ECONOMIC ANALYSIS OF FARM AND NON-FARM RURAL EMPLOYMENT IN MOROGORO DISTRICT TANZANIA

By

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ABSTRACT

ECONOMIC ANALYSIS OF FARM AND NON-FARM RURAL EMPLOYMENT IN MOROGORO DISTRICT, TANZANIA

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This study describes and analyzes the farm and non-farm rural employment in six villages of Morogoro District, Tanzania. Specifically, the objectives of the study are: (1) identification and description of the cropping system with attention being given to resource availability and utilization; (2) identification of the non-farm production activities and examination of their use of household resources; (3) identification of constraints facing producers of farm and non-farm products; and (4) development of a linear programming model for the purpose of analyzing specific factors on the employment and income of farmers. These factors include the government-mandated minimum area for cotton production, different producer prices, improved labor hiring arrangements, mechanization and the effect of increasing the size of market for both farm and non-farm products.

In 1983, a questionnaire was administered to 15 randomly selected farmers in each of six villages in Morogoro District. Cross-tabulations, averages and static linear programming were used in the analyses. Survey results reveal that an average of 2.74 adult equivalents cultivate an average farm of 2.2 ha in size. Linear programming results for two

villages indicate that; (1) the minimum cotton requirement has a negative effect on farmers' income; (2) non-farm products are more profitable than their farm counterparts (these products employ a substantial amount of the available labor and contributes significantly to the annual cash income in one of the villages); (3) with non-farm activities in place, labor has positive albeit low marginal value product in most months; (4) tractor hiring is not economic under the present cost structures; and (5) farmers would have been better off in terms of net cash income if food markets were working better because this would enable farmers to produce more non-farm products and use the income to buy food instead of producing it.

Policy recommendations include: (1) increasing research efforts in breeding drought-resistant and high yielding varieties of sorghum; (2) abolishing the minimum requirements of cotton; (3) liberalizing intra- and inter-village/district/regional trade of grain; (4) reducing hired labor restrictions; (5) synchronizing school holidays with the peak agricultural reason; and (6) stimulating the growth and development of the non-farm rural sector by assisting individuals and groups in procurement of raw material, encouraging higher quality output, and promotion of markets.

DEDICATION

To my beloved parents, Joseph and Mary,
who laid the foundation for my education.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The population of Sub-Saharan Africa is growing faster than that of any other area of the world. The annual growth rate has accelerated from 2.3 percent in the 1960s to 3.1 percent in 1984 (World Bank 1984). Although the death rate has fallen in recent years, it still exceeds 15 per 1,000 in most African countries. This rate is likely to decline further as better health services become available. The labor force is estimated to be growing at 3 percent annually and the rate is accelerating. Few African countries have committed themselves to reducing population growth rates. Even if they do, it will take time before any significant effects are felt because 46 percent of the population is under 15 years of age (World Bank 1984).

Since 1970, food production per capita in Sub-Saharan Africa has fallen 11 percent (Brown, 1984). It is desirable therefore to increase the farming sector's capacity to produce more food.

In many areas, the agricultural sector is failing to absorb the rapidly growing rural population given current technology. Furthermore, in most Sub-Saharan countries the urban population is 20 to 25 percent of the total and is growing at 5 to 7 percent annually. The growth rate of urban employment opportunities is well behind the urban population growth rates.

Efforts are also needed to improve the non-farm rural sector to increase employment, output and income for the growing rural population. Since the non-farm sector is so diversified in the type of activities and technologies employed, specific studies are necessary to delineate areas of possible improvement.

1.1 The Problem Statement

Due to the seasonality of farming in the tropics, particularly in areas where irrigation water is unavailable and where livestock are not kept, seasonal unemployment on farms is inevitable. Unemployment, though definitionally controversial, is used in this study to mean unused labor which could otherwise be profitably used to increase output and hence earnings. Although agriculture still remains an important sector in third world economies, its performance in the employment of the rural population has not been satisfactory. In Tanzania especially, the capacity of the agricultural sector to absorb labor and generate jobs for a long time has been overstated. In many social science research studies on Tanzania, it is often noted that over 90 percent of the economically active population is engaged in agricultural occupations. However, it should be stressed that this population group is only intermittently employed on farms. Because of the seasonality, there is virtually no farm work performed in some months of the year.

The existence of low productivity of labor in agriculture during the non agricultural seasons is perhaps too obvious to require any proof. The same is also true in densely populated areas and those that are unsuitable for farming because of tsetse fly infestation and poor soils (Atlas of Tanzania, 1967). The fact that technological development in

agriculture has not kept pace with the population growth rate of roughly 3 percent means that the problem of low productivity will continue and it will be difficult to feed the increasing population.

The school leaver problem is also an issue in Tanzanian rural employment. Only about 3 percent of the primary school leavers manage to get a place in secondary education, i.e. grade 9 onwards (Economic Survey, 1982-83). It is becoming difficult to absorb the remaining youth in farming because:

1) most of the youths are under 15 years of age and thus unable to contribute effectively as adults to farm labor given the farming equipment currently being utilized.
2) there is not enough suitable land for farming in some of the densely populated areas.
3) many young people have negative attitudes to taking farming jobs, which may be rational based on the rewards attainable from farming. Due to the increased population in some areas, low productivity of labor often leads to unattractive returns.

It is also reasonable to suggest that any policy to restrict rural to urban migration is likely to continue to fail if there is lack of desirable employment in the rural sector. The repeated government efforts in Tanzania to repatriate people from towns to the rural areas (or to "the land," as it is popularly called) is likely to fail as it has in the past. Policies should be directed towards making the rural areas more attractive for people's livelihood in terms of creating meaningful employment opportunities and infrastructure. For a country such as Tanzania with a narrow industrial base, rural to urban migration is likely to exacerbate the already existing moderate urban unemployment.

The foregoing reasons suggest that if employment, total output, family income and welfare are to increase or even remain at their current levels, a strategy beyond improvement of the existing farming system is desirable. A two-pronged strategy geared toward increasing farm and non-farm incomes is therefore suggested.

1.2 Objectives of This Study

This study is concerned with the description and analysis of farm and non-farm activities in the lowland areas of Morogoro District, Tanzania. The study seeks to find out how employment, output, and income can be increased in the region for both the farm and non-farm sector.

More specifically, the study focuses on the following objectives:

1. To identify and describe the cropping system currently being employed with attention being given to resource availability and utilization.
2. To identify non-farm production activities and to examine their use of household resources and their returns.
3. To identify constraints facing producers of farm and non-farm products.
4. To develop a linear programming model and use it to:
   a) determine the optimum farm and non-farm plan for the surveyed farmers.
   b) identify resource scarcities and hence the value of household resources in specific periods of the year.
   c) to analyze the effects of specific policy measures on employment and income of farmers, including the government mandated minimum area required for cotton production,

different producer prices, improved labor hiring arrangements, mechanization projects and increasing the quality of marketing arrangements for both farm and non-farm products.

1.3 Related Research and Findings

1.3.1 Employment and underemployment on farms

Little work has been done in establishing the nature, extent and scope of rural non-farm employment. Some studies have shown that part of the available labor is not used in farming in some months of the year. Kanga (1977) showed in his work in Tabora, that the main crops--beans, groundnuts, cassava and tobacco used in total only about 60 percent of the available labor. Minde (1979) reported that 50 percent of the available labor had not been used on farms in certain areas of Morogoro District.

Farm surveys elsewhere have shown that a significant proportion of the available rural labor is not used on farms. In Northern Nigeria, for example, Norman (1973) found that due to the seasonality of farming, 47 percent of the time of the average male adult in Dan Mahaway village was spent on off-farm activities. In rural western Nigeria, the International Labor Organization, (ILO) (1970) indicated that 27 percent of the employed males had their primary occupations in the rural non-farm sector. A similar study undertaken of four villages in Uganda (no date) revealed that 20 percent of the rural employed males were primarily engated in non-farm activities.

Some studies have also indicated a wide seasonal variation in non-farm rural jobs. Luning (1967) noted that 65 percent of the males in

rural Sokoto Province were primarily engaged in manufacturing activities during the dry season and 6 percent were engaged in the same activities during the wet season. Norman (1973) likewise indicated that 79 percent of the time of males in the north of Nigeria was devoted to non-farm jobs in September while only 27 percent was devoted to the same in February.

1.3.2 Linkages between farm and non-farm activities

In the literature there has been a long running debate over the strength of the linkages between farm and non-farm rural activities, the level of the demand of products emanating from non-farm activities and the long term sustenance of such non-farm products. Hirshman (1958) contends without empirical evidence that linkages between agriculture and other sectors of the economy are quite weak. Mellor (1976), on the other hand, argues that linkages between agriculture and other sectors are strong or could be potentially quite significant. Liedholm and Chuta (1976) in their studies in Sierra Leone were also convinced, based on empirical evidence, that linkages between agriculture and other sectors are quite strong.

The other serious concern on rural non-farm products has been that of demand. The demand for the products emanating from the small scale industries (SSI) supposedly originated from three spheres: 1) domestic demand from both rural and urban areas; 2) foreign demand (export demand); and 3) the demand arising from forward and backward linkages (Chuta and Liedholm, 1976). Allal and Chuta (1982) also noted that the primary markets for the products of small enterprises throughout Africa are overwhelmingly rural. Most of the items represent simple consumer goods, such as clothing, furniture, shoes, baked goods and metal products

catering to the needs of the low-income rural and urban population. In general these SSI are localized, with very limited spatial distribution of output. Marketing depends primarily on personal contact between small entrepreneur and the final consumer.

Hymer and Resnick (1969) have argued that the output from SSI is composed of inferior consumer goods (often referred to as Z goods); i.e., demand for such products declines as income increases. They conclude that promotional policies aimed at small producers will have little lasting impact. Resnick attempted to prove this hypothesis by studying the decline of rural industry under export expansion from 1870 - 1938 for Burma, Philippines and Thailand. It was evident from this study that weaving, spinning, iron and metal working, pottery, earthware, paper making and sugar manufacturing declined as Thailand developed an export rice economy. Some Z goods were, however, not replaced at all because of some particular taste patterns or specific advantages in the availability of raw materials. The statement that small scale industries products are inferior has also been made by ILO (1972), Child (1977) and Van Dijk (1978). Neck (1979) also makes reference to the relative decline of small enterprises in Western Europe in general and the United Kingdom in particular.

However recent evidence from Kenya, Sierra Leone, Nigeria and Ghana that SSI are efficient and profitable and that they in general have low capital-labor ratios helps to show that SSI have a major role to play in African economic development (Liedholm and Chuta, 1976). Child (1977), for example, found that the cost of capital per job created in the modern sector of Kenya was three times higher than in small-scale firms. Also the output-capital ratio for small-scale industries was found to be

higher than that of their large-scale counterparts in Sierra Leone (Chuta and Liedholm, 1979). A study by ILO (1970) concluded that small scale industries have the capacity to develop a pool of skilled workers as a basis for future industrial expansion. It is, however, reasonable to suggest that the role of the SSI sector in economic development over time will be largely determined by the linkages between the rural area, regional, national and international markets, the composition of the demand for products of the sector relative to large-scale modes of production, and factors affecting the supply responsiveness of these small firms.

1.4 Summary

The chapter highlights increasing population, low food production, and low income levels as the most important problems facing the Sub-Saharan region. These problems are discussed with reference to Tanzania to show the need for undertaking this study. Objectives of the study are specified to indicate the focus of the study. Theoretical aspects on employment in the developing economies, the extent, scope, and nature of the interaction between farm and non-farm activities and how they assist in providing employment and income to rural populations are briefly surveyed. Although the debate on the importance of rural non-farm activities continues there is now convincing evidence to indicate that these activities have a major role to play in the African economic development.

CHAPTER II

DESCRIPTION OF THE STUDY AREA AND METHODS

This chapter begins with a description ofthe physical, climatic and socio-economic characteristics of the villages in the study area. Supportive infrastructure such as markets, transportation, credit systems, training, research and extension are briefly described. The chapter concludes with information on the methodology used in the study, including methodological differences between this study and others on farm and non-farm activities, justification of the choice of the study areas, sampling techniques and data sources.

2.1 Description of Location, Climate and Infrastructure

2.1.1 Location

Morogoro District, where the study was based, is one of four Districts of Morogoro Region. The others are Kilosa, Ulanga and Kilombero. The District lies between latitudes 5^{o} and 7^{o} 40' South and longitudes 37^{o} 10' and 38^{o} 33' East of the Greenwich meridian. Morogoro, the capital town of the Region, is within the District of the study and is about 200 km west of the city of Dar-es-Salaam, the capital and the biggest port in the country (Figure 2-1). The study was conducted in six villages, Kingolwire, Fulwe, Doma, Melela, Mangae and Langali (Figure 2-2).

