in a manner consistent with the goal of profit maximization. Although the validity of this conclusion is challenged by Lipton (1968), it is however supported by similar conclusions derived by Hopper (1965) and Norman (1967 - 72) that peasant farmers are efficient under their traditional technologies of production.

When improved technology was introduced into the models, the optimal farm plan obtained while taking into account subsistence constraints, indicated a substantial pay-off of 57% increase in "real" total gross margin from Tshs 2692.00 to Tshs 4227.40. The increase was achieved by concentrating farmer's efforts, on the production of coffee, bananas and maize/beans enterprises. The dairy enterprise was negligible and its gross margin of Tshs 75.00 could be obtained by transferring the land to production of the maize/beans enterprise. On relaxing the subsistence constraints, model 4A, there was an increase of pay-off in total gross margin of over 36%, from Tshs 8300.00 to Tshs 11,350.00.

An interesting phenomenon was further observed when two models were developed which combined improved and the existing technology. Optimum farm plan model 3B indicated that "real" total gross margin, taking into account subsistence constraints, could be tremendously increased by well over 120% from Tsh 2692.00 to

TShs. 5924.50. On relaxing subsistence constraints under similar conditions the potential increase in total gross margin was about 55%, from TShs. 8300.00 to TShs. 12860.00.

In both these optimal farm plan models incomes were increased by the adoption of "mixed" technology in the farming system. Banana enterprise was produced using the existing technology while maize/beans and dairy were to be produced under improved technology. This evidence further proved the fact that, although farmers were efficient under the existing technology and that improved technology could provide dividends, a "mixed" technology could immensely increase their total net farm revenues.

However, the adaptability of either the improved technology or the "mixed" technology need to be examined in terms of resemblance to the observed situation in the area, and the validity of the optimal plans on the farmer's point of view and national policy at large. The analysis has proved that the possible improvements on the farmers income in the area is through a development path towards improved technology or "mixed technology. The optimal farm plans model 3A and 3B seem to be logical plans for adoption by farmers in the study area. These two farm plan models have a close resemblance to the current farm organization enterprises. The difference is that these plans indicate the adoption of pure coffee and banana croppings while in practice these two crops are intercropped. This anomally was mainly due to the nature of data collected and incorporated into the linear programming matrices. The conditions for adopting either of the two optimal plans was discussed earlier in this chapter and heavily depends on policy makers' willingness to review the coffee export tax, thus creating a favourable coffee cost-price structure. However, all in all, model 38 has clearly indicated the importance of "mixed" technology in the smallholder farms in the district.

Another important factor determining the relevancy of these two optimal farm plans as possible improvements of the peasant farm incomes, depends not only on the profitability of these plans, but also in the variability of the cash returns. The nature of the present static programming exercise has not allowed a rigorous test on this aspect, but there is no doubt that this may be an important factor in determining the farmer's attitude towards the adoption of these plans. However, dynamic linear programming and parametrization would be able to throw some more light on these aspects. Further work in these lines of research is urgently required.

The present analysis has indicated that under the existing technology farmers in the district are efficient but poor. Possible lines of improvements lie in the adoption of optimal farm plans under either improved technology or "mixed" technology. The peasant farmers in Moshi district need to be convinced on the potential profitability and desirability of these technologies towards the improvement of their farm incomes and hence their standards of living.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The present analysis of the small-scale coffee-banana farmers in Moshi rural district has clearly demonstrated that under the existing technology, farmers were, in general, allocating resources in a way consistent with the goal of profit maximization and secure family food supply. There is therefore, little gain to be achieved by trying to reallocate resources under the present technological sociological and economic conditions. The potential for increasing incomes through such re-allocation of resources seems to be very much limited.

The major limiting resource was found to be land. Therefore, a primary focus must be on increasing productivity of land through using more intensive and improved methods of production available from applied agricultural research. The practice of crop mixtures is predominant in the district. Although the intercroppings of maize and beans are justified technically and economically, the interrelationship between coffee and bananas intercropped requires more technical and economic research at the small-holder farm level. Such research is vital in order to establish optimum levels of crop mixtures that will enable the small-holders to maximize returns from their small-plots at the same time ensuring adequate bananas supply which is the staple food for the farmers in the district. The gains in terms of real net farm revenue and returns per unit of land and labour have been observed to be substantial under improved technology.

The study has further revealed that under the existing technology, small-holders in the area lack essential farm inputs and equipments a factor which has contributed greatly to low crop and livestock yields and thus low farm incomes. For example, it was established that over 50% of the farmers in the sample villages lack the essential coffee prunning, spraying and processing equipment, and less than 10% of the farmers were using improved seeds for maize and beans production. Yields per unit of land for almost all crop enterprises were very low as compared to potential yields under improved technology. The optimum farm plans obtained under the existing technology indicated that coffee which is a major cash crop in the district was not competitive enough in terms of profitability to enter the plans. This aspect could be attributed to the current low yields per unit of land coupled with the coffee low prices relative to the prices of the other crop or livestock enterprises. Under improved technology however, even when subsistence constraints were incorporated into the programming, coffee appears in the optimum plans occupying a substantial percentage of the total available land. This phenomenon is an indication that even under the existing coffee prices, the crop could be quite profitable if the yields per unit of land were improved. This factor applies to all the enterprises on small-holder farms in the district.

8.2 Recommendations to policy

The recommendations to policy makers arising from the preceeding conclusions may be grouped under four categories, mainly production policy, rural labour utilization policy, marketing policy and research policy.

8.2.1 Production policy

A clear implication that may follow from the above conclusions is that the small-scale farmers in the district need as a matter of agency to change their existing production technology to improved or "mixed" technology in order to improve farm incomes and raise their well-being. Since land is the major constraint in the area, much focus on development planners should be on increasing agricultural productivity through greater intensive use of the available land by employing improved production methods. Emphasis should be given to exploring the adaptability and usefulness of improved technology when combined with the traditional cropping patterns, particularly crop mixtures. For this purpose, the small-scale farmers in the district would require considerable help from the Government and Agricultural Development Institutions such as the Coffee Authority of Tanzania. Therefore a change in farm organization that may be slightly modified to suit local conditions, is suggested in the lines of the optimum farm models revealed under models 3A and 3B. This seems to be a practical proposition which could enhance the current farm incomes in the district.

An effective extension service is vital to accelerate the farmer's education on the adoption of production-increasing innovations, optimum farm plans and their economic implications. It appears that the present extension staff/ farmer ratio of 1:1500 in the district is highly inadequate to implement these propositions. It is therefore recommended that this ratio need to be highly reduced to say 1:500 bearing in mind the issue of proper training to obtain better quality staff as well. Farmers are more likely to accept new technology when there are closer demonstrations carried out on the farmer's fields under the farmer's actual conditions.

The small-farmer has limited capital. The government will therefore have to provide economic incentives in the form of subsidies. These subsidies need to be in the form of cash and inputs. Thus some form of institutional credit is required. The Tanzania Rural Development Bank should work in close collaboration with the Coffee Authority and the Ministry of Agriculture in planning a strategy towards this goal together with the village goverments to ensure proper administration of such a scheme and reduce rates of default. The present methods of inputs distribution and availability, has caused a lot of logistical problems in the district. The government agencies which are currently primarily responsible for inputs distribution system such as the crop authorities seem to have so many other functions that farmers are not able to get the inputs at their areas at the right time and in quantities they may require. It is therefore suggested that this responsibility be transferred to business organizations such as the Tanganyika Farmers Association, who are more experienced in performing these duties for the benefit of the small-holder farmers. Alternatively the government should re-establish the former Cooperative Unions which were dismantled in 1976. The Cooperative movements if properly established and adequately manned with qualified staff could very well carry out the function of inputs distribution in villages.

8.2.2 Marketing policy

The recommendations under this policy aspect are attempted on three categories, mainly improved marketing facilities, processing facilities and price controls.

It is a well known fact that the improvement and extension of rural feeder road facilities help to bring small-holder farmers closer to urban markets. Thus farmers can benefit from the selling of produce at a more favourable price, and encourage the supply of reasonably priced foodstuffs to a growing urban population. The feeder roads system in rural areas of the district require considerable improvements. The success of the current dairying programme and efficient marketing of most crops in the district need feeder roads which are passable throughout the year. The government in conjunction with the Coffee Authority should play a major role in this aspect as soon as possible. The village cooperatives seem to be well organized, but they need greater strengthening in terms of manpower.

Coffee is a major cash crop in the district, and despite government's efforts to diversify the peasant's economic dependence on this crop, it is likely that the situation may not change in the near future. The government has embarked on a major coffee improvement programme in the area. It is however pertinent to stress the importance of greater focus on the coffee processing facilities aspect. This study has shown that almost 100 per cent of the coffee processing is done by the farmers on their holdings without adequate facilities and equipment. Although the programme envisages that smallholders shall be supplied with hand pulpers at reasonable prices, it is highly unlikely that this approach shall pay dividends in the short run as regards improvements of coffee quality. It is therefore proposed that the issue of central coffee pulperies be reconsidered and planned for implementation. There are four central pulperies in the district, whose factories are not in working conditions. These have been neglected and they require overhauling, maintenance and proper administration by skilled personnel. More of these factories should be established at least in every ward and farmers compelled to send all their coffee for processing in these factories. Such a scheme would in the long run benefit the farmer and improve the coffee quality in general.