Figure 2-1 Tanzania: Location of Morogoro District

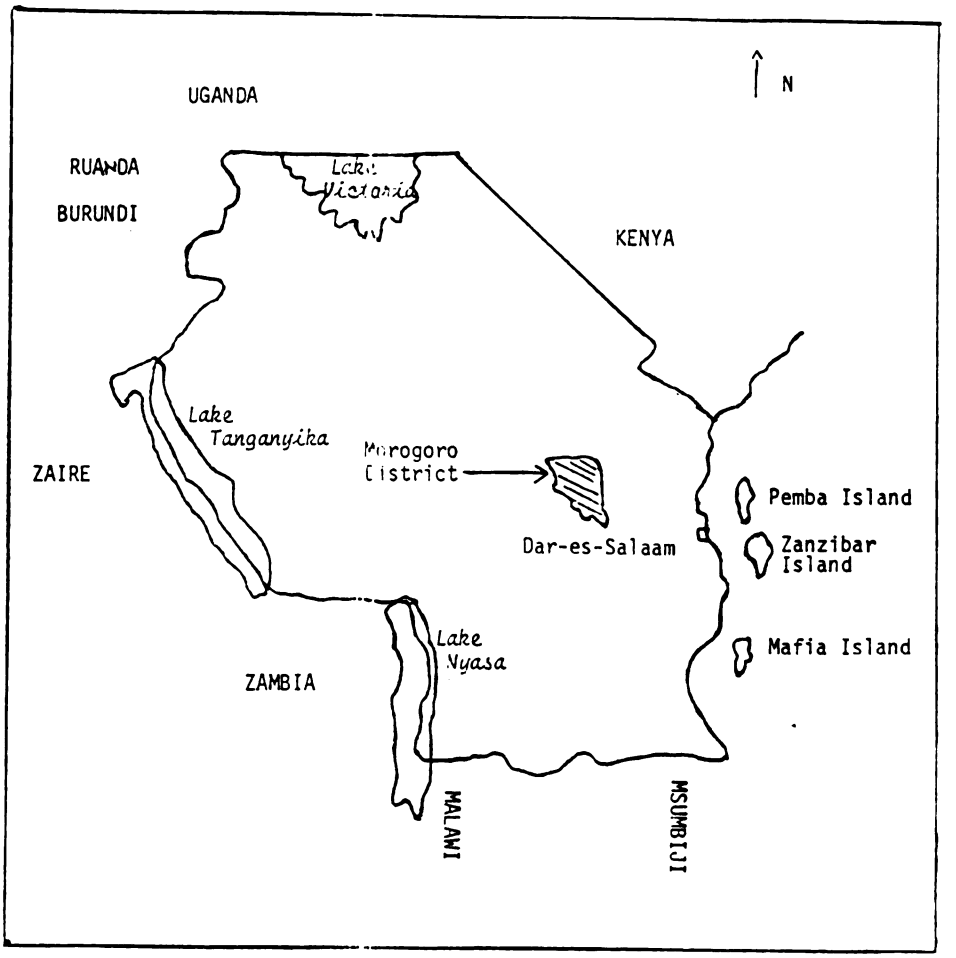
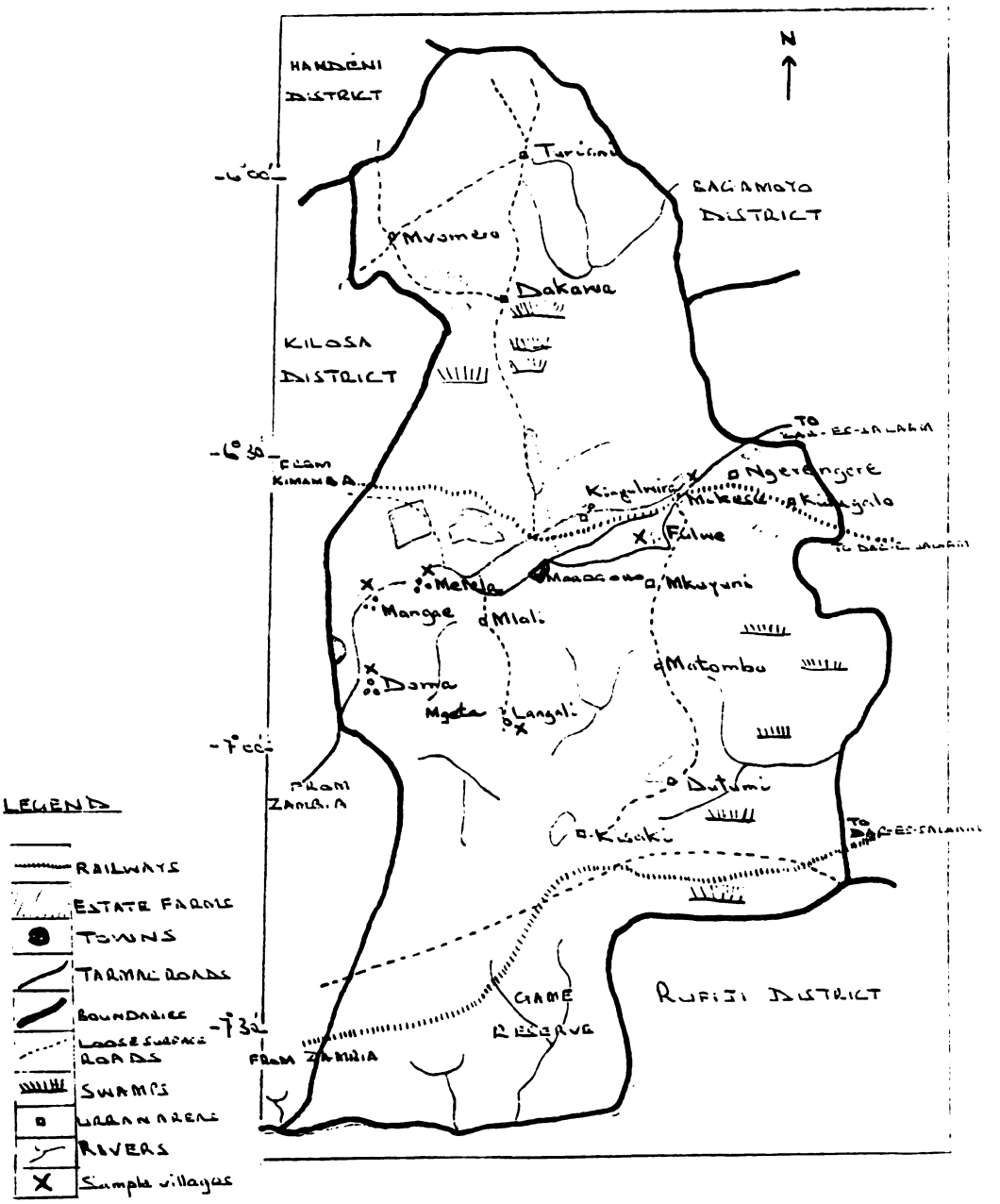


Figure 2-2 Morogoro District: Railways, roads and towns



2.1.2 Climatic conditions

Day and night temperatures vary widely within the District. This is attributed chiefly to the wide variation in altitude that exists. Temperatures as low as 14^{o}C in the high altitudes to as high as 36^{o}C in the low altitudes are not uncommon.

The District annual rainfall ranges from 400 to 1000 mm. Across the District, rainfall distribution is quite uneven; and reliability is somewhat higher in the upper altitudes when compared to the lower areas. Considered over a calendar year, the rainfall is bimodal in character (Figure 2-3). However, in the past 5-10 years the biomodal nature has become less prevalent because of frequent failure of the short rains. Normally short rains are expected in the October to January period and long rains from March through May. A dry spell is normally observed in February and in some years it extends into the following months, causing serious set-backs in crop yields. The short rains in the lower altitudes are often unreliable making it difficult to support most crops with the exception of beans. The long rains have their peak in April and are the main determinant of a good or bad year in terms of crop production.

Altitude ranges from 150 to 2,700 m above sea level. The peak is at the top of the Uluguru Mountains, whose slopes support a good number of temperate fruits such as peaches and a wide variety of vegetables. These fruits and vegetables are chiefly marketed in Morogoro town and in Dar-es-Salaam City.

2.1.3 Soils

A wide intra-district variation exists with regard to soil structure, texture and fertility. Soils may show remarkable differences even

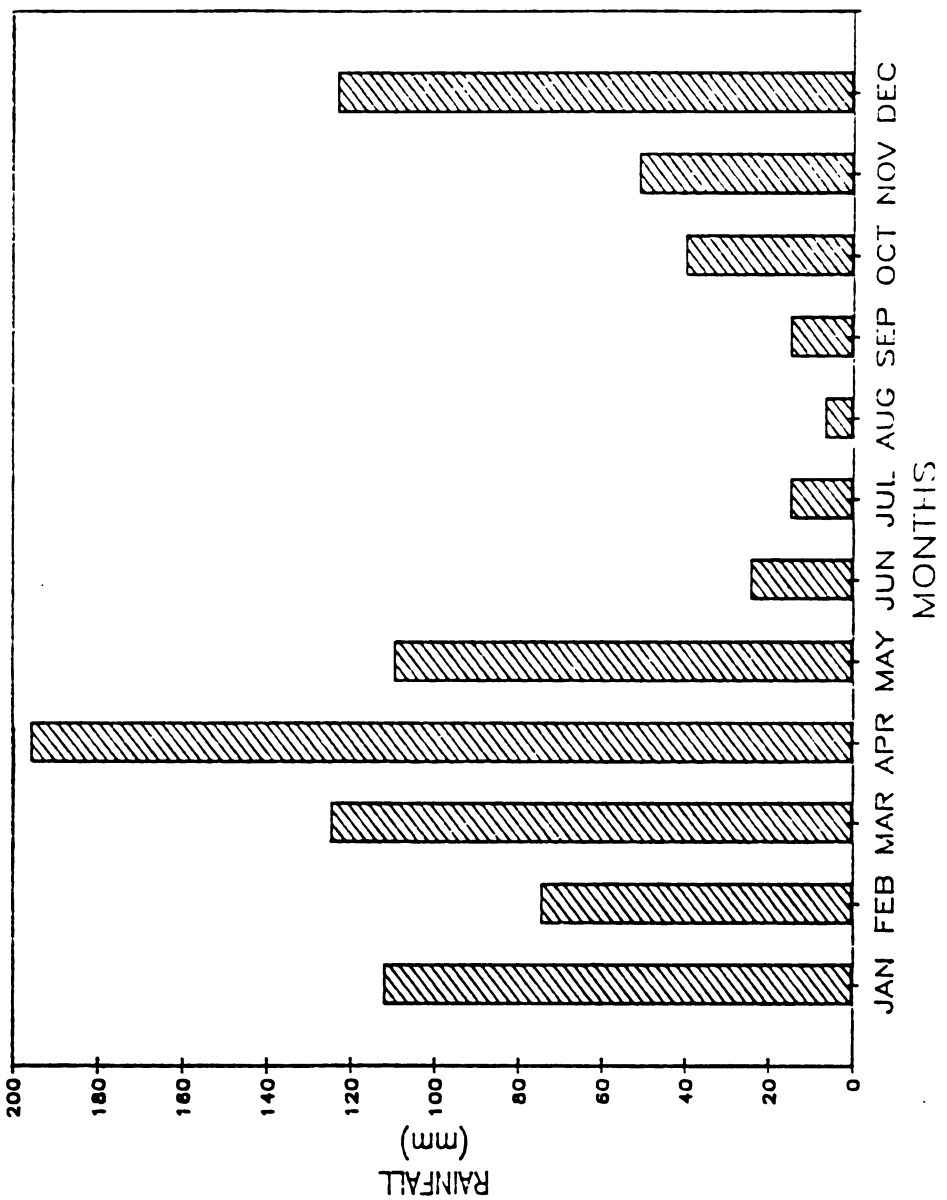


Figure 2-3 Morogoro District: Mean monthly rainfall, 1971-1982

within a few km. Therefore, if sound fertilizer use recommendations are to be effected, much effort has to be devoted to delineate areas over which the recommendations apply. On the average, soils are basically sandy with some patches of red to non-calcareous black soils. In the higher altitudes, brownish red, rather sandy soils, with very friable clay (sesquiodic kaolnite type) are common (Atlas of Tanzania, 1967).

The Morogoro District's natural vegetation consists of forests, which occur on the higher altitudes and occupy a reasonably large area. In the lower altitudes, woodland covered by the miombo is predominant. Wooded grasslands (i.e., grasses and shrubs with scattered trees) occur in the Wami and Mikumi areas. Bushland and thickets prevail in the semi-arid areas like Mkata ranch and Doma. Along the hill slopes, where the soils are rather infertile, species of Hypernhenia rufa and H. colina are common.

2.1.4 Human population

According to the 1978 Census,[1] Morogoro Regional human population was 938,000, of which Morogoro District's share (Morogoro Urban inclusive) was 418,000. Morogoro Region has a total area of 11,000 km^2 and Morogoro District is 2,890 km^2 in size. The population per km^2 was 84 and 145 people for the Region and District, respectively, compared with the overall average for Tanzania of 18.

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[1] A Census is carried out once every ten years. The next one is due in 1988.

2.1.5 Social and economic environment

The transportation network is still poorly developed and those who enjoy quick services are largely in villages near the truck roads or railways. Feeder roads, particularly in the higher altitudes, are impassable with ordinary vehicles in the rainy season. Delivery of inputs and disposal of outputs to markets depend in part on head transport, sometimes for long distances. The Zambia-Tanzania highway that passes through the district is used more for cargo transportation rather than passengers. The Dar-es-Salaam Kigoma railway built in 1897 also passes through the District. Due to deterioration of the beds and age of the rails, the railway is often troubled with derailment. Although replacement of rails is in progress, this seems to be on a piece-meal basis. Regular air transport is not available in the District. However, for emergency purposes, landing is possible at designated air strips.

Water for irrigation and domestic use is inadequate. Despite the rural water supply projects now in operation for 15 years, many villages still do not have a clean tap water supply. In some locations women and children walk 5 km just to get water for cooking. The time used for water transport could often be better used for farm work.

Substantial progress has been achieved under the policy of Ujamaa in the provision of social services--particularly in the areas of education and health. Ujamaa (Tanzanian Socialism), as formulated in 1962, simply referred to the desire to reactivate the spirit of cooperation in the traditional African communities.[2] Under Ujamaa, there came the Arusha

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[2]Ujamaa or Tanzanian socialism is well covered elsewhere. For example, see, Nyerere, 1967 and Nyerere, 1968.

Declaration that announced the nationalization of the major means of production. This involved the nationalization of the principal financial, manufacturing and trading institutions. It called for the complete stop of the accumulation of private wealth by leaders in the party and government. It indicated the ruling party's desire to give priority to rural development, thereby enabling a greater utilization of domestic as opposed to foreign resources. Under the Ujamaa policy, agricultural villages were encouraged to adopt a policy of cooperative living and working for the good of all. Farming was expected to be performed by a group of people who lived together in a village, undertaking together the farming, marketing and provision of local and small other requirements as a community.

2.1.6 Other supportive services

Agricultural credit. Up to 1983, the Tanzania Rural Development Bank (TRDB) was the sole formal institution responsible for financing smallholder agriculture. However, based on its principles and its mandate under the umbrella of the Tanzanian Socialist policy, its lending has been mostly confined to villages and groups rather than to individulas (Table 2-1). In 1983, the National Bank of Commerce (NBC), formerly concerned only with industrial and business financing, focused some of its attention on agriculture. Under a strategy popularly known as "front-line banking," pockets in the rural areas worth financing by the bank are identified. These are in the areas of small-scale enterprise development and crop and animal husbandry. The two financial institutions aim at colloborating rather than competing in the financing of the rural sector.