Coffee prices are low relative to those of other crops. It appears that these low coffee relative prices are due to government's policy of setting producer prices low by heavy taxation to the farmer. The current export tax on coffee of 30 - 40 per cent need to be removed or reduced to a level of say 5 - 10 per cent in order to give more price incentives to the small-holder farmers so that they may adopt improved technology on the crop. Also price fluctuations to small-holders should be seriously avoided. The Coffee authority need to give priority to this aspect and carry out proper investigations on the coffee cost-price structure, and advice government accordingly.

The marketing of bananas is highly unorganized in the district and farmers face very unstable prices for their crop produce. For example in a normal average season, banana prices are extremely low during the months of April, May, June and sometimes in November/ December. It is proposed that government look into the possibility of establishing a marketing organization or authority whose responsibility would be the development and marketing of bananas and other vegetable crops in the region and the nation as a whole. The National Agricultural and Food Corporation through its other subsidiaries has not been able to handle this problem properly, probably due to its many other functions.

8.2.3 Labour policy

The results of the empirical analysis, table 30 indicates that under the existing technology, and even if farmers were to adopt the optimal farm plans under mixed and improved technology, surplus family labour is present in most months of the year. It is imperative that additional off-farm employment need to be generated in the villages. Small-scale industries seem to be viable propositions. Village governments in coordination with the Small-scale Industries Development Organization (S.I.D.O.) have a major role to play in this respect through training and establishment of these industries. This scheme would be of considerable benefit in absorbing the large number of primary school leavers every year who do not have alternate employment opportunities.

8.2.4 Research policy

The problem of inadequate availability of agricultural statistics data in the district for planning purposes has been discussed earlier in this text. Therefore it is proposed that the Ministry of Agriculture as a matter of urgency establish a farm management division both at the regional and district levels. In addition to constant data collection and analysis on small-holder agriculture, the division could undertake major investigations and studies which are considered to be of immediate priority for proper small-holder farm planning in the district. The following subjects may be among those to be considered as being of high priority:

(a) The economics of mixed and pure stand croppings - mainly coffee/bananas.

(b) Investigations into labour input requirements for different enterprises in the farming system.

(c) Studies on the feed lots or on food and animal feed balances in the district. This aspect of study is important because there is no adequate data on which the many proposed dairy and other livestock programmes in the district could be evaluated and improved economically.

Finally agronomic researchers should focus on small-holder farms and include many field testing trials on small-holder farm conditions. In this way, new knowledge could easily be introduced to the peasant farming methods and could help to close the present gap existing between research stations and the extension service, in disseminating improved technology to the farmer.

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A1.1 TYPICAL RAINFALL DISTRIBUTION FOR THE COFFEE/BANANA BELT. LYAMUNGU AGRICULTURAL RESEARCH INSTITUTE: MOSHI (20 YEARS AVERAGES) MM.

1945-1975

STATION	ALTITUDE FT.	NUMBER OF YEARS RECORDED	MEAN MONTHLY RAINFALL (MM)													
			JAN	FEB	MARCH	APRIL	MAY	JUN	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	Annual Mean	Approx. Range (mm)
LYAMUNGU	4100	30	44	65	109	537	456	112	60	35	31	37	97	80	1663	1450-1850

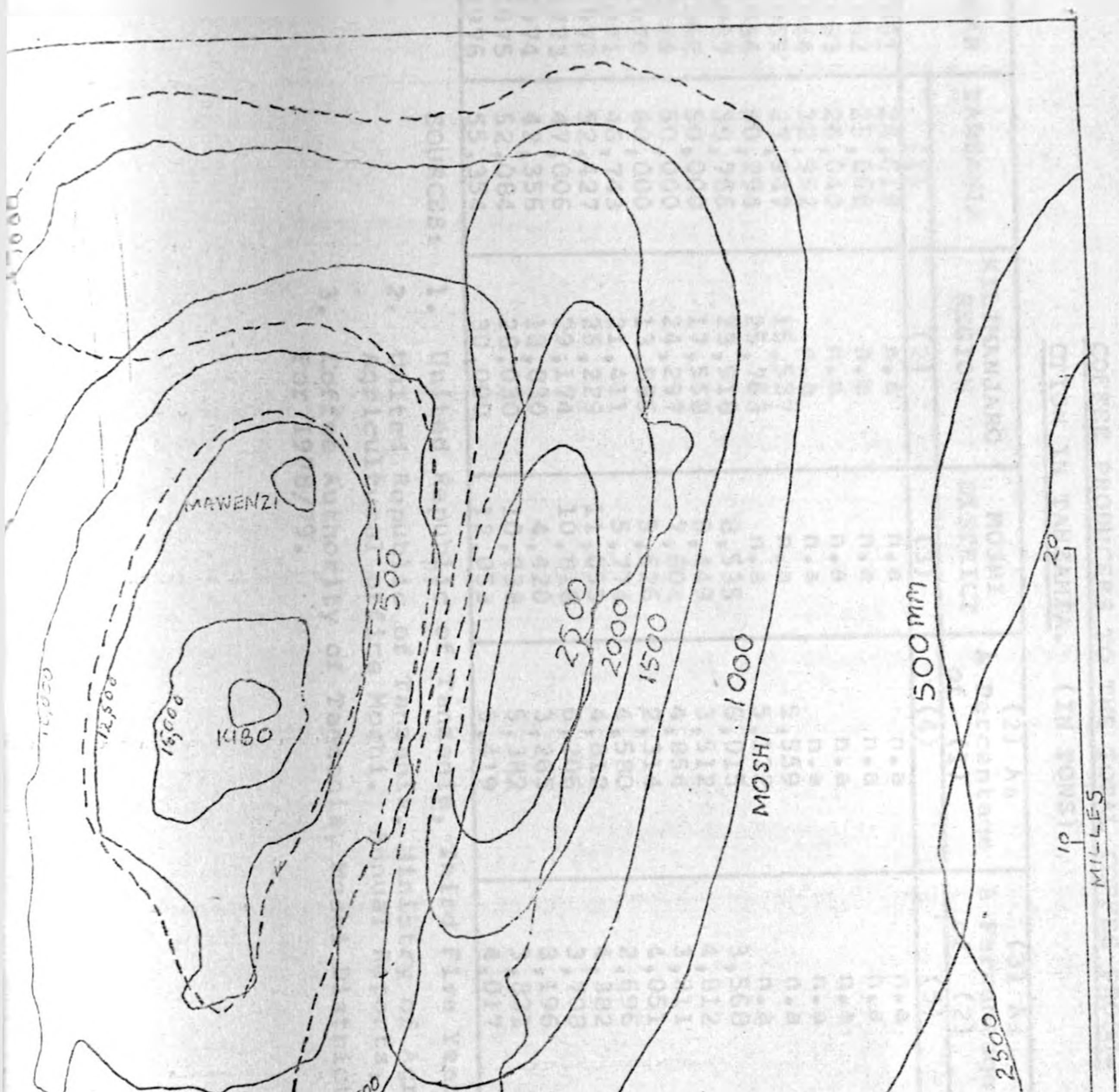
A1.2 TYPICAL RAINFALL DISTRIBUTION - MAIZE/BEANS BELT (LOWER AREAS) MOSHI TOWN METERIOLOGICAL STATION - 20 YEARS AVERAGES (MM)

1930-1975

STATION	ALTITUDE FT.	NUMBER OF YEARS RECORDED	MEAN MONTHLY RAINFALL (MM)													
			JAN	FEB	MARCH	APRIL	MAY	JUN	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	Annual Mean	Approx. Range (MM)
MOSHI TOWN METERIO-LOGICAL STATION	2668	44	40	44	117	290	156	30	12	12	13	34	55	48	852	700-1000

SOURCE: Tanzania, Ministry of Agriculture
Annual Reports Moshi District. 1930-1975

A1.3: ISOHYTES MAP FOR MOSHI DISTRICT



(ISOHYETS ARE IN MILLIMETRES, AND BROKEN LINES INDICATE THE PROBABLE RAINFALL DISTRIBUTION IN AREAS WITHOUT RAINFALL, REPORTING STATIONS.)