Table 2-1 Tanzania: Principal borrowers from the Tanzania Rural Development Bank (TRDB), 1976/77 - 1980/81

	1976/77		1977/78		1978/79		1979/80		1980/81	
Borrower	Value Mill Tshs	% of Total	Value Mill Tshs	% of Total	Value Mill Tshs	% of Total	Value Mill Tshs	% of Total	Value Mill Tshs	% of Total
Primary Co-ops	13.1	16.9	0	0	.6	0.4	1.1	0.7	0.2	0.2
Villages	33.1	43.1	102.8	41.6	110.8	59.6	115.6	55.1	91.4	90.3
District Dev. Corps.	4.3	5.3	.6	.2	3.4	1.8	.8	3.4	.1	.1
Parastatals	19.5	25.2	70.4	28.5	32.4	17.4	43.1	20.7	2.3	2.3
Associations	7.3	9.5	71.9	29.1	31.7	15.6	17.1	14.0	0	0
Partnerships	0	0	.2	.1	.6	2.1	2.1	1.0	.3	.3
Individuals	0	0	1.1	.5	3.1	3.1	10.6	5.1	7.0	6.8
TOTAL	77.3	100.0	247.0	100.0	182.6	100.0	190.4	100.0	101.3	100.0

Source: The Economic Survey, 1982. Government Printer, Dar-es-Salaam, Tanzania

Marketing channels. Farmers are encouraged to sell their crop produce to designated parastatals--cotton to the Tanzania Cotton Authority (TCA), and maize, sorghum, millet, beans, sunflower and sesame to the National Milling Corporation (NMC). Despite this arrangement, it is only in the case of cotton where 100 percent is marketed through Tanzania Cotton Authority. A considerable volume of the rest of the crops produced finds their way through the informal markets where pricing efficiency is higher than in their formal counterparts.

Education and training. Tanzania has a 79 percent literacy rate, the highest in Africa (World Bank, 1983). However, there seems recently to be change in emphasis from formal to technical education. The current educational pyramid is characterized by a broadening bottom of primary school pupils and a widening top of high-level manpower. The middle of the pyramid is therefore weak because it lacks medium, technically trained manpower, which are important in most economies. Education is free from grade one through the university, permitting academically gifted individuals to obtain education irrespective of their socio-economic backgrounds.

Agricultural research and extension. Agricultural research in Tanzania dates back to 1930's. Since its establishment, it has undergone numerous reforms in its administration, organization, research emphasis and philosophy. Single commodity research was the norm until the late 1970's, when farming systems research evolved with its holistic, multidisciplinary, location-specific, farmer-involvement approach. In 1982, following the split of the Ministry of Agriculture, the Tanzania Agricultural Research Organization (TARO) and the Tanzania Livestock Research Organization (TALIRO) were formed under the Ministry of Agriculture and

the Ministry of Livestock Development respectively. The split was carried out with a view to strengthening research for both livestock and crops. Following a cabinet reshuffle and the need to cut administrative costs, these two Ministries were joined again to become the Ministry of Agriculture in June 1984.

To date the extension service has a weak linkage with research. Over the years, it has widely been criticized for failing to conduct effective programs. Studies of the extension programs since the 1960's reveal little success in increasing agricultural output through the application of modern farming techniques (Hulls, 1972; Moris, 1976). The reasons for failure have been ascribed to lack of funding, poor planning, poor back-up facilities, lack of transport and low technical and educational competence of the extension staff. However, it is not fair to lay the blame on the agent alone. Factors related to the general agricultural policy and the failure of the research/extension system to generate innovations adapted to the conditions faced by farmers are also important.

2.1.7 Sampled village characteristics

Six villages were covered in the survey--Kingolwira, Fulwe, Doma, Melela, Langali and Mangae. Each of the villages had a primary school (grade one to seven) and a dispensary or a first aid kit. Five out of the six villages had a tap water supply. Despite the fact that the farthest distance between any two of the survey villages was 95 km, significant variation existed in terms of altitude, rainfall, vegetation and household occupations (Table 2-2). These differences will be taken into account in the analysis and in drawing of policy recommendations.

Table 2-2 Morogoro District: Surveyed village characteristics

Village Group	Villages	Altitude	Rainfall	Main Crops	Non-Farm Employment
I	Mangae Melela	Lowland	Unreliable	Cotton Maize Sorghum Millet Beans	Leading villages Chiefly baskets and mats
II	Doma Fulwe Kingolwira	Lowland	Unreliable	Cotton Maize Sorghum Sesame Sunflower Cassava	Non-farm employment scanty
III	Langali	Highland	Quite reliable	Maize Beans Cabbage Bananas	Virtually non-existent

Collinson (1972) and Bartlett (1978) have cautioned against assuming that farmers are a relative homogeneous group. This assumption ignores specific socio-economic and agro-climatic conditions of individual farmers.

Five of the six villages (Fulwe, Kingolwira, Mangae, Melele and Doma) are accessible by tarmac roads whereas Langali has an earth road access. A railway also passes through the villages of Fulwe and Kingolwira.

2.2 Methods

This section describes the methodological differences between this study and others on farm and non-farm activities, the justification of the choice of the study area, sampling techniques used and sources of primary and secondary data.

2.2.1 Methodological differences between this study and others on non-farm and off-farm employment

A number of studies have identified, mapped, quantified, appraised and evaluated non-farm activities (Liedholm and Chuta, 1976; Chuta and Liedholm, 1979; Haggblade, Defay and Pitman, 1979). These studies have chiefly been concerned with the survey and study of non-farm rural activities and industries per se. The first and the last studies covered both rural and urban whereas the second study by Chuta and Liedholm concentrated on rural-farm activities.

The foregoing studies have one characteristic in common--non-farm activities are handled independently of farm operations. This research study recognized non-farm activities as an integral part of the farming system. This study recognizes that the family labor has to be allocated to farming operations in order to produce food to meet subsistence requirements as well as to cash crops and non-farm production activities.

It is not the interest of this study to deal with artisans who are involved full time in non-farm activities. The thesis of this study is that any strategies to promote rural employment, farm output and rural farm family income which do not take into account available local resources and a thorough review of the current farming system are likely to result in very limited usefulness.

2.2.2 Justification of the choice of the survey area

This geographical area was chosen based in part on the findings of an earlier study (Minde, 1979). In that study it was found that about 50 percent of the available labor was not used in farming. Based on that study, the principal researcher wanted to do further research to determine the extent of "surplus labor" from farm operations and hence find out how this available labor could best be harnessed to promote employment, total output and farm income. The following factors were also instrumental in selecting the survey area:

1. Distance from the faculty of Agriculture, Forestry and Veterinary Science where the researcher was based.
2. Accessibility of the researcher to the villages given the transportation and fuel limitations at the time of the research.
3. Familiarity with some of the villages based in part on the Master of Science research work conducted in 1978 and 1979.

2.2.3 Sampling technique

Six villages in Morogoro District were purposely chosen, bearing in mind accessibility factors. In every village, the village register was used as the sampling frame. From the register, a list of 15 names was drawn randomly using a systematic random sampling technique with a random

start. The sizes of the villages were found not to differ significantly in terms of their human populations. There was therefore no need to vary the sample sizes from village to village.

2.2.4 Data sources

Data were collected from both primary and secondary sources. Primary data were obtained by interviewing 90 rural farm households in six villages, Fulwe, Melela, Mangae, Doma, Kingolwira and Langali. The purpose was to obtain information on farming and non-farming activities for an entire year.

Information collected included labor use on farm and non-farm activities, level of education, labor allocated to social activities, ages of household members and their numbers, area utilized for different crops, peak periods for farm activities, and production and selling of produce from the farm and non-farm activities. Field data collection was from late January to early December, 1983. Six enumerators assisted in the process. One was located in each village. The interviewers were primary school teachers who had a grade twelve level of education. All of them were residents in the respective research villages. They were chosen in part because of their familiarity with the villages and their ability to understand English, Swahili and the vernacular of the village in which they were stationed. The principal researcher had a close supervisory relationship with the interviewers throughout the data collection period.

Interviewing was conducted in the months of March, June, September and December. To gather data on labor use, farmers were asked to estimate the number of days they spent on each crop and for each operation in the previous three months. Thus, when interviewing in March, data

collected referred to December through February. Data were also tabulated for the ages of individuals in the household engaged in farming activities. Thus, when a day in a farming activity involved a child, adjustment was made to account for the age of the child. These adjustments are discussed in greater detail in a later chapter. In the weaving activities, farmers were asked to estimate the number of hours they spent per day and thus the total number of hours used in finishing a mat or basket. The hours were then converted to man-days.

Secondary data collection was through the Ministry of Industries and its affiliates, the Ministry of Agriculture and the Regional Agriculture Office in Morogoro. Ilonga Research Station, which serves the study area, was also visited for the purpose of gathering information on crop husbandry recommendations.

2.3 Summary

The chapter has described in general the physical and socio-economic environment of the study District. The District varies considerably in rainfall temperatures, soils and vegetation. The District is served by railways, all weather and earth surfaced roads.

Channeling of credit to farmers is limited since only one formal credit institution exists. Due to various reasons, the extension service has shown a weak linkage with research.

Types of data collected were of primary and secondary type. These data are used in the next chapter to analyze the household characteristics.

CHAPTER III

HOUSEHOLD CHARACTERISTICS

This chapter describes the household characteristics and constraints facing the surveyed farmers. Emphasis is on the utilization of land, labor and capital by the households. The extent and the nature of non-farm and off-farm employment and how they relate to farming are also described. The information contained in this chapter also forms the foundation for the building of analytical models in the next chapter.

3.1 Land

3.1.1 Land availability

Studies by CIMMYT (1977) indicate that the District has a low person/land ratio of approximately 20 ha available for each family. Although more land can be obtained by just clearing new areas, the farmer has to travel farther from home as he/she becomes more selective with respect to land quality. Most of the farmers had more than one plot (shamba) located at different sites around the village. The number of plots per household ranged from 1 to 8, and on average a household cultivated 2.21 ha (Table 3-1).

In principle, land is not owned but is available for farming mostly through the village councils. Although the person/land ratio is low, much land cannot be cultivated because of swamps, mountains, woods, etc. and almost all can only be used for a few consecutive years, then it must be left fallow. Land per se is not legally sold in Tanzania.

Table 3-1 Survey farms: Number of plots, average area per plot and average farm size per village, 1983

Village	No. of Plots Total	Average per household	Total Area	Average farm size per household	Area per plot
	No.	No.	Ha	Ha	Ha
Melela	86	5.6	40.0	2.67	0.47
Langali	63	4.2	20.0	1.33	.31
Fulwe	61	4.1	41.0	2.73	.67
Mangae	52	3.5	22.8	1.52	.43
Kingolwira	48	3.2	39.8	2.65	.82
Doma	40	2.7	28.5	1.90	.70
Total or Average	350	3.9	32.01	2.21	.57

However, there is an increasing tendency for informal selling of land, particularly that which has been cleared. Land holding in villages underwent a major reform, particularly after the Arush Declaration of 1967. Following that year, there was an upsurge of communal cultivation in Ujamaa villages, which involved the communal tillage, planting, and harvesting, followed by sharing of the proceeds on the basis of each according to his/her contribution. Block farming also became quite common in the post Arush Declaration period. These are essentially individually owned farms arranged closely together. The individual plots are separated by foot paths or narrow roads to facilitate the running of farm vehicles. Block farming allows for a more effective use of the limited number of extension personnel and the supply of inputs. Varmint control and mechanization can also be more effectively accomplished with this style of farming. Some farmers believe that this style of farming deprives them of their right to choose fertile virgin land at their best convenience from season to season. Since the mid 1970's there has been a quiet and slow withdrawal from both communal and block farming. Although such farms were common in the surveyed villages in the early 1970's, no farmer surveyed indicated that he/she belonged to either of these systems when this study was conducted.

3.1.2 Land use

Cultivated area per farmily in the survey area was 2.21 ha (Table 3-1). Farmers are also known to be selective in the type of land they use. The low person/land ratio facilitates this selection. Normally, the land cultivated by farmers forms a set of concentric rings radiating from the homesteads. The rings close to the households are planted to more favorable crops.

Most of the crops grown require well-drained fertile soils. However, a crop like paddy requires wet valley bottoms. In the lowland areas of the district one finds the wet areas and valleys. These areas retain moisture and are being continuously and intensively utilized for the production of tomatoes, bananas, cabbage and paddy.

A wide variation exists across villages in terms of crops grown (Table 3-2). The variation is chiefly attributed to differences in rainfall availability and reliability. Maize and sorghum dominate as the chief food crops. Maize was grown in all six villages. In three of the villages, maize was grown by all households surveyed, whereas sesame was grown in only one village. Cotton dominates as a cash crop and was grown in five out of the six villages. Except under very special circumstances relating to disease or old age, it is mandatory for every household to plant 0.4 ha (1 acre) of cotton in all villages where cotton can grow. Failure to do so may lead to fine, imprisonment or both.

Vegetables grown include tomatoes, cabbage, and cowpeas. Cowpeas are harvested green before flowering to prepare a vegetable dish which supplements the staple food in the area. Vegetable farming is carried out in small patches around households. Sometimes the areas are so small that it becomes difficult to account for labor use in these areas.

Beans normally are planted following early maize or paddy either in pure stands or intercropped, and they form an important part of the late season food supply. Beans are planted in heavy wet valley bottom land in the last part of the rainy season from late April onwards. Bean area per household was less than 0.5 ha. This in part reflects the delicate nature of the crop in terms of timing and also it is the most risky crop in terms of insects, diseases and drought sensitivity.