(from: Anderson, G.D.: a survey of the soils and land use potential of the southern and eastern slopes of Mt. Kilimanjaro Tanzania)

A1.4 CONTRIBUTION FOR MOSHI DISTRICT SMALLHOLDER COFFEE PRODUCERS TO THE TOTAL COFFEE PRODUCTION IN TANZANIA. (IN TONS)

YEAR	TANZANIA	KILIMANJARO REGION	MOSHI DISTRICT	(2) As A Percentage of (1)	(3) As A Percentage of (2)	(3) As A Percentage of (1)
	(1)	(2)	(3)	(4)	(5)	(6)
1961	24,618	n.a	n.a	n.a	n.a	n.a
1962	25,668	n.a	n.a	n.a	n.a	n.a
1963	26,040	n.a	n.a	n.a	n.a	n.a
1964	32,952	n.a	n.a	n.a	n.a	n.a
1965	27,947	15,537	n.a	5,559	n.a	n.a
1966	50,294	25,763	n.a	5,122	n.a	n.a
1967	39,766	23,918	8,535	6,015	3,568	2,146
1968	50,000	17,558	8,449	3,512	4,812	1,689
1969	50,000	24,297	7,804	4,854	3,211	1,560
1970	60,000	13,885	5,626	2,314	4,051	937
1971	46,743	21,411	5,774	4,580	2,696	1,235
1972	52,427	25,229	11,055	4,812	4,382	2,108
1973	47,006	29,174	10,818	6,206	3,708	2,301
1974	42,356	13,830	4,420	3,265	3,196	1,043
1975	52,084	28,030	10,738	5,382	3,831	2,061
1976	55,354	30,000	12,053	5,419	4,017	2,177

SOURCES:
1. United Republic of Tanzania, Third Five Years Plan 1976-1981
2. United Republic of Tanzania, Ministry of Agriculture, Regional Agricultural office Moshi. Annual Reports, 1965-1976.
3. Coffee Authority of Tanzania, Moshi District office, work Plan for 1978/79.

A2.1 FARM QUESTIONNAIRE

DISTRICT ....DIVISION ....

VILLAGE ....VILLAGE CHAIRMAN........

FARMER/FARM NUMBER..............DATE.............

ENUMERATOR ....

1. Are you the owner of this farm?

Yes .... NO ....

2. What is your name?.............................

3. Are you managing it on behalf of someone?

Yes .... NO ....

If you are managing it for someone, for whom are you managing the farm?

Husband Son Relative Friend

Father Brother Employer

4. What is your Age? Write approximate

Age ....

(a) 15-19 (e) 35-39

(b) 20-24 (f) 40-44

(c) 25-29

(d) 30-34

(k) Over 60

5. What level of Education did you Achieve?

(a) None (d) Form 1-2 (g) Over Form 6

(b) Std 1-4 (e) Form 3-4 (h) Adult Education

(c) Std 5-8 (f) Form 5-6

A2.2

(i) Technical Training

(j) Others - Specify

____

____

6. Are you:

(a) Single (b) Married (c) Divorced

(d) Widowed

7. If you are/or were married, how many wives does/did your husband have?

(i) one (ii) Two (iii) Three

(iv) Four (v) Five (vi) Six or more

- please specify.

8. FAMILY STRUCTURE:

No.	Member of family	Sex	Age	Living on farm	Living off the Farm	Schooling
1.						
2.						
3.						
4.						
5.						
6.						
7.						

A2.3

9. FARM STRUCTURE AND LAND - USE:

(a) How many acres of Land do you have:

....Acres.

(b) What rights do you have to this land?

Inherited ....Bought ....

Renting ....

(c) How many separate pieces of Land do you have? ....

(d) How many are more than ¼ mile from your House?

No.	Plot Number	Distance From Home	Acreage
(i)			
(ii)			
(iii)			
(iv)			
(v)			
(vi)			

(e) Do you pay rent for any Land?

(i) Yes .... No. ....

If Yes, What kind of Rent? ....

....

....

....

(f) Can Land be bought locally? ....

Yes ....No ....

A2.4

(g) How much would a cropped Land like yours here worth per acre (including Improvements except buildings?).

T.shs. ....

10. FARM SIZE AND CROPS:

(a) What area on this farm is at present not used for cultivation?............... Acres.

CROPS

(i) COFFEE:

Age Distribution	Acreage	Spacing	Number of Trees per Acre	YIELDS	
				Cheries Bags/Acre	Parchment Coffee Bags/Acre
1-4 Yrs.					
4-20 Yrs					
Over 20 Yrs					

11. TOTAL COFFEE PRODUCTION ON THE FARM

Total Coffee Acreage at Bearing Age	Amount Sold (Bags)	Total Receipts (Shs)	Price per Kg 1977/78 Season

A2.5

12. BANANAS:

Variety	Acreage	Banana Stools/ Acre	Yields per Acre	Approximate Spacing
(i)				
(ii)				
(iii)				
(iv)				
(v)				

13. TOTAL PRODUCTION:

Month	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JU	JUL	AUG	SEP
Number of Bunches sold per Month												
Average Weight of Bunch												
Total Produ- ction Per Acre												
Bunches Con- sumed At Home												

A2.6 14. OTHER CROPS & MIXTURES

** Crop or Crop mixture	Number of Plots	Approx. Acreage	Number of Units Harvested	Amount Sold (Units)	Price per Unit	Amount Consumed at Home (Units)
(i)						
(ii)						
(iii)						
(iv)						
(v)						
(vi)						
(vii)						
(viii)						
(ix)						
(x)						

** Indicate if interplanted or Double cropped.

A2.7

15. INPUTS

(a) Did you use Fertilizers of any kind on (crop) last year/Season.

Yes, ...NO ....

If Yes, please specify as indicated below:-

Type 1.......... Crop or crop Mixtures ....Quantity ....Cost(SHS)
2..........-do- .... -do- ....-do-......
3..........-do- .... -do- ....-do-......
4..........-do- .... -do- ....-do-......
5..........-do- .... -do- ....-do-......

(b) Did you use any other inputs of any kind on (crops) last year/season, such as Insecticides, Fungicides, Herbicides etc.

TYPE	Crop or crop mixtures	Quantity	Cost (T. Shs)
1.			
2.			
3.			
4.			
5.			

(c) Did you buy seeds or seedlings for (mention crop) last Year/season e.g. Hybrid Maize seeds.

Type	Crop
1.	
2.	
3.	
4.	

A2.8

16. CROP HUSBANDRY AND LABOUR REQUIREMENTS PER MONTH

Crop	Acreage	Operation	CROP LABOUR REQUIREMENTS PER MONTH											
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG.	SEP
Coffee/ bananas (Inter- planted)		CULTIVATION												
		MULCHING												
		WEEDING												
		APPLYING FERS.												
		PLANTING COFFEE												
Or Coffee pure stand or Bananas (Pure Stand)		PRUNNING COFFEE												
		SPRAYING CBD SPRAYING ANTESTIA												
		PICKING COFFEE												
		DRYING COFFEE												
		HARVESTING BANS.												
		MARKETING BANANAS												
		MARKETING COFFEE												
Maize/ Beans Or Maize Pure Stand.		LAND PREPARATION												
		PLANTING .												
		WEEDING												
		APPLYING FERTS.												

........../2

A2.9

Crop	Acreage	Operation	CROP LABOUR REQUIREMENTS PER MONTH											
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG.	SEP
MAIZE/ BEANS Or Maize pure Stand		HARVESTING												
		PROCESSING												
		MARKETING												
Livestock Numbers		MILKING												
		MARKETING												
		COLLECTING FODDER AND FEEDS												
		HERDING												

A2.10 17. OFF-FARM ACTIVITIES

PERSON IN THE FAMILY	SEX	AGE	KIND OF WORK	Rate of Pay in cash/kind Eg. per Month Contract or Casual	NUMBER OF DAYS "OFF-FARM" EMPLOYED PER MONTH											
					OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1.																
2.																
3.																
4.																
5.																
6.																
7.																
8.																
9.																
10.																
11.																

A2.11 18. HIRED LABOUR

* Type of Labour	Sex	Age	Kind of Work Hired For	Number of People/and Place of Origin	Wages Paid (In Kind/ or Cash)	Estimated Cost per Month- Including Boarding or Lodging	Periods for which labour is Hired	Total Costs
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
11.								

INDICATE WHETHER PERMANENT, SEASONAL, CASUAL OR whether employed per day, week, month or year. Also indicate whether there is communal work groups or labour sharing on an alternate basis.

A2.12

19. Besides the above, have you any other incomes such as pensions, etc.

Yes ....No ....

If Yes, please specify,

TYPE OF INCOME	AMOUNT PER MONTH OR YEAR
1.	
2.	
3.	
4.	

20. Does any one of your family either son or Daughter working elsewhere remit any sums of money to you on the farm?

Yes ....No ....

If Yes, kindly specify,

Member of family	Age	Sex	Amount (T.Shs) remitted per month or Year.
1.			
2.			
3.			
4.			
5.			

21. <u>CAPITAL COSTS</u>

Could you inform us on the assets you have on this farm such as Tractors, Buildings, sprayers. Jembes, Pangas, Pulpers etc.

A2.13

ITEM	YEAR OF PURCHASE OR BUILDING	COST (SHS)	ESTIMATED LIFE	MAINT. AND REPAIRS (SHS)	OPER. COSTS	BEGN. OF YR. VAL.	END OF YEAR VAL.
Farm Builds.							
Stores							
Tractor (Type)							
Sprayer (types)							
Pulpers (Types)							
Jembes							
Shovels							
Pangas							
Others Specify							

A2.14

22. Crop Marketing

CROP	BUYER	METHOD OF TRANSPORT	DISTANCE TO MARKET	PRICE PER UNIT (E.G. KG BUNCH/BAGS/ etc.
(i)				
(ii)				
(iii)				
(iv)				
(v)				
(vi)				

(a) What is your opinion about the existing crop prices? Are they

(i) Satisfactory
(ii) Too low
(iii) Not high enough
(iv) No comments
(v) Others (specify) ....
....