Table 3-2 Sample farms: Total hectarage and number of farms under crops in the six survey villages, 1983

Crop	Kingolwira		Fulwe		Melela		Mangae		Doma		Langali	
	No.	Ha.	No.	Ha.	No.	Ha.	No.	Ha.	No.	Ha.	No.	Ha.
Maize	15	12.4	15	17.9	9	5.2	13	5.6	14	10.2	15	16.1
Sunflower	3	1.2	2	.6	4	2.4	1	.4	4	2.0	0	0
Sorghum	11	11.2	0	0	14	19.4	15	10.4	3	2.0	0	0
Beans	1	.6	5	1.0	5	1.0	0	0	0	0	15	4.5
Paddy	8	5.5	7	3.0	3	1.0	0	0	2	.4	0	0
Sesame	0	0	4	1.4	0	0	0	0	0	0	0	0
Cotton	7	3.0	13	6.4	6	3.6	14	6.5	12	4.8	0	0
Bananas	2	.6	14	5.1	4	1.6	0	0	0	0	2	.6
Cassava	5	1.0	2	.6	0	0	0	0	1	.5	0	0
Millet	0	0	14	8.8	0	0	0	0	11	8.9	0	0
Vegetables	0	0	7	2.0	2	.5	0	0	0	0	5	1.4

Paddy planted is of the dry-land type. The decision to plant paddy is determined by the availability of the appropriate soil type and moisture. Cassava was grown by at most one-third of the households in any of the villages. Cassava, thought by many as a simple crop in terms of moisture requirements, can be very sensitive to moisture, particularly in the planting period. This partly accounts for its absence in the relatively drier areas of Mangae and Doma. The boundary between a cash crop and a food crop is very obscure, since most of the crops that are grown can be sold as well as consumed. Crops like cotton, sesame and sunflower are grown almost entirely for sale.

3.1.3 Area and crop yields

In order to ensure data collection consistency and to help facilitate the data analysis, certain assumptions were used. In the case of intercropping resource use i.e., labor, land and capital, estimates were based on the proportion of the area which was occupied by the various crops in the mixture. Since data were collected all the year round, it was possible for the interviewers to have on-the-spot observation of the crop mixture and hence get reliable estimates. Thus, for instance, if a ha of maize and of beans were intercropped in the ratio of beans:maize equals 1:3, then beans and maize would be allocated 1/4 and 3/4 of the land area respectively. In situations where an activity such as weeding benefited both crops simultaneously, the total amount of resource spent (e.g. labor) was distributed between the crops proportionately based on the ratio of beans and maize in the mixture.

Some researchers are opposed to this approach. Truman Phillips (1983) recommends that an intercropping should be treated as a unit of

analysis instead of breaking the area proportionately into the different crops. However, his technique presents some problems. Firstly, when the proportion of farmers using intercropping is small, it is difficult to construct a "representative farm." Secondly, a problem arises when there is large variation in the nature of the combination of the different crop enterprises among farms. Given these problems it may be difficult to draw policies to be applicable to a large group of farms.

Average farm area for maize across villages ranged from 0.5 to 1.1 ha per household, whereas cotton centered around 0.4 ha reflecting the 0.4 ha mandatory requirement (Table 3-3). Because of its extremely high labor requirement, farmers indicated that given the freedom, they would not grow cotton since they feel alternative competing cash crops like sunflower and maize are more profitable.

A wide variation existed in yields across villages. Maize yield per ha for example varied from 279 kg/ha (3.1 bags) in Mangae to 1962 kg/ha (21.8 bags) in Fulwe. Sorghum yields varied widely across villages --300 kg/ha (3 bags) in Doma to 690 kg/ha (6.9 bags) in Kingolwira. Based on research station experiments at Ilonga, Tanzania (Table 3-4), these yields are very low, with the exception of maize in Fulwe. The low yields are attributed to lack of sufficient moisture and low or non-use of modern technology like fertilizers, insecticides, etc.

Paddy in irrigated areas in the country yields over 2450 kg/ha (35 bags) as compared to 140 kg/ha (2 bags) in Melela village, which uses an upland rice technology. Although beans show high yields per ha of up to 1440 kg/ha (16 bags), it should be noted that the area under beans is almost always under 0.5 ha and that such high yields represent

Table 3-3 Sample farms: Area and yield per ha (in kg) for the various crops. Averages for sample households growing those crops, 1983

	Kingolwira		Fulwe		Melela		Mangae		Doma		Langali	
Crop	Avg. ha	Yield Per ha	Avg. ha	Yield Per ha	Avg. ha	Yield Per ha	Avg. ha	Yield Per ha	Avg. ha	Yield Per ha	Avg. ha	Yield Per ha
Maize	0.82	693	0.99	1962	0.58	315	0.43	279	0.72	531	1.1	369
Sunflower	.40	348	.30	402	.60	90	.40	150	.50	180	0	0
Sorghum	1.00	690	0	0	1.40	510	.70	460	.67	300	0	0
Beans	.60	522	.20	1400	.20	558	0	0	0	0	.30	783
Paddy	.70	315	.43	1141	.30	140	0	0	.20	350	0	0
Sesame	0	0	.35	765	0	0	0	0	0	0	0	0
Cotton	.42	280	.49	500	.60	336	.46	452	.40	620	0	0
Bananas 1/	.30	23	.37	68	.40	34	0	0	0	0	.30	58
Cassava	.20	1200	.30	1150	.30	1080	0	0	.50	900	.20	1250
Millet	0	0	.62	1230	0	0	0	0	.80	580	0	0

1/ Number of bunches rather than kg are reported.

Table 3-4 Ilonga Research Station, Tanzania: Yields of selected crops, 1983/84

Crop	Variety	Yield/ha (Kg)
	Kito	3,000
	Katumani	2,500
Maize	I.C.W.	4,000
	Staha	4,500
	Serena	2,800
Sorghum	Lulu	2,500
	Tegemeo	3,000
Cotton	IL 74	2,000-3,000
Sesame	Morana	800
Sunflower	Record	1,000
Cassava	Kigoma	4,200
Cowpeas	Tumaini	1,500-2,300

Source: Ilonga Research Station

extrapolation of the output from the small plots. One should not necessarily conclude that a farmer growing one ha of beans would realize 16 bags.

3.2 Family Composition, Labor Force and Labor Profiles

3.2.1 Family composition and labor force

Labor is the most important resource in smallholder agriculture in developing countries. Since most of the labor is supplied by family members, a thorough examination of its composition will lead to a better understanding of the labor supply and demand situation.

Labor requirements and use. A six-day work week was assumed. A man-day was taken to be eight hours. However, when a farmer reported performing a certain activity, which after its completion he/she was not able to undertake other tasks because of fatigue, then it would be counted as a man-day equivalent although it was less than 8 hours. The concept of man-day equivalent is also complicated by the fact that work intensity varies from season to season and from one activity to another. Children aged between 10-16 years of age who were not attending school were assumed to be equal to 0.5 man-equivalent whereas man and woman 17 years of age up to 55 years of age were taken to be equal to one man-equivalent. A worker above 55 years of age was again counted as 0.5 man-equivalent. Although women were slower than men in operations like land clearing and spraying, the opposite was true for harvesting and weeding. On this basis one man-day was assumed to be equal to one-woman day. In this research study, there is no noticeable division of labor with regard to men and women for farm operations. As is usually the case, in addition to farming activities women were also expected to attend fully

to home based activities such as cooking, fetching water for domestic purposes and looking after the young.

Given these assumptions labor availability was determined on a monthly basis by multiplying the mean adult-equivalent per family by the number of days in the month. From this was subtracted four Sundays each month and Christmas in December. Labor used on farms was recorded for each crop and for each activity monthly and the peak weeks associated with each activity were noted. For non-farm activities individuals were asked to estimate the number of hours in producing various items.

The surveyed households had an average of 5.6 members, with a range of from 1 to 20 family members. There were 2.74 adult equivalents per household. Table 3-5 has some interesting figures which are important in understanding the composition of rural families as it relates to farm work. Fifty percent of the total family members living at home (i.e., those that eat from the same pot) were 16 years of age or under. Thirty percent fell in the 0-10 years of age category. When the figure of the disabled is added to the list we find that exactly 50 percent of the entire members are dependent on the remaining 50 percent. Only 2.2 percent of the total members were found to be disabled either due to old age, mental retardation, etc. About 62 percent of those in the 10-16 years were attending school. Since schooling is a full time activity, this group cannot be expected to contribute much to farm work. This does not imply that the remaining 38 percent of the 10-16 year group does not attend school. The finishing age for grade 7 is often below age 16. Since opportunities for further education are limited, it is common for youths below the age of 16 to join the farm labor force. Therefore, part of the 10-16 age group already finished primary school.

Table 3-5 Sample farmers: Age distribution, disabled, and number of individuals working outside home per village, 1983

Age Group / Village	0-10		11-16				17-55		56 and above		Disabled		Members not Staying at Home	
			Total		Proportion in School									
	No.	Per House	No.	Per House	No.	Per House	No.	Per House	No.	Per House	No.	Per House	No.	Per House
Kingolwira	36	2.4	17	1.1	13	0.9	37	2.5	8	0.5	2	0.1	9	0.6
Fulwe	30	2.0	32	2.1	28	1.9	41	2.7	7	.5	4	.3	22	1.5
Doma	33	2.2	23	1.5	11	.7	36	2.4	3	.2	0	0	12	.8
Langali	15	1.0	11	.7	8	.5	23	1.5	14	.9	2	.1	12	.8
Melela	26	1.7	34	2.3	16	1.1	28	1.9	13	.9	5	.3	5	.3
Mangae	21	1.4	16	1.1	5	.3	14	.9	11	.7	0	0	1	.1
Total or Average	161	1.8	133	1.5	81	.9	179	2.0	46	.6	13	.1	61	.7

The reasons for the variation in age groups and number of family members across villages is not immediately obvious. Langali village for example had 15 members in the 0-10 age group; whereas Kingolwira had 36. Also, Langali families had 5.1 members; whereas Kingolwira had 7.3 members per household.

In all villages and also in all but one age group, females outnumbered males. However there were more disabled males than females (Table 3-6). If the individuals not staying at home are ignored there were 292 females and 247 males in all age groups. This difference is attributed to differential migration of males and females. Migration is much more common among the males. Table 3-5 also indicates that 35 percent of the potential labor force is not at home.

3.2.2 Land-labor relations

The most common tool used in land cultivation is the hand hoe. Thus, there are serious limitations to the area that can be cultivated by the family. Fifty-six percent of the total households cultivated less than 3 ha. Also Table 3-7 indicates that as farm size increases, the average family size (in terms of adult equivalents) increases. However the cause and effect relationship is still being debated. One of the postulates is that farm size is a function of family size, the argument being that larger households will tend to acquire more land than small households. However, the opposite cound be true in the sense that the larger farms induce larger family sizes through increased birth rates, turning to polygamy, or adopting permanent relatives. These could also be functions of wealth in which case the wealthy can acquire more land and/or labor to cultivate more land. In the area, 2.74 adult equivalents were found

Table 3-6 Sample farmers: Age distribution, number of disabled, and members working outside home based on the total of 15 households by village and sex, 1983

Age Class	0 - 10			11 -16			11-16 (School)			17-55			56+			Disabled			Members Not staying at home		
	M*	F*	T*	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Kingolwira	14	22	36	8	9	17	6	7	13	17	20	37	3	5	8	1	1	2	9	0	9
Fulwe	13	17	30	14	18	32	12	14	26	19	22	41	4	3	7	3	1	4	20	2	26
Doma	15	18	33	10	13	23	6	5	11	16	20	36	2	1	3	0	0	0	9	3	12
Langali	8	7	15	6	5	11	4	4	18	10	13	23	6	8	14	1	1	2	10	2	12
Melela	14	12	26	15	19	34	9	6	15	13	15	28	6	7	13	2	3	5	5	0	5
Mangae	10	11	21	7	9	16	3	2	5	6	8	14	5	6	11	0	0	0	1	0	1

*M = Male
*F = Female
*T = Total

Table 3-7 Sample farmers: Relationship between farm size, family size, and available labor force, 1983

Farm Size	Proportion of Total Farmers		Average Farm Size	Average Family size
Ha.	No.	Percent	Ha.	Adult Equivalents
> 0 -<1.0	12	13.3	0.73	2.2
1.0 - 1.9	31	34.4	1.32	2.5
2.0 - 2.9	34	37.8	2.45	2.6
3.0 - 3.9	8	8.9	3.21	3.8
4.0 & Above	5	5.6	7.97	4.8
Total /Average	90	100.0	2.21	2.74

cultivating on average 2.21 ha, or an average of 0.8 ha per adult equivalent.

Mechanization is practiced by a few farmers by custom hiring. It is found most often on the large farms (Table 3-8). Mechanization refers to nothing more than the preparation of the seedbed by a tractor.

3.3 Seasonal Distribution of Family Labor Use on Farms

3.3.1 Seasonal labor distribution by location

Since farmers do not usually keep records, they were asked to estimate the number of man-days they spent on each of the crops that they planted. The month that the operation was performed was also noted. When an operation overlapped a 2-month period, an estimate of the monthly labor distribution was collected. Table 3-9 shows the average labor use for each crop per household. The actual number of households involved, area cultivated for each crop and labor required per ha are shown in Appendix B.

From Table 3-9, labor profiles for each location were drawn. This represented average household labor use on the various crops on a monthly basis. For most villages, labor peaks were in December-January-February. This is the period in which land preparation, cultivation, planting and weeding are performed. The heavy labor use in July-August represents the harvesting period (Figures 3-1 through 3-6).

Kingolwira village. Peak labor demand periods were in months of February and July where 160 and 147 man-days respectively were used. June, September, November and December were essentially slack months.