(b) Have you had any problems with marketing of the major crops? Yes .... No ....

If Yes, please explain:

....
....
....
....
....

A2.15

23. LIVESTOCK ENTERPRISE

(a) Livestock Inventory: (i) Dairy Herd:

Class	Grade Cattle		Indigeneous Cattle	
	Number	Total Value	Number	Total Value
Cows (Total)				
Cows in Milk				
Heifers 2 yrs.				
Female Calves 1 Year				
Young Bulls 1 Year	--			
Mature Bulls				
Total				

(ii) Other Livestock

TYPE	MATURE				IMMATURE			
	MALE		FEMALE		MALE		FEMALE	
	NO	Total Value (T.Shs)	No	Total Value (T.Shs)	No	Total Value (T.Shs)	No.	Total Value (Tshs)
Beef								
Sheep								
Goats								
Poultry (i) chicken (ii) Others								
Others (specify)								

A2.16

24. LIVESTOCK EXPENSES

TYPE OF EXPENSES	AMOUNT BOUGHT	COST PER UNIT (T. SHS.)	TOTAL COST
1.			
2.			
3.			
4.			
5.			
6.			

25. LIVESTOCK PRODUCTS

KIND OR PRODUCT	AMOUNT PRODUCED PER DAY, MONTH OR YEAR	AMOUNT CONSUMED AT HOME	AMOUNT SOLD	PRICE PER UNIT
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				

26. OTHER LIVESTOCK EXPENSES:

(a) Do you graze or stall-feed your livestock?

....

(b) How much grazing Land do you have?

....

(c) Have you established improved pastures on your farm?

Yes ....No ....

If not, what are the major problems?

1.......................................
2. ....
3. ....

(d) If you stall-feed your cattle, where do you collect your fodder grass ....
...............How many miles from the Home-stead? ....what means of transport do you use ....
....
What is the approximate cost per month
....

(e) Approximately how much did you spend on supplementary feeds and salt for your cattle last year? (HS) ....

(f) Are there any Dipping/Spraying facilities for your livestock in this village? Please specify.

Place ....Distance from Home ....who owns it ,...
..............Cost per animal ....

A2.18

(g)

	Month Item	No. of cattle affected	Total costs	Vet. Asst. sought YES/NO
For the veterinary expenses you had since last year, can you tell me the month, Item, No. of cattle affected and if you requested for treatment or not				

27. CREDIT:

(1) How much money did you borrow this past season to pay for some of your costs of production on this farm?

AMOUNT (T.SHS)	BORROWED FROM	USED FOR	TERMS OF REPAYMNET (IN CASH, OR IN KIND) DURATION OF LOAN AMOUNT TO BE REPAYED OR INTEREST RATE.
1.			
2.			
3.			
4.			
5.			
6.			
7.			

(2) Besides money borrowed, did you take Fertilizers, Insecticides, seeds or other inputs on credit this past year or season.

Yes ....No ....

A2.19

If Yes, please specify:-

Type	Amount	From whom or where	Used for	Terms Repayment as above
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

(3) If more production credit had been available to you this past season/year would you have used it?

Yes .... No.................

If yes, how and why ....

....

....

....

28. <u>EXTENSION CONTACT AND QUALITY</u>

	Kilimo Staff	Vet. Staff	Staff from Ushirika	DDD'S Office
(1) How many times have Govt., officials visited your farm since last year 1977				

(2) There are several committees in this Village, is anyone from this farm a member of any of these committees.

A2.20

Specify as below:

Member of family	Committee participating	State status in the Committee eg. member, Chairman etc.
1.		
2.		
3.		

(3) Have you or any member of the family attended agricultural courses? When and where?

....

....

....

(4) Did you Hire a tractor for your farming activities?

Yes ....No ....

(5) Which crops and operations did you use the Hired tractor on?

1. ....
2. ....
3. ....

(6) (i) What is the current Hire charges (SHS)

......................per ....

(ii) What is your opinion on these charges .....

....

....

(7) The Government is trying to improve tools, equipment, machines etc at its Research stations so that better and or cheaper tools equipment and machines can be made available for farming in this area.

Can you tell us which one you think is important.

A2.21

Better Hand Tools	Better Ox-equipment	Better Tractor Hire service
Small machines	Other - Specify	

* Please tick whichever is appropriate.

(8) What else do you think the Government could do to help you with farm work in this area?

....

....

....

....

(9) What do you consider as your greatest problem with farming in this Village?

1. Land shortage ....
2. Inadequate rain ....
3. Lack of operating capital ....
4. Purchased inputs eg. fertilizers and insecticides are very essential but expensive ....
5. Lack of extension advice ....
6. Lack of proper tools ....
7. Others - please specify ....

....

....

....

A3.1 GROSS MARGIN CALCULATION

ENTERPRISE: BANANAS : EXISTING TECHNOLOGY

DETAILS	UNITS	Unit Price T.SHS	Units per Hectare	Value per Hectare (Tshs)
I Yield	Kg	0.65	9600	6240.00
Gross output				6240.00
II Allocatable costs				
1. Weeding & Prunning	Man-days		23	350.00
2. Fertilizers				
2.1 Manure	Tons		3	300.00
3. Transport				
4. Depreciation on tools				150.00
5. Other costs				100.00
Total variable costs				900.00
6. Labour requirements				
6.1 weeding			63	
6.2 prunning			20	
6.3 harvesting			40	
6.4 Other labour			10	
Total labour requirements			133	
Gross margin				5340.00
Gross margin per man-day				40.00

A3.2

FARM NO: REPRESENTATIVE FARM

GROSS MARGIN CALCULATIONS - COFFEE/BANANA SMALL-HOLDERS:

AREA: MOSHI (RURAL) DISTRICT: SAMPLE VILLAGES:

CROP MIXTURES: MAIZE/BEANS SEASON: 77/78

INPUT-OUTPUT DATA PER HECTARE: EXISITING TECHNOLOGY

ITEM	Unit	Unit per Hectare	Unit Price Tshs.	Value per Hectare Tshs
(A) OUTPUT:				
1. YIELD MAIZE	Kg	1260	0.85	1071.00
BEANS	Kg	324.9	3.15	1023.40
2. GROSS OUTPUT				2094.40
(B) VARIABLE INPUTS:				
3. SEEDS MAIZE	Kg	25	1.60	40.00
BEANS	Kg	10	3.15	31.50
4. TRACTOR HIRE CULTIVATION:	Tshs	300	-	300.00
5. OTHERS e.g. Transport, bags etc:	Tshs	-	-	25.50
6. TOTAL VARIABLE COSTS	Tshs	-	-	397.00
(C) GROSS MARGIN	Tshs	-	-	1697.40
(D) LABOUR INPUTS IN MAN-DAYS				
7. LAND PREPARATION:		0.5		
8. PLANTING:		15		
9. WEEDING:		68		
10. HARVESTING:		35		
11. SELLING, TRANSPORT, MARKETING		14		
12. TOTAL LABOUR INPUT (MAN-DAYS		164.5		
(E) GROSS MARGIN PER MAN-DAY				10.30

A3.2

(E) GROSS MARGIN PER MAN-DAY: = TShs. 10.30

(GE) MONTHLY LABOUR REQUIREMENTS PER HECTARE:

JANUARY	=	-
FEBRUARY	=	0.5
MARCY	=	15
APRIL	=	68
MAY	=	32
JUNE	=	-
JULY	=	15
AUGUST	=	20
SEPTEMBER	=	14
OCTOBER	=	-
NOVEMBER	=	-
DECEMBER	=	-

A3.4

FARM NO: REPRESENTATIVE FARM SAMPLE AREA.

GROSS MARGIN CALCULATIONS - COFFEE/BANANA

SMALL-HOLDERS:

AREA: MOSHI (RURAL) DISTRICT: SAMPLE VILLAGES:

CROP: MIXED BEANS SEASON: 77/78

INPUT-OUTPUT DATA PER HECTARE
(UNDER PRESENT CROP HUSBANDRY)

ITEM	UNIT	UNIT PER HECTARE	UNIT PRICE TSHS.	VALUE PER HECTARE TSHS.
(A) OUTPUT				
1. YIELD	Kg	324.72	3.15	
2. GROSS OUTPUT				1022.75
(B) VARIABLE INPUTS:				
3. SEEDS	Kg	25	3.15	78.75
4. TRACTOR HIRE CULTIVATION:	Tshs	300.00		300.00
5. OTHERS e.g. Transport, bags etc:	Tshs			40.00
6. TOTAL VARIABLE COSTS				418.75
(C) GROSS MARGIN				604.12
(D) LABOUR INPUTS IN MAN-DAYS				
7. LAND PREPARATION:		30.3		
8. PLANTING:		12.5		
9. WEEDING:		17		
10. HARVESTING:		15		
11. TOTAL LABOUR INPUT (MAN-DAYS)		74.8		
12. GROSS MARGIN PER MAN-DAY				8.61

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A3.4

(E) GROSS MARGIN PER MAN-DAY: = TShs. 8.61

(G) MONTHLY LABOUR REQUIREMENTS PER HECTARE:

JANUARY	-
FEBRUARY	0.5
MARCH	12.5
APRIL	17
MAY	15
JUNE	-
JULY	-
AUGUST	-
SEPTEMBER	-
OCTOBER	-
NOVEMBER	-
DECEMBER	-

A3.5

FARM NO: REPRESENTATIVE FARM SAMPLE AREA.