Table 3-8. Sample farms: Relationship between farm size, family size and total area mechanized per crop per village, 1983

Farm Size (ha)	Family size (Adults Eq)	Total no. of hectares mechanized											
		Kingolwira		Fulwe		Doma		Langali		Melela		Mangae	
		ha	crop(s)	ha	crop(s)	ha	crop(s)	ha	crop(s)	ha	crop(s)	ha	crop(s)
0-0.9	2.2	-		-		-		-		-		-	
1-1.9	2.5	-		-		0.4	maize	-		0.4	maize	-	
2-2.9	2.6	0.4	maize	-		0.4	maize	-		-		-	
3-3.9	3.8	-		-		2.2 1.6 .4	maize millet cotton	-		-		-	
4 and above	4.8	2.4	sorghum	-		-		-		1.2 1.2 2.0	cotton sunflower sorghum	-	

Table 5-3 Sample farms: Labor use in man-days per average household per actual area cultivated, 1983

Crop	Village	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Kingolwira	18.7	24.6	8.3	15.7	27.6	0	24.6	16.6	0	0	0	0
	Doma	35.5	10.6	12.0	0	0	8.0	8.0	17.0	0	0	18	4
Sorghum	Melela	17.7	14.5	16.4	20.6	27.5	13.5	31.5	25.5	30.3	0	0	18.7
	Mangae	14.2	19.4	15.0	13.6	21.4	11.1	9.6	12.6	0	0	24	20.0
	Kingolwira	20	28.0	11.0	0	0	0	44.0	0	0	0	0	0
	Fulwe	0	0	9.8	8.0	10.6	0	6.8	4.0	0	0	0	0
Beans	Langali	8.7	10.2	9.0	23.4	17.7	9.1	10.8	0	0	0	9.2	9.3
	Melela	0	0	10.7	3.5	19.0	12.0	2.0	0	0	0	0	2.0
	Kingolwira	13.5	19.5	11.8	15.0	0	0	18.0	10.0	0	0	0	0
	Fulwe	15.0	19.0	14.0	33.0	20.0	34.0	27.0	0	0	0	0	35.2
Paddy	Doma	9.0	4.0	10.0	12.0	0	6.0	0	0	0	0	0	15.0
	Melela	12.0	3.5	0	12.0	18.0	0	0	0	0	0	0	8.7
	Fulwe	12.5	22.7	17.3	31.7	12.0	20	19.6	18.5	0	0	0	19.1
Millet	Doma	15.8	8.0	10.0	13.0	0	20	11.0	18.7	0	0	12	25.0
	Kingolwira	17.7	18.8	7.7	11.2	12.0	6.0	14.0	21.3	0	16	16.6	15.0
	Fulwe	20.9	26.8	14.3	16.0	15.0	20.2	17.7	0	0	0	20.0	26.4
	Doma	8.8	16.5	10.5	12.0	0	0	15.6	13.5	4.0	9	20.1	19.0
Maize	Langali	18.5	19.0	21.5	26.5	19.4	0	8.0	10.0	17.0	16.6	23.5	19.2
	Melela	19.5	24.0	13.6	13.2	5.0	8.8	0	20.0	0	0	0	15.3
	Mangae	19.2	15.3	6.2	18.7	15.7	15.4	0	0	0	24.0	6.0	13.8
	Kingolwira	24.0	23.0	4.0	8.0	0	8.0	10.0	5.0	8.0	0	0	4.2
	Fulwe	13.0	21.0	21.0	0	0	6.0	0	9.0	0	0	0	6.0
Sunflower	Doma	3.0	10.0	11.5	9.8	15	0	12.0	10.0	0	0	15	14.5
	Melela	9.3	14.0	6.3	16.0	18	8.0	24.0	0	0	0	0	0
	Mangae	24.0	22.0	20.0	15.0	5	8.0	0	4.0	0	0	0	0
	Kingolwira	15.3	12.6	6.5	17.6	18.6	6.0	36.0	25.0	21.7	36.0	0	18.0
	Fulwe	20.8	25.1	26.7	18.5	5	7.5	14.8	28.1	22.6	30.0	0	31.0
Cotton	Doma	13.2	14.7	10.2	12.8	8.7	14.0	15.3	15.4	18.5	19.3	44	0
	Melela	16.0	8.7	10.0	24.4	18.0	8.0	36.0	31.8	25.0	0	0	17.0
	Mangae	16.5	22.5	10.2	18.5	23.0	17.2	15.0	18.2	20.1	0	0	22.5
	Kingolwira	18.0	18.0	6.0	0	16.0	0	0	0	0	0	0	0
	Fulwe	14.6	0	8.3	5.0	14.7	12.0	0	8.5	0	32.0	0	20.0
Bananas	Langali	0	0	0	0	8.5	10.0	0	10.0	0	0	0	0
	Melela	2.0	1.0	15.0	10.0	10.0	16.0	0	0	0	0	0	0
	Kingolwira	0	15.0	5.3	0	9.5	5.5	0	0	0	0	0	0
	Fulwe	0	0	0	10.0	0	0	0	0	0	0	0	20.0
Cassava	Doma	0	0	0	0	0	0	0	0	0	8.0	0	0
	Langali	0	0	0	6.0	0	0	0	0	0	0	0	0
	Melela	20	0	6.0	0	0	0	0	0	0	0	0	0
	Fulwe	15.5	23.0	16.2	21.6	34.0	24.0	20.0	0	0	0	0	12.0
Vegetables	Langali	0	4.0	4.0	8.0	16.0	14.0	16.0	7.5	18.0	12.0	0	0
	Melela	0	0	5.5	6.0	6.0	4.0	0	0	0	0	0	0
Sesame	Fulwe	7.2	23.0	23.5	12.0	0	28.6	14.5	4.0	0	0	0	26.0