GROSS MARGIN CALCULATIONS - COFFEE/BANANA SMALL-HOLDERS:

AREA: MOSHI (RURAL) DISTRICT: SAMPLE VILLAGES:

CROP: MAIZE SEASON: 77/78

INPUT-OUTPUT DATA PER HECTARE: EXISTING TECHNOLOGY

ITEM	UNIT	UNIT PER HECTARE	UNIT PRICE TSHS.	VALUE PER HECTARE TSHS.
(A) OUTPUT				
1. YIELD	KG	1485.0	0.85	
2. GROSS OUTPUT				1262.00
(B) VARIABLE INPUTS:				
3. SEEDS	Kg	25	1.60	40.00
4. TRACTOR HIRE CULTIVATION:				300.00
5. TOTAL VARIABLE COSTS				340.00
(C) GROSS MARGIN				922.00
(D) LABOUR INPUTS IN MAN-DAYS				
6. LAND PREPARATION:		0.5		
7. PLANTING:		16		
8. WEEDING:		108		
9. HARVESTING:		25		
10. SELLING, TRANSPORT, MARKETING		9		
11. TOTAL LABOUR INPUT (MAN-DAYS)		158.5		
(E) GROSS MARGIN PER MAN-DAY				5.80

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A3.5

(E) GROSS MARGIN PER MAN-DAY: TShs. 5.80

(G) MONTHLY LABOUR REQUIREMENTS PER HECTARE:

JANUARY	-
FEBRUARY	0.5
MARCH	8
APRIL	68
MAY	48
JUNE	-
JULY	-
AUGUST	20
SEPTEMBER	14
OCTOBER	-
NOVEMBER	-
DECEMBER	-

A3.6

FARM NO:

GROSS MARGIN CALCULATIONS - COFFEE/BANANA SMALL-HOLDERS:

AREA: MOSHI (RURAL) DISTRICT: SAMPLE VILLAGES:

CROP: BANANAS SEASON: 1977/78

INPUT-OUTPUT DATA PER HECTARE: IMPROVED TECHNOLO

ITEM	UNIT	UNIT PER HECTARE	UNIT PRICE TSHS.	VALUE PER ECTARE TSHS.
(A) OUTPUT				
1. YIELD	Kg	20,000	0.65	
2. GROSS OUTPUT				13000.00
(B) VARIABLE INPUTS:				
3. FERTILIZERS: (Manure)	Tons	6	500.0	3061.00
4. SPRAYS & DUSTS: Aldrin/Dieldrin	Kg	50	5.00	247.00
5. Mulching	Tons	6	200	1160.00
6. OTHERS e.g. Transport, bags etc:				1480.00
7. TOTAL VARIABLE COSTS				5950.00
(C) GROSS MARGIN				7049.00
(D) LABOUR INPUTS IN Man- MAN-DAYS				
8. APPLY FERTILIZERS:		50		
9. WEEDING:		82		
10. HARVESTING:		60		
11. SELLING, TRANSPORT, MARKETING		50		
12. TOTAL LABOUR INPUT (MAN-DAYS)		242		
(E) GROSS MARGIN PER MAN-DAY		29.00		

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A3.6

(E) GROSS MARGIN PER MAN-DAY: 29.00

(G) MONTHLY LABOUR REQUIREMENTS PER HECTARE:

JANUARY	22
FEBRUARY	20
MARCH	26
APRIL	30
MAY	30
JUNE	30
JULY	10
AUGUST	10
SEPTEMBER	10
OCTOBER	22
NOVEMBER	22
DECEMBER	10

A3.7

FARM NO: REPRESENTATIVE

GROSS MARGIN CALCULATIONS - COFFEE/BANANA SMALL-HOLDERS:

AREA: MOSHI (RURAL) DISTRICT: SAMPLE VILLAGES:

CROP MIXTURES: MAIZE/BEANS SEASON: 1977/78

INPUT-OUTPUT DATA PER HECTARE: IMPROVED TECHNOLOGY

ITEM	UNIT	UNIT PER HECTARE	UNIT PRICE TSHS.	VALUE PER HECTARE TSHS.
(A) OUTPUT				
1. YIELD MAIZE	Kg	2700	0.85	2295.00
BEANS	Kg	900	3.15	2835.00
2. GROSS OUTPUT				5130.00
(B) VARIABLE INPUTS:				
3. SEEDS: MAIZE	Kg	25	5.75	143.75
BEANS	Kg	25	3.15	78.75
4. FERTILIZERS: TSP	Kg	50	82.35 per 50Kg	82.35
SA	Kg	150	58.85 per 50Kg	176.55
5. SPRAYS & DUSTS:	Kg	10	4.00	40.00
6. TRACTOR HIRE CULTIVATION:	Ha.	Tshs	300	300.00
7. OTHERS e.g. Transport, bags etc:				825.00
8. TOTAL VARIABLE COSTS				1646.40
(C) GROSS MARGIN				3483.60
(D) LABOUR INPUTS IN MAN-DAYS				
9. LAND PREPARATION:				
Tractor:		0.5		300.00

A3.7

ITEM	UNIT	UNIT PER HECTARE	UNIT PRICE TSHS.	VALUE PER HECTARE TSHS.
10. PLANTING:		20		143.75
11. APPLY FERTILIZERS:		15		
12. WEEDING:		65		
13. HARVESTING:		25		
14. SELLING, TRANSPORT, MARKETING		15		
(E) GROSS MARGIN PER MAN-DAY		23.22		

(F) GROSS MARGIN PER MAN-DAY - TShs. 23.00

(G) MONTHLY LABOUR REQUIREMENTS PER HECTARE:

JANUARY .... NIL

FEBRUARY 0.5

MARCH 23

APRIL 25

MAY 22

JUNE 25

JULY 20

AUGUST 35

SEPTEMBER 35

OCTOBER .... NIL

NOVEMBER .... NIL

DECEMBER .... NIL

A5.1

HECTARES CROPPED UNDER PERMANENT AND ANNUAL CROPS AND THEIR PERCENTAGES OF TOTAL LAND IN THE SAMPLE AREA

FARM NO.	Permanent Crops (Ha) Coffee/Bananas	Annual Crops (Ha) Maize/Beans/F. Millets	Total (Ha)
1	1.22	0.20	1.41
2	0.91	0.41	1.32
3	0.41	N/L	0.41
4	0.91	N/L	0.91
5	0.61	0.1	0.71
6	0.81	0.41	1.22
7	1.01	0.61	1.62
8	1.22	0.41	1.63
9	2.53	1.11	3.64
10	2.43	1.11	3.54
11	0.41	N/L	0.41
12	1.01	0.41	1.42
13	1.01	0.51	1.52
14	1.01	1.01	2.02
15	0.51	0.3	0.81
16	1.52	0.41	1.93
17	1.01	1.22	2.23
18	1.01	0.30	1.31
19	1.22	0.81	2.03
20	1.22	0.41	1.63
21	1.22	0.81	2.03
22	0.41	1.22	1.63
23	0.41	0.61	1.02
24	0.61	0.41	1.02
25	0.41	N/L	0.41
26	1.62	0.81	2.43
27	0.61	1.62	2.23

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A5.1

Farm NO.	Permanent Crops (Ha) Coffee/Bananas	Annual Crops (Ha) Maize/Beans/F. Millets	Total (Ha)
28	0.41	0.61	0.61
29	0.41	0.2	0.61
30	0.61	0.1	0.71
31	1.01	NIL	1.01
32	1.42	NIL	1.42
33	0.51	1.02	1.53
34	0.71	2.53	3.24
35	0.41	0.80	1.21
36	1.22	0.61	1.83
37	0.81	0.41	1.22
38	1.22	1.01	2.23
39	0.61	0.82	1.43
40	0.41	NIL	0.41
41	1.01	0.2	1.21
42	1.01	0.41	1.42
43	1.01	0.2	1.21
44	0.81	1.22	2.03
45	2.03	0.41	2.44
46	1.01	0.61	1.62
Total	43.92	25.97	69.88
% of all land	62.85%	37.16%	100.00

AS.2

SIZE OF HOUSEHOLD, AGE DISTRIBUTION AND SEX STRUCTURE OF THE LABOUR STOCK IN SAMPLE AREA

Farm Number	Total in Household	Children 0-14 Years	Children in School over 7 yrs	Adults on Farm 15-60		Adults on Farm over 60 yrs		Adults off Farm 15-60 yrs	
				M	F	M	F	M	F
1	6	4	-	1	1	-	-	-	-
2	7	3	3	1	1	-	-	-	1
3	3	1	-	1	1	-	-	-	-
4	9	6	4	1	1	-	-	-	-
5	9	4	4	3	1	-	-	-	-
6	9	1	3	1	1	1	-	3	1
7	5	3	-	1	1	-	-	-	-
8	4	2	2	1	1	-	-	-	-
9	11	6	7	1	1	-	-	-	-
10	11	5	5	2	2	-	-	1	-
11	8	5	3	1	1	-	-	-	-
12	12	4	6	1	2	-	-	3	-
13	7	-	-	2	4	-	-	-	1
14	2	-	-	1	1	-	-	-	-
15	7	3	2	1	1	-	-	1	1
16	12	5	7	1	1	-	-	1	-
17	12	3	2	3	3	1	-	1	1
18	9	7	1	1	1	-	-	-	-
19	6	-	4	1	1	-	-	-	-
20	11	-	-	4	2	-	-	3	2
21	5	1	2	1	2	-	-	-	-
22	7	3	1	2	1	-	-	-	-
23	5	3	-	1	1	-	-	-	-
24	5	-	-	3	2	-	-	-	-

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A5.2

Farm Number	Total in House-Hold	Children 0-14 Years	Children in School over 7 yrs	Adults on Farm 15-60		Adults on Farm over 60 yrs		Adults off Farm 15-60 Yrs	
				M	F	M	F	M	F
25	5	2	-	2	1	-	-	-	-
26	7	-	-	3	4	-	-	-	-
27	4	1	-	2	1	-	-	-	-
28	2	-	-	1	1	-	-	-	-
29	5	-	1	-	2	-	-	2	-
30	5	3	-	1	1	-	-	-	-
31	4	2	2	1	1	-	-	-	-
32	7	1	-	2	4	-	-	-	-
33	7	1	2	1	3	-	-	-	-
34	7	-	-	2	1	1	-	2	1
35	11	5	4	2	2	-	-	1	-
36	8	5	3	1	1	-	-	-	-
37	9	-	-	5	1	1	1	-	3
38	11	-	2	1	1	1	-	4	3
39	13	-	-	2	1	1	-	3	7
40	8	-	-	4	2	-	-	-	2
41	13	6	5	1	2	-	-	1	1
42	8	3	5	1	1	-	-	-	1
43	7	2	4	1	1	-	-	1	-
44	9	2	3	1	3	-	-	1	1
45	8	-	-	1	1	-	-	4	2
46	10	1	2	3	3	1	-	-	2
Total	350	103	89	74	72	7	1	32	30
% of Total	-	29.43	25.43	21.14	20.57	2	0.29	9.14	8.57

AVERAGE NUMBER OF PEOPLE PER HOUSEHOLD: 8

AVERAGE NUMBER OF FARM WORKERS PER HOUSEHOLD: 3.2

A6.1 Model 1: OPTIMAL PLAN SOLUTION

PROBLEM LP01 SOLUTION

DUMP:DUMP 3

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

	NAME		VALUE	OBJECTIVE	REDUCED COST
	PRODCO	+	0	1570.3000	-3598.3198
B	PRODBA	+	0.7711	-200.0000	0
B	PRODMZ	+	0.0222	-340.0000	0
	PRODBN	+	0	-418.7500	-1906.8265
B	PRODMZBN	+	0.8310	-397.0000	0
B	PRODCW	+	1.1570	2916.4200	0
B	SELBA	+	83.8179	13.0000	0
	SELMZ	+	0	76.5000	-200.8430
	SELBN	+	0	283.5000	-38.6474
	MARHR	+	0	-15.0000	-15.0000
B	APRHR	+	45.5564	-15.0000	0
B	MAYHR	+	16.6249	-15.0000	0
B	JULHR	+	1.2288	-15.0000	0
	AUGHR	+	0	-15.0000	-15.0000
	SEPHR	+	0	-15.0000	-15.0000
	CRDTA	+	0	-1.1200	-0.3239
	OBJECTIVE		3021.2477		

A6.1 MODEL 1: OPTIMAL PLAN SOULTION

PROBLEM LP01 SOLUTION

DUMP:DUMP 3 RIGHT HAND SIDE LIMITS

ROW INFORMATION OBJECTIVE PROFIT

NAME		SLACK	R.H.S.	PRICE
# PROFIT	Z	3021.2477	0	
LAND	+	0	1.7400	-2609.6729
B JANL	+	25.0160	67.0000	0
B FEBL	+	15.8100	56.1000	0
B MARL	+	9.0842	40.2000	0
APRL	+	0	40.2000	-15.0000
MAYL	+	0	56.1000	-15.0000
B JUNL	+	16.2366	56.1000	0
JULYL	+	0	51.1000	-15.0000
B AUGL	+	4,8679	67.0000	0.000000030
B SEPL	+	4,2920	56.1000	0
B OCTL	+	16.2366	56.1000	0
B NOVL	+	16.2366	56.1000	0
B DECL	+	14.3210	51.1000	0
OPCA	+	0	3500.0000	-0.7911
BANPRD		0	-315.0000	-7.0000
MZPRD		0	-12.0000	-277.3430
BNPRD		0	-3.0000	-322.1474
B MARH	+	13.6000	13.6000	0
B APRH	+	82.7936	128.3500	0
B MAYH	+	47.5251	64.1500	0
B JULYH	+	22.1712	23.4000	0
B AUGH	+	40.4100	40.4100	0
B SEPH	+	24.5600	24.5600	0
B CRDT	+	2900.0000	2900.0000	0

A6.1 MODEL 1: OPTIMUM PLAN SOLUTION

PROBLEM LP01

DUMP:DUMP 3

OBJECTIVE RANGING

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

VARIABLE	TYPE	OBJECTIVE	LOWER LIMIT OF OBJECTIVE	INCOMING AT LOWER LIMIT	UPPER LIMIT OF OBJECTIVE	INCOMING AT UPPER LIMIT
PRODBA	+	-200.0000	-1139.6128	SELBN	20211.3000	OPCA
PRODMZ	+	-340.0000	-504.4309	SELBN	1012.1443	PRODBN
PRODMZBN	+	-397.0000	-1544.2739	PRODBN	-257.4828	SELBN
PRODCW	+	2916.4200	875.2900	OPCA	3764.8900	CRDTA
SELBA	+	13.0000	11.1833	SELBN	52.4650	OPCA
APRHR	+	-15.0000	-53.9016	PRODBN	-10.1972	SELBN
MAYHR	+	-15.0000	-20.1718	SELBN	0	MAYL
JULHR	+	-15.0000	-35.0992	PRODBN	0	JULYL

A6.2 MODEL 2: OPTIMAL PLAN SOLUTION

PROBLEM LP01 SOLUTION

DUMP:DUMP 3 RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

	NAME		VALUE	OBJECTIVE	REDUCED COST
	PRODCO	+	0	1570.3000	-3833.4424
B	PRODBA	+	1.6449	-200.0000	0
	PRODMZ	+	0	-340.0000	-10616.3646
	PRODBN	+	0	-418.7500	-5290.0395
	PRODMZBN	+	0	-397.0000	-14616.2548
B	PRODCW	+	0.9510	2916.4200	0
B	SELBA	+	850.7439	13.0000	0
B	SELMZ	+	0	76.5000	0
B	SELBN	+	0	283.5000	0
	MARHR	+	0	-15.0000	-15.0000
B	APRHR	+	0	-15.0000	0
	MAYHR	+	0	-15.0000	-15.0000
	JULHR	+	0	-15.0000	-15.0000
	AUGHR	+	0	-15.0000	-15.0000
	SEPHR	+	0	-15.0000	-15.0000
	CRDTA	+	0	-0.0800	-0.0800
	OBJECTIVE	+	13504.1120		

A6.2 MODEL 2: OPTIMAL PLAN SOLUTION

PROBLEM LP01 SOLUTION

DUMP:DUMP 3 RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

ROW INFORMATION

	NAME		SLACK	R.H.S.	PRICE
#	PROFIT	Z	13504.1120	0	
	LAND	+	0	1.7400	-3261.4060
B	JANL	+	20.6185	67.0000	0
B	FEBL	+	14.2419	56.1000	0
B	MARL	+	20.9725	40.2000	0
	APRL	+	0	40.2000	-194.7578
B	MAYL	+	3.1388	56.1000	0
B	JUNL	+	14.2419	56.1000	0
B	JULYL	+	9.2419	51.1000	0
B	AUGL	+	14.0388	67.0000	0
B	SEPL	+	14.2419	56.1000	0
B	OCTL	+	14.2419	56.1000	0
B	NOVL	+	14.2419	56.1000	0
B	DECL	+	15.8216	51.1000	0
B	OPCA	+	698.5032	3500.0000	0
	BANPRD	+	0	0	-13.0000
	MZPRD	+	0	0	-76.5000
	BNPRD	+	0	0	-283.5000
B	MARH	+	0	0	0
	APRH	+	0	0	-179.7578
B	MAYH	+	0	0	0
B	JULYH	+	0	0	0
B	AUGH	+	0	0	0
B	SEPH	+	0	0	0