Figure 3-1 Average household monthly labor use on farms for Kingolwira, 1983

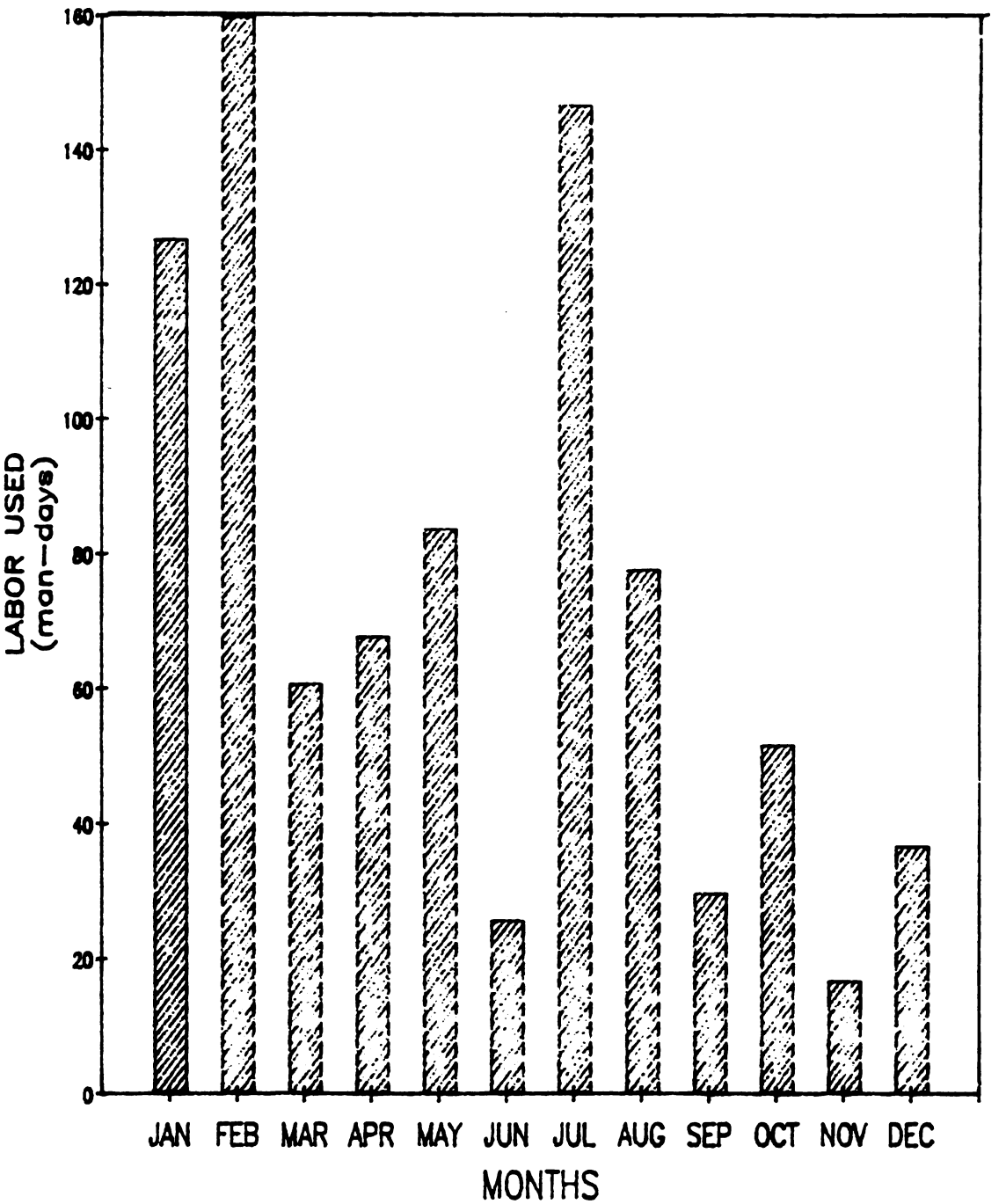


Figure 3-2 Average household monthly labor use on farms for Doma, 1983

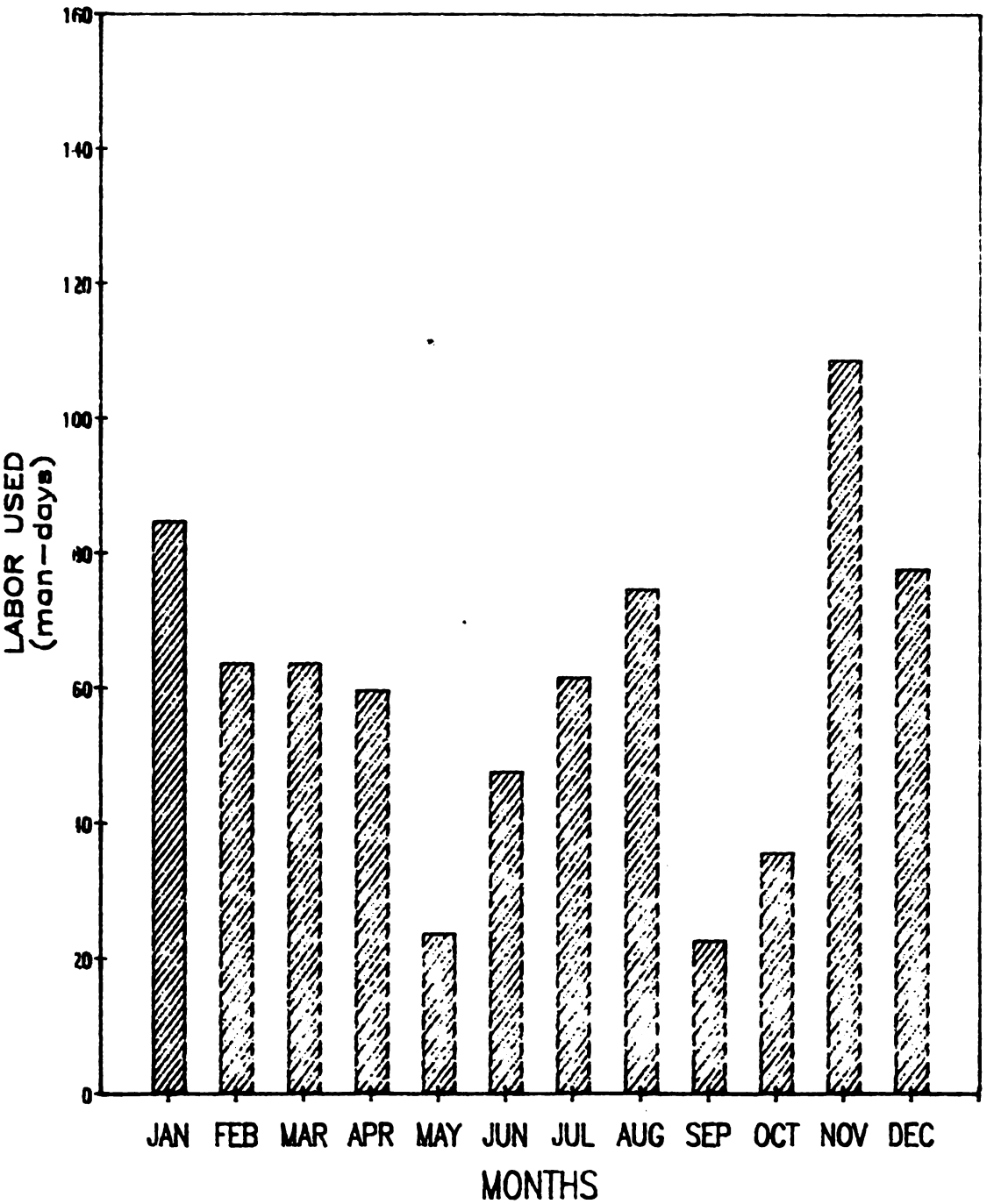


Figure 3-3 Average household monthly labor use on farms for Fulwe, 1983

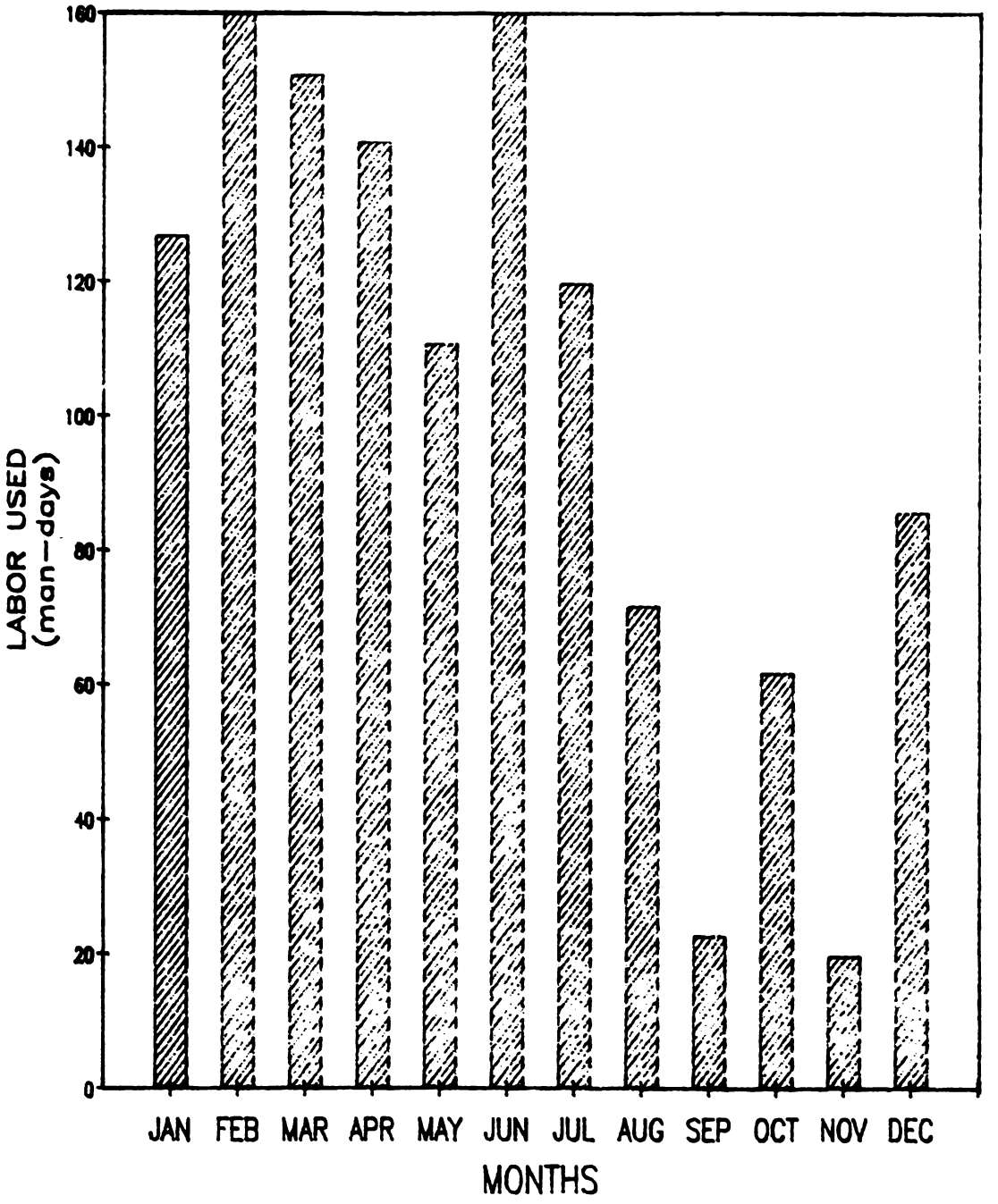


Figure 3-4 Average household monthly labor use on farms for Langali, 1983

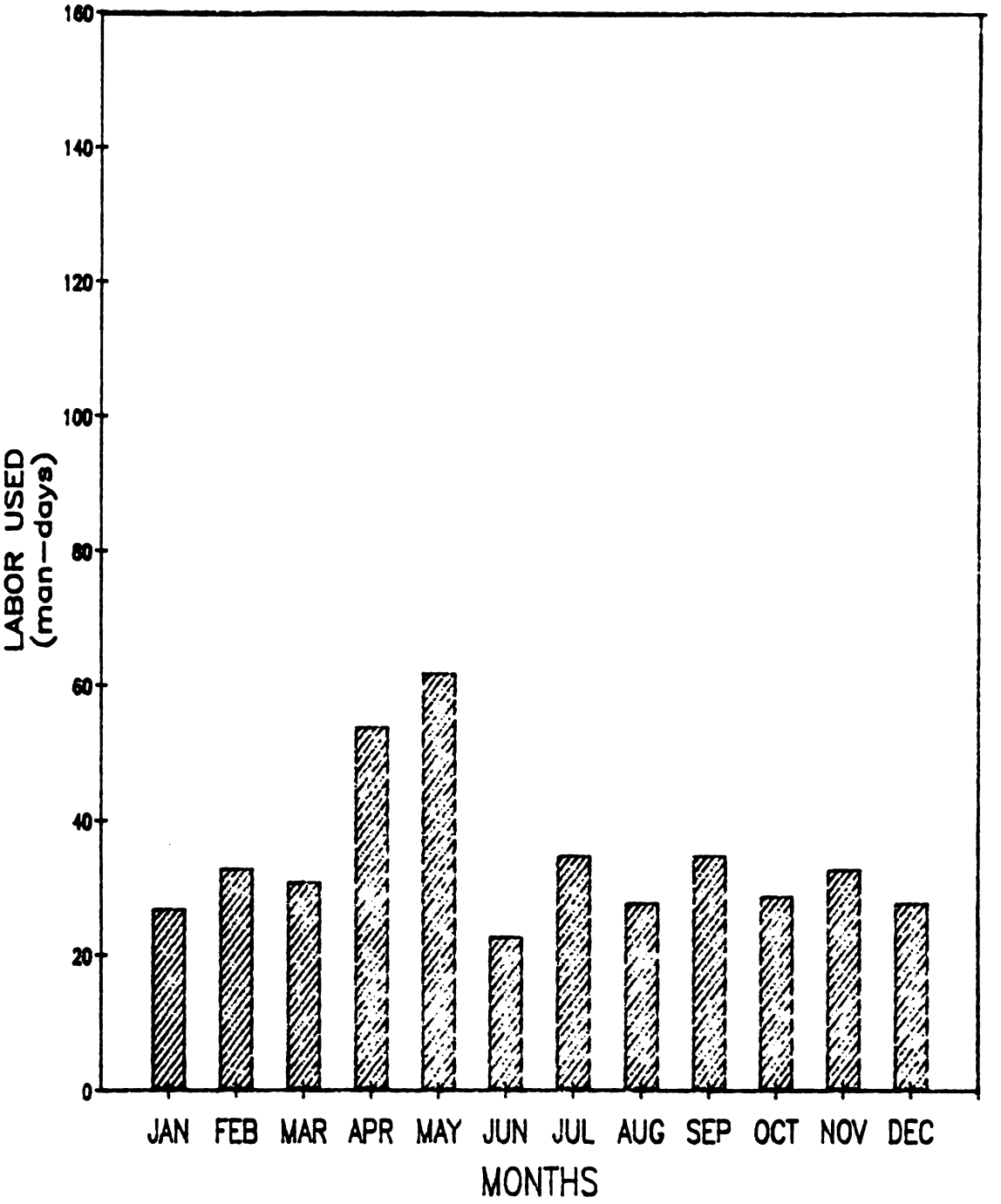


Figure 3-5 Average household monthly labor use on farms for Melela, 1983

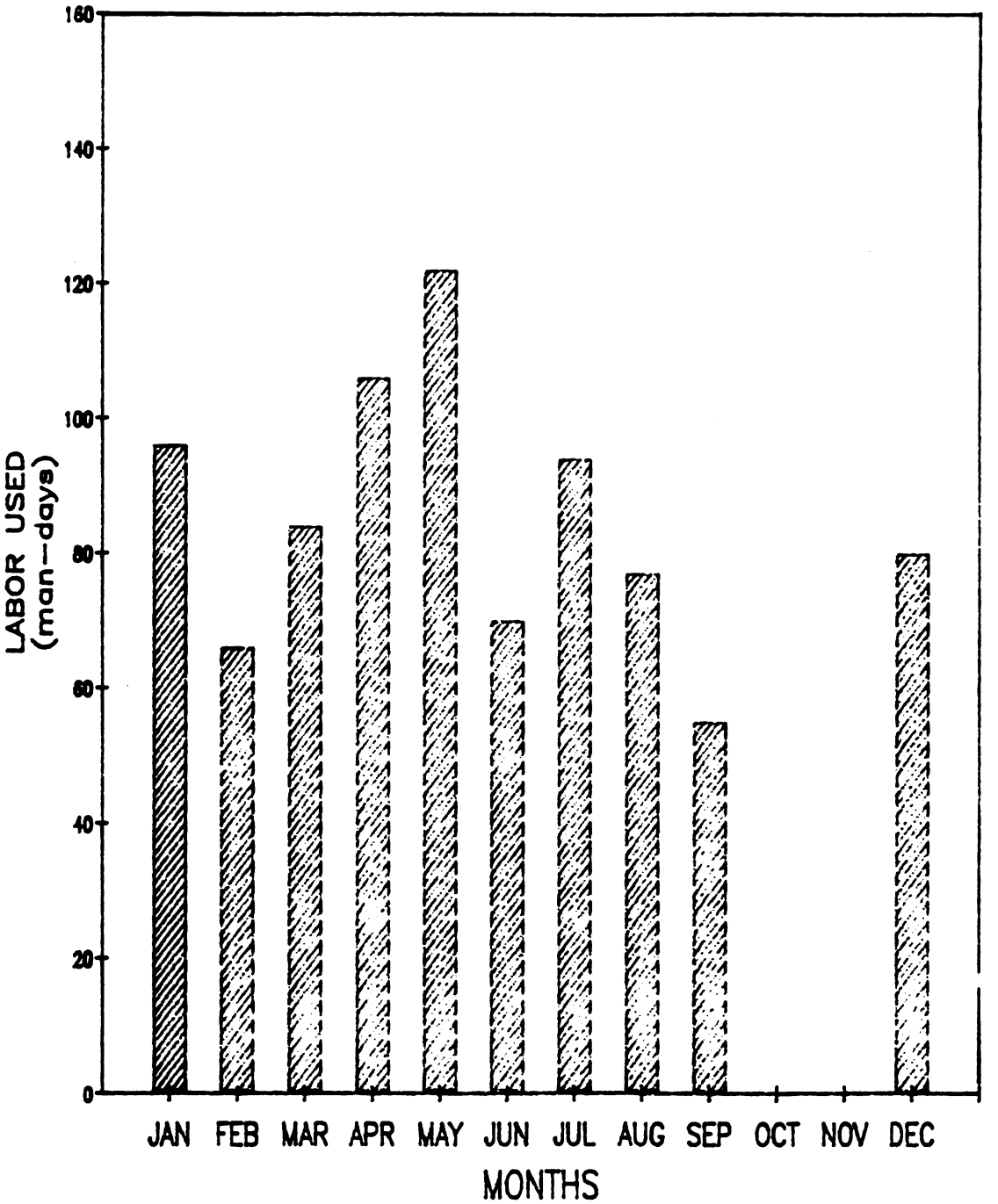
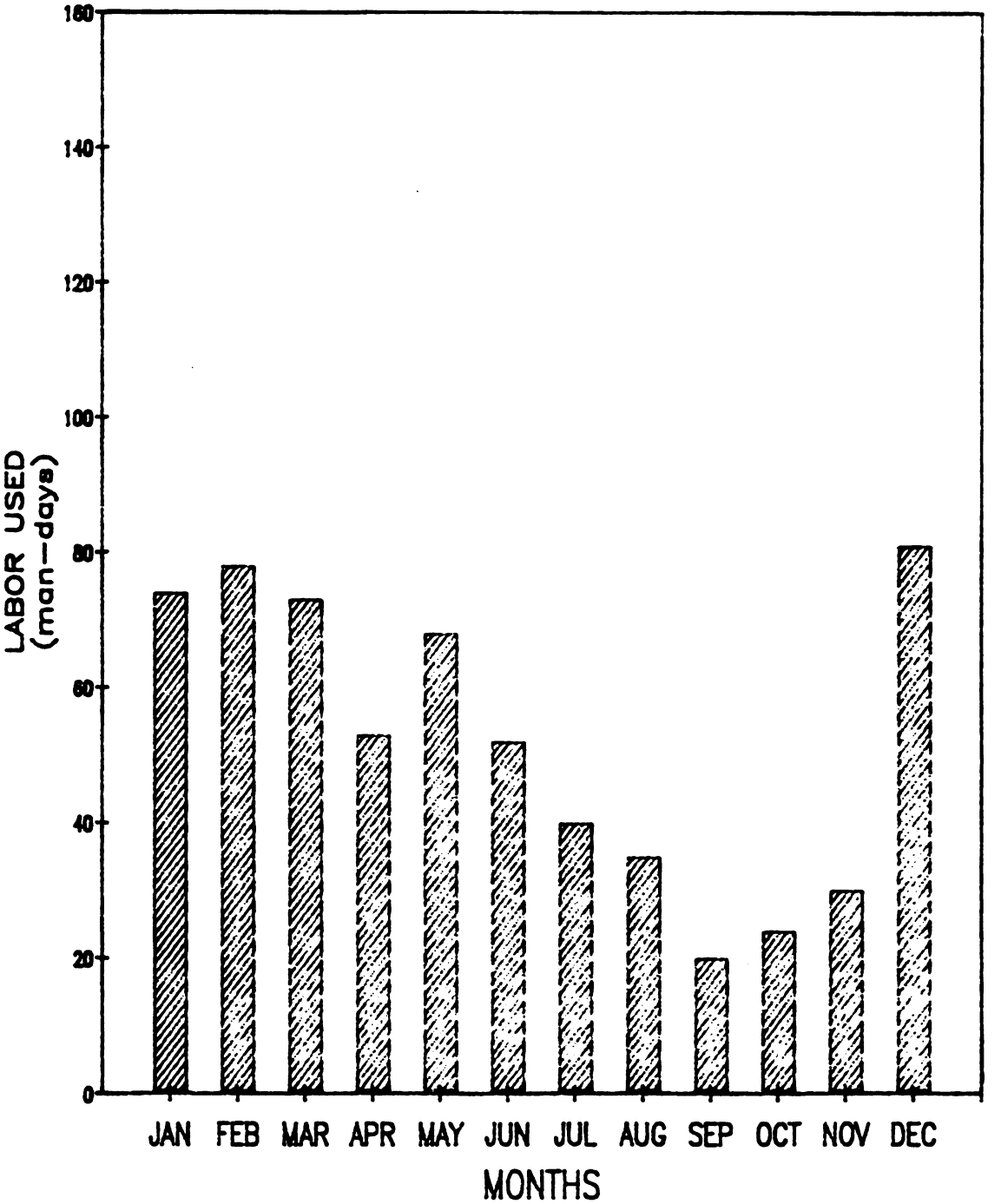


Figure 3-6 Average household monthly labor use on farms for Mangae, 1983



Fulwe village. December through July were the busy months with less labor needed in the remaining months. The labor requirements closely match that of Kingolwira which is just 16 km away.

Doma village. The pattern of labor requirement is essentially the same as in the other two locations (Kingolwira and Fulwe) with the exception that the peaks are lower. Kingolwira and Fulwe have on the average bigger family sizes and hence more labor available (Table 3-1).

Langali village. In this village labor is more evenly distributed and the peaks are smaller compared with the other locations. Rainfall is more reliable here and the cropping pattern differs from the others, with vegetables, beans and maize being the dominant crops. Planting of maize occurs in November and harvesting takes place in April and May. This explains the peaks shown in Figure 3-4. Immediately following maize harvest, beans are planted and harvested in July.

Melela village. Three labor peaks are evident in this location; a January peak, representing land preparation and cultivations; a May peak denoting the weeding time; and a July peak indicating the month when most of the maize, cotton and millets are harvested. There is a complete lack of agricultural activities in October and November.

Mangae village. This location has its greatest peak in December, of approximately 80 man-days. From this month the pattern depicts a gradual decline in monthly labor use to September, when the demand again increases. Table 3-10 shows annual labor requirements per ha of crops. Cotton has the highest labor requirement, followed by sesame and beans.

Table 3-10. Sample farms: Annual labor requirements for the principal crops, 1983

Crop	Labor requirements in man-days per ha
Cotton	213
Sesame	175
Beans	153
Sunflower	148
Vegetables	144
Paddy	135
Millet	102
Maize	97
Sorghum	93
Bananas	67
Cassava	51

3.4 Labor Use on Non-farm, Off-farm and Social Activities

3.4.1 A descriptive profile of the major non-farm activities

3.4.1.1 Introduction

This section describes the major non-farm rural activities common in the rural areas surveyed. Although the types of non-farm activities are numerous, the ones that contribute significant employment in the household are basket making, mat making, charcoal manufacturing, carpentry and brewing (Table 3-11). Of less importance and not addressed in this study are pottery, black-smithing, brick making, tailoring, broom and hat making. Standard household activities such as cooking, washing clothes, caring for the young, etc., although important, are also not addressed in this study.

There appears to be little relationship between farm size, years of education, and involvement in non-farm activities. One would expect small farm sizes to be associated with high non-farm employment. However, the scale of farm size is so narrow that there is not much difference between large and small farms (Table 3-12).

When households involved in non-farm activities were grouped by village, it became apparent that location was an important variable determining the presence or absence of non-farm activities (Table 3-13). A further investigation indicated that basket mat weaving dominated the non-farm activities. Furthermore, these activities were more common in villages which had the raw material necessary for baskets and mats.

The following sections are an enterprise-by-enterprise description of the dominant non-farm activities. Areas discussed include resource use skill, seasonality, availability of raw material and marketing channels.

Table 3-11. Sample of farmers: Proportion of households in the different non-farm activities, 1983

Enterprise	Number of Farmers	Proportion of sample of 90 farmers - %
Basket making	30	33.3
Mat making	25	27.8
Brewing	16	17.8
Charcoal manufacturing	3	3.3
Carpentry	1	1.1

Table 3-12 Sample farms: Relationship between farm size, family size, education and involvement in non-farm activities, 1983

Farm Size	Total Farmers		Avg. Farm Size	Average Family Size	Education	Farms Involved in Non-Farm Activities	
Ha	No.	Percent	Ha	Adult Equivalent	Years	No.	Percent
> 0 < 1.0	12	13.3	0.73	2.2	3.9	5	10.9
1.0 - 2.9	31	34.4	1.32	2.5	3.6	16	34.8
2.0 - 2.9	34	37.8	2.45	2.6	3.8	21	45.7
3.0 - 3.9	8	8.9	3.21	3.8	3.4	3	6.5
4.0 & above	5	5.6	7.97	4.8	2.6	1	2.1
Total or Average	90	100.0	2.21	2.74	3.46	46	100.0

Table 3-13 Sample farmers: Involvement in non-farm and off-farm activities in relation to distance from Morogoro Town, 1983

Village (Location)	Total No. of House-holds	No. of Households in Non-farm Activities	No. of House-holds in Off-farm Employment[1/]		Distance from Morogoro town
			Type	Urban	(km)
Kingolwira	15	5	4	5	13
Fulwe	15	7	2	2	29
Doma	15	6	3	6	67
Langali	15	0	4	7	40
Melela	15	13	1	4	32
Mangae	15	15	3	2	51

[1/] Urban include house-repair, masonry work, hotel and restaurant, general construction work and petty business.

3.4.1.2 Basket and mat making

Basket and mat making were the most abundant non-farm activities for the survey farmers. Most of these activities were concentrated in the villages of Mangae and Melela. About 30 percent of the farmers were involved in basket making, while 28 and 18 percent were involved in mat weaving and brewing respectively. The primary resources employed in basket making and mat weaving are labor and dry leaves of herbaceous plants belonging to the palm family. Some sisal twine may often be necessary for tying the different segments together.

A great variation in size, form, embroidery and workmanship of baskets and mats existed. This variation was also reflected in their use and prices. During the season of low agricultural activity, weaving may begin in the morning. But as farm operations become important, weaving takes place in the late afternoon after farm work and may continue to the early hours of the night.

Men and women were found to participate more or less equally in the weaving. A typical situation was to find a husband and wife seated beside their dwelling or in the shade, weaving while talking to each other. However, women, usually quit early to prepare the noon or evening meal. No child labor input was observed. Currently only the middle aged and the old are involved. The number of baskets made per month per family was on average 5.1, while that for mats was 2.5. A basket took 2-5 full days (depending on the type) to complete while a mat took 5-7 days. A typical rectangular mat would measure about 6 feet by 3 feet and a circular one has a 3-4 foot as radius. Mats manifest a high degree of variation in style, workmanship, and embroidery. Knowledge on how to weave is passed from one generation to another.

A majority of baskets and mats were made after the peak agricultural months of June, July, and August. The number of baskets made per household in September to November quarter was 30 while in the December to February quarter it was only 10.

Seventy-five percent of the farmers involved in the enterprise obtained the required raw materials from the neighboring vegetation. However, some had to travel up to 16 km on bicycle or on foot to head carry the leaves. A few purchased the leaves from venders. Normally green leaves are collected and they are then dried in the sun before weaving. The availability of the raw material in or near the village was instrumental in determining the presence of weaving in a given location.

As far as marketing is concerned, there were no contractual arrangements or ready markets for baskets or mats. These items are sold in three main markets--rural, urban, and tourist. Rural and tourist demand in total is less than urban demand. Most farmers merchandise their baskets and mats by the road side. As she/he waits for a buyer, weaving is also taking place. Those items with embroidery sell faster than others. Those who buy in bulk for further retailing in towns go straight to the household of the seller. About seven types of baskets were identified and their prices varied from TShs 20 to TShs 200. Four types of mats were identified--rectangular plain, circular plain, embroidered rectangular, and embroidered circular. Their prices varied from TShs 50 to TShs 200.

Baskets are used for shopping and storage of farm produce and sometimes clothes. Mats are used in the drying of farm produce such as maize flour, sorghum and beans. A particular type of mats is widely used in mosques for praying, while some other types are used to decorate.

3.4.1.3 Charcoal manufacturing

This was by far the most physically difficult activity as perceived by the participating individuals. Charcoal making involves working sometimes in a harsh environment--in humid and hot weather. This activity is done predominately by middle aged people, perhaps because of the physical strength required.

Necessary inputs are labor, a few fixed inputs such as axes, bush knives (pangas), hoes, spades, and gunny sacks for bagging the charcoal. The process of charcoal manufacturing involves felling of trees, cutting them into short pieces, erecting a furnace, firing it, permitting the furnace to cool, and then bagging the charcoal. Once the charcoal is bagged, it is ready for sale. The number of trees felled at any particular period may vary from 10-30 all depending on their size, time available for the charcoal making, the dispersion of trees to be felled, the weather, and the nutritional and health status of the individual. It takes on the average 10-15 days from felling the trees to bagging. Participants indicated that they had learned the skill of charcoal making from their friends, neighbors, and parents.

Raw materials needed include logs of trees and shrubs, which are cut into sizeable parts for burning. Since the shrubs and bushes are often far from the homesteads, charcoal manufacturing may involve vacating the homestead for one to two weeks. At some sites one may not find enough trees to fell to make charcoal production worthwhile. Therefore it may involve walking long distances before enough trees are found to justify a firing site.

After the charcoal has been packed into bags, it is carried to the road side by head to await for buyers. Some charcoal may be carried

from the kiln to the homestead for storage. Charcoal sold at the road side is chiefly bought by individuals in cars and trucks who take it to to the city/town either for their own consumption or for retailing. Demand for charcoal in the rural areas is negligible chiefly because firewood is the most common source of energy for cooking. Markets for charcoal are not guaranteed and the seller does not normally know how soon he can dispose of his charcoal after bagging. Some spend 3-7 days on the road side--sleeping and taking their meals--while awaiting for buyers. The price per bag of charcoal ranged from TShs 50 in the peak manufacturing months to TShs 60 during the rainy season.

Although charcoal manufacturing is not affected by rain, there is normally a fall in output in the rainy season because this is the busy season for farming operations. Charcoal manufacturers indicated that they go to the bush to make charcoal only when they feel that they badly need cash.

3.4.1.4 Brewing

This is entirely a women's enterprise. The brew is sorghum beer. However, sorghum is just the major ingredient. Maize flour, sugar and, of course, water are the other important ingredients. About one tin (20 liters) of cooked sorghum flour is mixed with one-third tin of cooked maize flour (about 6 litres) and 2-3 kg of sugar. This is enough to make one drum of brew with a capacity of 10 tins or 200 litres. The empty drum costs an average of TShs 400 and lasts for an average of 5 years. Brewing is normally a single-person business. However, one may be assisted by one or two family members. The whole process from flour making to sale of the beer may take a week's time but the effective days of work are approximately three.

Sorghum beer is an important part of the rural culture, particularly in the dry season. It provides "recreation" to farmers after a long day's work. Since it is relatively cheap compared to industrially bottled beer, a large percentage of the population consumes this brew. The peak brewing period is immediately after harvest, reflecting the ready availability of raw materials--sorghum and maize. The required grain is readily available from the surrounding farmers. However, during the agriculture growing season, brewers may have to travel long distances to search for sorghum and millet and at this time the price may be more than tripled.

Customers for the brew are from the surrounding homesteads and nearby villages. Brewers have to get a permit from the village council to brew. In an attempt to regulate the flow of product to market, the brewers also use an informal system of communication. In 20 percent of the cases brewers reported that they poured away the brew because it was unfit for human consumption.

3.4.1.5 Carpentry

This is perhaps the most diversified industry in terms of products made. Products include doors, stools, chairs, tables and beds. A wide variation exists within and between carpenters with regard to articles made. For example, one may identify 4 to 5 distinct types of chairs produced.

Material used includes lumber, nails, saws, files, chisels, hammers, and planes. With the exception of lumber and nails most of the inputs are fixed costs. Entry to the enterprise is limited by the high initial capital requirement. Only 3 percent of the 90 households were involved

in some form of carpentry. A door took on the average 6 days to produce and a stool about half a day.

As far as skill is concerned, the enterpreneurs had undergone apprenticeship in various institutions including the Tanzania Peoples' Defense Forces workshop (TPDF) and Rural Training Centers (RTC).

Carpentry demands raw material (inputs) which cannot be freely and easily obtained as is the case of other enterprises. Materials necessary for the making of doors, chairs, stools, etc. are obtained from sellers/ retailers within the rural areas and occasionally from Morogoro town saw mills. The high cost of materials and equipment was mentioned as one of the chief problems facing this enterprise. All the carpenters reported that they normally work on a contract basis. This means that until someone has placed an order for a certain item, it is not produced. The reason is because the production of most items (e.g., a bed, chair or stool) requires relatively large amounts of cash for raw materials and equipment procurement and the enterpreneurs can ill afford large investments in inventories. Demand for the products is mostly rural based. Many of the products are inferior in quality and cannot compete with products from their counterparts in the urban areas. Prices for the products of the carpentry industry vary from a low of TShs 40 to a high of TShs 1,200.

3.4.2 Labor use on non-farm activities

A distinction between "non-farm" and "off-farm" was made at the beginning of the study. Non-farm are those non-agricultural activities that are performed by a member or members of the household within the farm household boundary (see 3.4.1). Off-farm work includes agricultural or

non-agricultural activities that are performed by a member or members of the household outside the farm. Social activities are the non-productive (in a material sense) type of obligations on the part of the family members. They include attending funerals, traditional dances, ceremonies, visiting relatives, and so forth.

As in the case of farming activities, labor used for non-farm activities was recorded quarterly in March, June, September, and December. In each case farmers were asked to estimate the number of hours spend in each activity for the last three months. Units were recorded in man-hours since most non-farm activities were performed following normal daily farming activities. Average total hours per quarter ranged from 0 in Kingolwira in September-November to 298 in Melela in September-November (Table 3-14). Non-farm activities were not found in Langali. This should not imply that there are no possibilities for such activities. The opportunity cost of engaging in them however, may have been high.

For purposes of the study, total labor used per quarter for non-farm activities was spread evenly across the three month period. Table 3-15 shows the number of man-days by month by village used in non-farm activities. Hours figures were converted into day figures by dividing the hours by 8.

When the labor is summarized on an enterprise basis basket weaving used the most labor followed by mat weaving and brewing (Table 3-16).