A6.2 MODEL 2: OPTIMAL PLAN SOLUTION

PROBLEM LP01

DUMP:DUMP 3

OBJECTIVE RANGING

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

VARIABLE	TYPE	OBJECTIVE	LOWER LIMIT OF OBJECTIVE	INCOMING AT LOWER LIMIT	UPPER LIMIT OF OBJECTIVE	INCOMING AT UPPER LIMIT
PRODBA	+	-200.0000	-3050.6650	LAND	20696.8500	APRH
PRODCW	+	2916.4200	826.7350	APRH	5179.9331	LAND
SELBA	+	13.0000	7.4883	LAND	53.4038	APRH
SELMZ	+	76.5000	0	MZPRD	719.9160	PRODMZ
SELBN	+	283.5000	0	BNPRD	1165.1732	PRODBN
APRHR	+	-15.0000	-194.7578	APRH	+INF	

A6.3 : MODEL 3A. OPTIMAL PLAN SOLUTION

PROBLEM LP01

DUMP:DUMP 3

COLUMN INFORMATION

	NAME		VALUE	OBJECTIVE	REDUCED COST
B	PRODCO	+	1.0159	6449.2000	0
B	PRODBA	+	0.3165	-5951.4000	0
B	PRODMZBN	+	0.4000	-1646.4000	0
B	DAIRY	+	0.0378	-5526.6300	0
B	SELBAN	+	1.5141	13.0000	0
	SELMZ	+	0	76.5000	-77.1323
B	SELBN	+	1.0000	283.5000	0
B	SELMLK	+	113.4519	2.5000	0
	FEBHR	+	0	-15.0000	-15.0000
	MARHR	+	0	-15.0000	-15.0000
	APRHR	+	0	-15.0000	-12.3400
	MAYHR	+	0	-15.0000	-15.0000
	JUNHR	+	0	-15.0000	-15.0000
	JULYHR	+	0	-15.0000	-15.0000
	AUGHR	+	0	-15.0000	-15.0000
	SEPHR	+	0	-15.0000	-15.0000
	OCTHR	+	0	-15.0000	-15.0000
B	CRDTA	+	2000.0000	-0.0800	0

OBJECTIVE 4227.4359

A6.3: MODEL 3A. OPTIMAL SOLUTION PLAN

PROBLEM LP01 SOLUTION

DUMP:DUMP 3 RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

ROW INFORMATION

NAME		SLACK	R.H.S.	PRICE
# PRODIT	Z	4227.4359	0	
LAND	+	0	1.7400	-5481.5143
B JANL	+	36.0111	67.0000	0
B FEBL	+	32.6496	56.1000	0
B MARL	+	4.6053	40.2000	0
APRL	+	0	40.2000	-2.6600
B MAYL	+	8.2615	56.1000	0
B JUNL	+	6.4519	56.1000	0
B JULYL	+	13.6743	51.1000	0
B AUGL	+	22.4784	67.0000	0
B SEPL	+	14.8293	56.1000	0
B OCTL	+	26.8598	56.1000	0
B NOVL	+	32.8321	56.1000	0
B DECL	+	33.2558	51.1000	0
OPCA	+	0	7000.0000	-0.1516
BANPRD	+	0	-315.0000	-12.4680
MZPRD	+	0	-12.0000	-153.6323
BNPRD	+	0	-3.0000	-283.5000
MLKPRD	+	0	0	-2.4987
B FEBH	+	300.0000	300.0000	0
B MARH	+	300.0000	300.0000	0
B APRH	+	200.0000	200.0000	0
B MAYH	+	200.0000	200.0000	0
B JUNH	+	200.0000	200.0000	0
B JULYH	+	200.0000	200.0000	0
B AUGH	+	200.0000	200.0000	0
B SEPH	+	200.0000	200.0000	0
B OCTH	+	200.0000	200.0000	0
CRDT	+	0	2000.0000	-0.0716

A6.3: MODEL 3A OPTIMAL PLAN SOLUTION

PROBLEM LP01

OBJECTIVE RANGING

DUMP:DUMP 3

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

VARIABLE	TYPE	OBJECTIVE	LOWER LIMIT OF OBJECTIVE	INCOMING AT LOWER LIMIT	UPPER LIMIT OF OBJECTIVE	INCOMING AT UPPER LIMIT
PRODCO	+	6449.2000	4356.5665	SELMZ	7074.5186	APRL
PRODBA	+	-5951.4000	-6582.5228	APRL	-3023.5715	APRHR
PRODMZBN	+	-1646.4000	-INF		667.5676	SELMZ
DAIRY	+	-5526.6300	-5834.8819	CRDT	-3309.3733	SELMZ
SELBAN	+	13.0000	12.3689	APRL	15.9278	APRHR
SELBN	+	283.5000	0	BNPRD	514.8968	SELMZ
SELMLK	+	2.5000	2.3972	CRDT	3.2391	SELMZ
CRDTA	+	-0.08000	-0.1516	CRDT	+INF	

A6.4: MODEL 3B. OPTIMAL PLAN SOLUTION

PROBLEM LP01

DUMP:DUMP 2

SOLUTION

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

	NAME		VALUE	OBJECTIVE	REDUCED COST
	PRODC01	+	0	6449.2000	-485.3196
	PRODC02	+	0	1570.3000	-4746.8339
	PRODBA1	+	0	-5951.4000	-1158.4676
B	PRODBA2	+	1.1555	-200.0000	0
B	PRODMZBN	+	0.4000	-1646.4000	0
	PRODBNMZ	+	0	-397.0000	-3514.8684
B	PRODCW	+	1.8450	-5526.6000	0
B	SELBAN	+	282.6261	13.0000	0
	SELMZ	+	0	76.5000	-119.6573
B	SELBN	+	1.0000	283.5000	0
B	SELMLK	+	5534.9150	2.5000	0
	JANHR	+	0	-15.0000	-15.0000
	FEBHR	+	0	-15.0000	-15.0000
B	MARHR	+	5.1670	-15.0000	0
B	APRHR	+	20.6996	-15.0000	0
B	MAYHR	+	3.5996	-15.0000	0
	JUNHR	+	0	-15.0000	-15.0000
	JULYHR	+	0	-15.0000	-6.5306
	AUGHR	+	0	-15.0000	-15.0000
B	SEPHR	+	1.0300	-15.0000	0
	OCTHR	+	0	-15.0000	-15.0000
	NOVHR	+	0	-15.0000	-15.0000
	DECHR	+	0	-15.0000	-15.0000
B	CRDT	+	4086.1363	-0.0800	0
	OBJECTIVE		5924.5104		

A6.4: MODEL 3B. OPTIMAL PLAN SOLUTION

PROBLEM LP01

DUMP:DUMP 2

SOLUTION .

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

ROW INFORMATION

	NAME		SLACK	R.H.S.	PRICE
#	PROFIT	Z	5924.5104	0	
	LAND	+	0	1.7400	-5179.2198
B	JANL	+	20.7224	67.0000	0
B	FEBL	+	12.8000	56.1000	0
	MARL	+	0	40.2000	-15.0000
	APRL	+	0	40.2000	-15.0000
	MAYL	+	0	56.1000	-15.0000
B	JUNL	+	3.0000	56.1000	0
	JULYL	+	0	51.1000	-8.4694
B	AUGL	+	2.0704	67.0000	0
	SEPL	+	0	56.1000	-15.0000
B	OCTL	+	12.9700	56.1000	0.00000095
B	NOVL	+	13.0000	56.1000	0
B	DECL	+	12.6220	51.1000	0
	OPCA	+	0	7000.0000	-0.0800
	BANPRD		0	-315.0000	-11.9730
	MZPRD		0	-12.0000	-195.7073
	BNPRD		0	-3.0000	-283.0500
	MLKPRD	+	0	0	-2.4658
B	JANH	-	0	0	0
B	FEBH	-	0	0	0
B	MARH	-	5.1670	0	0
B	APRH	-	20.6996	0	0
B	MAYH	-	3.5996	0	0
B	JUNH	-	0	0	0
B	JULYH	-	0	0	0
B	AUGH	-	0	0	0
B	SEPH	-	1.0300	0	0
B	OCTH	-	0	0	0
B	NOVH	-	0	0	0
B	DECH	-	0	0	0
B	CRDTA	-	4086.1363	0	0

A6.4: MODEL 3B. PTIMAL PLAN SOLUTION

PROBLEM LP01

OBJECTIVE RANGING

DUMP:DUMP 2

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

VARIABLE	TYPE	OBJECTIVE	LOWER LIMIT OF OBJECTIVE	INCOMING AT LOWER LIMIT	UPPER LIMIT OF OBJECTIVE	INCOMING AT UPPER LIMIT
PRODBA2	+	-200.0000	-713.8943	PRODCO1	903.0760	JULYL
PRODMZBN	+	-1646.4000	-9178.2609	PRODBNMZ	1943.3204	SELMZ
PRODCW	+	-5526.6000	-5636.9076	JULYL	-5441.5446	JULYHR
SELBAN	+	13.0000	12.0064	PRODCO1	15.1328	JULYL
SELBN	+	283.5000	-INF		642.4720	SELMZ
SELMLK	+	2.5000	2.4632	JULYL	2.5284	JULYHR
MARHR	+	-15.0000	-23.0964	JULYL	-8.7570	JULYHR
APRHR	+	-15.0000	-23.9324	JULYL	-8.1125	JULYHR
MAYHR	+	-15.0000	-23.9324	JULYL	-8.1125	JULYHR
SEPHR	+	-15.0000	-23.4694	JULYL	-8.4694	JULYHR
CRDT	+	-0.08000	-0.1000	JULYL	-0.06455	JULYHR

A6.5 MODEL 4A: OPTIMAL PLAN SOLUTION

PROBLEM LP01 SOLUTION

DUMP:DUMP 2 RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

	NAME		VALUE	OBJECTIVE	REDUCED COST
B	PRODCO	+	1.2503	6449.2000	0
B	PRODBA	+	0.3346	-5951.4000	0
	PRODMZBV	+	0	-1646.4000	-2783.8394
B	DAIRY	+	0.7755	-5526.6300	0
B	SELBAN	+	334.6094	13.0000	0
B	SELMZ	+	0	76.5000	0
B	SELBN	+	0	283.5000	0
B	SELMLK	+	2326.5306	2.5000	0
	FEBHR	+	0	-15.0000	-15.0000
	MARHR	+	0	-15.0000	-10.1775
B	APRHR	+	2.9638	-15.0000	0
	MAYHR	+	0	-15.0000	-15.0000
	JUNHR	+	0	-15.0000	-15.0000
	JULYHR	+	0	-15.0000	-5.0088
	AUGHR	+	0	-15.0000	-15.0000
	SEPHR	+	0	-15.0000	-15.0000
	OCTHR	+	0	-15.0000	-15.0000
B	CRDTA	+	6967.6272	-0.0800	0

OBJECTIVE 11350.3900

A6.5: MODEL 4A. OPTIMAL PLAN SOLUTION

PROBLEM LP01

DUMP:DUMP 2

ROW INFORMATION

NAME		SLACK	R.H.S.	PRICE
# PROFIT	Z	11350.3900	0	
LAND	+	0	1.7400	-5449.9866
B JANL	+	14.6353	67.0000	0
B FEBL	+	18.4078	56.1000	0
MARL	+	0	40.2000	-4.8225
APRL	+	0	40.2000	-15.0000
B MAYL	+	2.0587	56.1000	0
B JUNL	+	1.3085	56.1000	0
JULYL	+	0	51.1000	-9.9912
B AUGL	+	14.6497	67.0000	0
B SEPL	+	7.7506	56.1000	0
B OCTL	+	5.9858	56.1000	0
B NOVL	+	13.2375	56.1000	0
B DECL	+	14.2533	51.1000	0
OPCA	+	0	7000.0000	-0.0800
BANPRD	+	0	0	-12.5528
MZPRD	+	0	0	-76.5000
BNPRD	+	0	0	-283.5000
MLKPRD	+	0	0	-2.4851
B FEBH	-	0	0	0
B MARH	-	0	0	0
B APRH	-	2.9638	0	0
B MAYH	-	0	0	0
B JUNH	-	0	0	0
B JULYH	-	0	0	0
B AUGH	-	0	0	0
B SEPH	-	0	0	0
B OCTH	-	0	0	0
B CRDT	-	6967.6272	0	0

A6.5 MODEL 4A. OPTIMAL PLAN SOLUTION

PROBLEM LP01

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

DUMP:DUMP 2

COLUMB INFORMATION

VARIABLE	TYPE	OBJECTIVE	LOWER LIMIT OF OBJECTIVE	INCOMING AT LOWER LIMIT	UPPER LIMIT OF OBJECTIVE	INCOMING AT UPPER LIMIT
PRODCO	+	6449.2000	6154.0520	MARHR	6589.0520	MARL
PRODBA	+	-5951.4000	-6066.1988	JULYHR	-5722.4085	JULYL
DAIRY	+	-5526.6300	-5624.5436	JULYL	-5477.5436	JULYHR
SELBAN	+	13.0000	12.8852	JULYHR	13.2290	JULYL
SELMZ	+	76.5000	0	MZPRD	169.2946	PRODMZBN
SELBN	+	283.5000	0	BNPRD	561.8839	PRODMZBN
SELMLK	+	2.5000	2.4674	JULYL	2.5164	JULYHR
APRHR	+	-15.0000	-19.4117	MARL	-5.6893	MARHR
CRDTA	+	-0.08000	-0.1023	JULYL	-0.05880	JULYHR

A6.6: MODEL 4B. OPTIMAL PLAN SOLUTION

PROBLEM LP01

DUMP:DUMP 2

ROW INFORMATION

SOLUTION

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

NAME		SLACK	R.H.S	PRICE
# PROFIT	Z	12860.9777	0	
LAND	+	0	1.7400	-5179.2198
B JANL	+	6.6471	67.0000	0
B FEBL	+	0	56.1000	0
MARL	+	0	40.2000	-15.0000
APRL	+	0	40.2000	-15.0000
MAYL	+	0	56.1000	-15.0000
B JUNL	+	0	56.1000	0
JULYL	+	0	51.1000	-15.0000
B AUGL	+	0.4611	67.0000	0
SEPL	+	0	56.1000	-8.4694
B OCTL	+	0	56.1000	0
B NOVL	+	0	56.1000	0
B DECL	+	1.1860	51.1000	0
OPCA	+	0	7000.0000	-0.0800
BANPRD	+	0	0	-11.9730
MZPRD	+	0	0	-76.2459
BNPRD	+	0	0	-283.2459
MLKPRD	+	0	0	-2.4659
B JANH	-	0	0	0
B FEBH	-	0	0	0
B MARH	-	6.6210	0	0
B APRH	-	26.3389	0	0
B MAYH	-	10.4389	0	0
B JUNH	-	0	0	0
B JULYH	-	5.0000	0	0
B AUGH	-	0	0	0
B SEPH	-	0	0	0
B OCTH	-	0	0	0
B NOVH	-	0	0	0
B DECH	-	0	0	0
B CRDTA	-	4003.0132	0	0

A6.6: MODEL 4B. OPTIMAL PLAN SOLUTION

PROBLEM LP01

OBJECTIVE RANGING

DUMP:DUMP 2

RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

CULUMN INFORMATION

VARIABLE	TYPE	OBJECTIVE	LOWER LIMIT OF OBJECTIVE	INCOMING AT LOWER LIMIT	UPPER LIMIT OF OBJECTIVE	INCOMING AT UPPER LIMIT
PRODBA2	+	-200.0000	-719.8101	PRODC01	903.0760	SEPL
PRODCW	+	-5526.6000	-5636.9076	SEPL	-5441.5446	SEPHR
SELBAN	+	13.0000	11.9950	PRODC01	15.1328	SEPL
SELMZ	+	76.5000	0.2541	MZPRD	192.6308	PRODMZBN
SELBN	+	283.5000	0.2541	BNPRD	631.8925	PRODMZBN
SELMLK	+	2.5000	2.4632	SEPL	2.5284	SEPHR
MARHR	+	-15.0000	-23.0964	SEPL	-8.7570	SEPHR
APRHR	+	-15.0000	-23.9324	SEPL	-8.1125	SEPHR
MAYHR	+	-15.0000	-23.9324	SEPL	-8.1125	SEPHR
JULYHR	+	-15.0000	-23.4694	SEPL	-8.4694	SEPHR
CRDT	+	-0.08000	-0.1000	SEPL	-0.06455	SEPHR

A6.6: MODEL 4B. OPTIMAL PLAN SOLUTION

PROBLEM LP01 SOLUTION

DUMP:DUMP 2 RIGHT HAND SIDE LIMITS
OBJECTIVE PROFIT

COLUMN INFORMATION

	NAME		VALUE	OBJECTIVE	REDUCED COST
	PRODCO1	+	0	6449.2000	-499.6869
	PRODCO2	+	0	1570.3000	-4694.5894
	PRODBA1	+	0	-5951.4000	-1158.4676
B	PRODBA2	+	1.5465	-200.0000	0
	PRODMZBN	+	0	-1646.4000	-3483.9253
	PRODBNMZ	+	0	-397.0000	-5192.8794
B	PRODCW	+	1.9349	-5526.6000	0
B	SELBAN	+	799.8528	13.0000	0
B	SELMZ	+	0	76.5000	0
B	SELBN	+	0	283.5000	0
B	SELMLK	+	5804.8279	2.5000	0
	JANHR	+	0	-15.0000	-15.0000
	FEBHR	+	0	-15.0000	-15.0000
B	MARHR	+	6.6210	-15.0000	0
B	APRHR	+	26.3389	-15.0000	0
B	MAYHR	+	10.4389	-15.0000	0
	JUNHR	+	0	-15.0000	-15.0000
B	JULYHR	+	5.0000	-15.0000	0
	AUGHR	+	0	-15.0000	-15.0000
	SEPHR	+	0	-15.0000	-6.5306
	OCTHR	+	0	-15.0000	-15.0000
	NOVHR	+	0	-15.0000	-15.0000
	DECHR	+	0	-15.0000	-15.0000
B	CRDT	+	4003.0132	-0.0800	0

OBJECTIVE 12860.9777