3.4.3 Off-farm rural employment

Off-farm employment was basically agricultural. Activities included cultivation, weeding and harvesting of crops like millet, sorghum and cotton. Wages ranged from TShs 10 to TShs 20 per day depending on the

Table 3-14 Sample farmers: Average quarterly labor use on non-farm activities, 1983

Village	Dec-Feb		Mar-May		Jun-Aug		Sep-Nov	
	Number of Involved Households	Avg Hrs	Number of Involved Households	Avg Hrs	Number of Involved Households	Avg Hrs	Number of Involved Households	Avg Hrs
Kingolwira	1	6	4	23	4	38	0	0
Fulwe	8	147	4	86	3	93	3	100
Doma	8	117	8	125	8	110	8	105
Melela	10	58	12	143	13	82	12	298
Mangae	15	120	15	90	15	108	15	183

Table 3-15 Sample farmers: Monthly distribution of labor in non-farm activities per average household involved, 1983

Month / Village	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
	Man-days per household											
Kingolwira	.25	.25	.88	1.00	1.00	1.80	1.50	1.50	0	0	0	.25
Fulwe	6.21	6.12	3.50	3.50	3.80	3.88	3.88	3.88	4.12	4.12	4.25	6.12
Doma	4.38	5.00	5.00	5.25	4.38	5.12	4.25	3.75	4.00	3.25	5.88	5.25
Melela	2.38	2.38	5.88	6.12	5.88	3.38	3.38	3.50	12.38	12.38	12.50	3.50
Mangae	5.00	4.38	3.75	3.12	4.38	4.50	5.00	4.00	7.50	7.00	8.38	5.62
Average	3.63	3.63	3.80	3.79	3.88	3.74	3.60	3.60	5.60	5.35	6.20	4.15

Table 3-16 Sample farmers: Total labor use on non-farm activities by enterprise, man-hours per annum, 1983

Enterprise	Village					Total
	Kingolwira	Fulwe	Dome	Melela	Mangae	
Baskets	55	0	1010	2020	3900	6985
Mats	110	0	980	1280	2188	4549
Brewing	64	400	755	1820	1427	4466
Charcoal	30	320	206	668	0	1224
Carpentry	0	610	0	0	0	610
Other[1/]	0	769	705	1150	0	2624
Total	250	2099	3656	6938	7515	20458

[1/] Other includes house repair, tailoring and bun selling.

task and time of the year. Active months for off-farm employment were September through January, which correspond to the late harvesting of cotton, and land preparation and cultivation of food crops (Table 3-17). Since landless laborers do not exist hiring of labor for agricultural work was not common. Non-agricultural labor hiring activities were also scanty in the rural areas. This phenomenon is a matter of concern to the rural population because it limits choices of employment. One has either to do his own farm work, indulge in non-farm activity in the household, or migrate from the village for off-farm non-agricultural employment in the urban areas.

3.4.4 Labor use on social activities

Upton (1973) and Mbithi (1974) emphasized the need to take into account farmers' backgrounds and attitudes in farm management planning and analysis. The same should also hold when one is involved in agricultural development planning exercises involving the use of rural labor. The independent decision making framework of the farmer has been described by Mbithi (1974) as that of "a responsive and adaptive actor in a dynamic and fluid environment." The decision making framework used by the farmer to allocate his/her labor is strongly influenced by the culture of which he/she is a product and this person's complex values, cognitions, beliefs and experiences. A death of a relative or neighbor, an annual crop festival, marriage ceremonies, and the like may claim a substantial amount of the household labor. Table 3-18 gives the average number of man-days spent on social activities per household. September and October, which are slack months in terms of agricultural labor, had a slightly higher number of social activity days.

Table 3-17. Sample farmers: Off-farm labor: Hiring out of labor by village by month per average household involved, 1983

Village	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	Man-days per involved household											
Kingolwira	-	4	-	-	-	-	-	-	-	-	-	-
Fulwe	2.0	-	-	-	-	-	-	-	-	-	-	2.2
Doma	4.0	-	-	-	-	-	-	-	3.0	2.0	-	2.2
Melela	1.0	-	-	-	-	-	-	-	3.0	-	-	-
Mangae	1.0	-	-	-	-	-	-	-	2.0	-	3.0	1.0
Average	1.6	.8	-	-	-	-	-	-	1.6	.4	.6	1.1

Table 3-18 Sample farmers: Labor use per household on social activities by month by location 1983[1/]

Village	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	Man-days[2/]											
Kingolwira	-	-	1.4	-	-	1.0	-	-	1.2	-		1.4
Fulwe	2	1.2	1.4	-	-	-	1.0	-	1.0	1.0	-	-
Doma	1	-	1.0	-	-	1.4	-	-	-	1.0	-	-
Langali	-	1.4	1.2	-	-	1.3	-	-	1.0	-	-	-
Melela	3	1.0	2.0	3.0	2.0	2.0	3.0	1	4.0	3.0	3.0	2.0
Mangae	1	1.0	1.0	1.4	1.0	1.4	1.0	1	1.0	2.0	1.7	1.4

[1/] Does not include Sundays and Christmas.

[2/] A dash indicates a number less than 1.

3.4.5 Comparison of labor stock and labor use on farm, non-farm, off-farm and social activities

In accounting for labor available at the household, the average number of adult equivalents at the household was multiplied by the number of days in the month less 4 Sundays and Christmas day in December. Other national festivals exist but are not deducted because they are perceived differently by different groups. A national independence day, for example, means little to a farmer who is contemplating getting his field ready for planting as the rainy season begins.

3.4.5.1 Labor available and its allocation by village

For this section information is gathered from Tables 3-5, 3-6, 3-9, 3-15, 3-17 and 3-18. Using the information from these tables, tables are constructed for each village in the survey to show total labor use per household for four activities, namely farming, non-farm activities, off-farm activities, and social activities (Table 3-19). For most months the sum of these times devoted to these activities is found to be more than the amount of available labor obtained by the conventional method of multiplying the number of adult equivalents by the number of working days per month. The difference is due partly to: 1) the unique property which labor has of "stretching itself" in critical periods when it is most needed; and 2) possible response bias in reporting labor utilization on farm activities. Farmers might have worked for only a few hours in a day on the farm but a full day may be reported. It is not unusual for farmers to over-report resource utilization and under-report output in survey studies.

The method of labor accounting in agriculture is always open to criticism. Questions which are likely to be raised include: How long

Table 3-19(a) Kingolwira sample farmers: Labor stock and use per household, 1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Man-days											
1. Labor available[1/]	77	68	77	74	77	74	77	77	74	77	74	74
2. Labor in farm[2/]	127	160	61	68	84	26	147	78	30	52	17	37
3. Labor non-farm[3/]	0.25	0.25	0.88	1	1	2	2	2	0	0	0	.25
4. Labor off-farm[4/]	0	4	0	0	0	0	0	0	0	0	0	0
5. Labor social[5/]	0	0	1	0	0	1	1	0	1	0	0	1
6. Total (2+3+4+5)	127	164	63	69	85	29	150	80	31	52	17	38

[1/] Adapted in part from Table 3-5.

[2/] Adapted from Table 3-9.

[3/] Adapted from row 1 of Table 3-15.

[4/] Adapted from row 1 of Table 3-17.

[5/] Adapted from row 1 of Table 3-18.

Table 3-19(b) Fulwe sample farmers: Labor stock and use per household, 1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						Man-days						
1. Labor available	82	73	82	79	82	79	82	82	79	82	79	79
2. Labor in farm	127	161	151	141	111	173	120	72	23	62	20	86
3. Labor non-farm	6	6	4	4	4	4	4	4	4	4	4	6
4. Labor off-farm	2	0	0	0	0	0	0	0	0	0	0	2
5. Labor social	1	1	1	0	0	1	1	0	1	1	0	0
6. Total (2+3+4+5)	136	168	157	145	115	178	125	76	28	67	24	94

Table 3-19(c) Doma sample farmers: Labor stock and use per household, 1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						Man-days						
1. Labor available	78	70	78	75	78	75	78	78	75	78	75	75
2. Labor in farm	85	64	64	60	24	48	62	75	23	36	109	78
3. Labor non-farm	4	5	5	5	4	5	4	4	4	3	6	5
4. Labor off-farm	4	0	0	0	0	0	0	0	3	2	0	2
5. Labor social	1	0	1	0	0	1	0	0	0	1	0	0
6. Total (2+3+4+5)	94	69	70	65	28	54	66	79	30	42	115	85

Table 3-19(b) Langali sample farmers: Labor stock and use per household, 1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						Man-days						
1. Labor available	54	49	55	53	55	53	55	55	53	55	53	53
2. Labor in farm	27	33	31	54	62	23	35	28	35	29	33	28
3. Labor non-farm	0	0	0	0	0	0	0	0	0	0	0	0
4. Labor off-farm	0	0	0	0	0	0	0	0	0	0	0	0
5. Labor social	0	1	1	0	0	1	0	0	1	0	0	0
6. Total (2+3+4+5)	27	34	32	54	62	24	35	28	36	29	33	28

Table 3-19(e) Melela sample farmers: Labor stock and use per household, 1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						Man-days						
1. Labor available	80	71	80	77	80	77	80	80	77	80	77	77
2. Labor in farm	96	66	84	106	122	70	94	77	55	0	0	80
3. Labor non-farm	2	2	6	6	3	3	4	4	12	12	12	4
4. Labor off-farm	1	0	0	0	0	0	0	0	3	0	0	0
5. Labor social	3	1	2	3	2	2	3	1	4	3	3	2
6. Total (2+3+4+5)	102	69	92	115	127	75	101	82	74	15	15	86

Table 19(f) Mangae sample farmers: Labor stock and use per household, 1983

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						Man-days						
1. Labor available	45	40	43	45	43	45	43	45	43	45	43	43
2. Labor in farm	74	78	73	53	68	52	40	35	20	24	30	81
3. Labor non-farm	5	4	4	3	4	5	5	4	8	7	8	6
4. Labor off-farm	1	0	0	0	0	0	0	0	2	0	3	1
5. Labor social	1	1	1	1	1	1	1	1	1	2	2	1
6. Total (2+3+4+5)	81	83	78	57	73	58	46	40	31	33	43	89

in terms of hours should a man-day be? How does one account for different work intensities within a man-day for different individuals? How are the nutrition and state of health of the individual accounted for in the man-day calculation? At what age do we start counting an individual as an adult in terms of farm work? Because of these problems, special adjustments in the labor use and availability figures will be needed for planning purposes.

3.5 Income Sources for Households

Basically four sources of income for the rural households were identified. These were field crops, non-farm activities, home remittances and, of least importance, off-farm activities.

3.5.1 Farm income

Farm income in this case refers to income derived from farming operations.

3.5.1.1 A note on methods

In order to describe what is taking place in the rural households in terms of income, three different procedures are used:

a) Total value product - This is defined as the product of the total output of a given crop (in kg) and the market price per unit of the output.

b) Gross margins - Conventionally, this is defined as gross revenue less variable costs. In this study it is defined as total value of output less cash operating (out of pocket) expenses. These are calculated on per ha basis for each crop and location.

c) Actual receipts from sales - These are the actual cash receipts by the farmers from the estimated fraction of total output sold.

3.5.1.2 Income variation among crops

A wide variation of income generated by different crops and between villages was revealed (see Table 3-20). The differences can be partly explained by rainfall differences, soils, and acreage cultivated for each crop.

Each of the three types of incomes has a particular use in understanding smallholder incomes. Total value product reflects the value of the products if they were all sold. On the average, sesame has the highest figure (TShs 1874), followed by maize, with TShs 1304.8. Gross margins per ha are of value when attempting some enterprise budgeting or computations of returns per man-day or man-hour. They are also useful in formulating objective function coefficients for programming purposes. A high gross margin per se does not necessarily mean that higher priority should be attached to the crop. Sesame appears most attractive with a gross margin of TShs 5355, but it is grown only in one village; moreover, it is not technically very easy for a family to grow up to a ha of sesame because of the delicate nature of the crop husbandry operations including pulverization of the seedbed, early and continuous weeding, etc.

Actual receipts - These are included in order to give a measure of the liquidity of the farm household for the year. Actual crop receipts in conjunction with the other types of income (non-farm, off-farm and home remittances), allow rural farm households to purchase goods and services such as food, clothing, education, health services, and labor.

3.5.2 Income from non-farm employment

Since labor use on non-farm activities was computed quarterly, income from these activities was computed on a similar basis. Mangae had the highest per household non-farm income, TShs 3169 in the June-August

Table 3-20 Sample farmers: Income from crop production activities per household, 1983

Crop	Village	Total Value Product[1]	Gross Margin per Hectare[2]	Actual Receipts[3]
		(TShs)		
Maize	Kingolwira	1250.1	1500.6	62.5
	Fulwe	4136.0	4136.0	206.8
	Doma	841.1	923.1	42.0
	Langali	892.9	811.8	44.6
	Melela	401.9	699.0	20.1
	Doma	306.9	613.8	15.3
	Average	1304.8	1447.3	65.3
Sorghum	Kingolwira	1104.0	940.4	220.0
	Melela	144.0	816.0	228.8
	Mangae	160.0	400.0	32.0
	Doma	240.0	480.0	48.0
	Average	412.0	659.1	132.2
Sunflower	Kingolwira	494.2	1235.4	494.2
	Fulwe	428.1	1427.1	428.1
	Doma	191.7	639.0	191.7
	Melela	191.7	69.5	191.7
	Mangae	213.0	532.5	213.0
	Average	303.7	780.7	303.7
Sesame	Fulwe	1874.2	5355.0	1311.9
Cotton	Kingolwira	475.1	1131.2	475.1
	Fulwe	989.8	2020.0	989.8
	Melela	814.5	1307.4	814.5
	Mangae	839.9	1826.1	839.9
	Doma	1001.9	2479.8	1001.9
	Average	824.2	1752.9	824.2
Paddy	Kingolwira	882.0	1260.0	132.3
	Fulwe	1962.5	4564.0	294.3
	Melela	168.0	560.0	25.2
	Doma	280.0	1400.0	42.0
	Average	823.1	1946.0	123.4
Millet	Fulwe	1220.2	1968.0	219.6
	Doma	742.4	793.2	133.6
	Average	981.3	1380.6	176.6
Beans	Kingolwira	1566.0	2610.0	360.2
	Fulwe	1444.0	7200.0	331.2
	Melela	558.0	2790.0	128.3
	Langali	1174.5	3915.0	270.1
	Average	1184.6	4928.8	272.5
Cassava	Kingolwira	180.0	900.0	36.0
	Fulwe	258.8	862.5	51.8
	Melela	243.0	810.0	48.6
	Doma	300.0	600.0	60.0
	Langali	187.5	937.5	37.5
	Average	233.9	821.9	46.8

[1] Actual average area cultivated (ha) * yield/ha * price.

[2] Yield per ha (kg) * price - variable costs including hired labor, tractor hire, insecticides etc.

[3] Percentage of the output sold multiplied by total value product column.

quarter. This is about TShs 1056 per month. No definite relation between non-farm income and period of the year was observed. Although one would have expected more non-farm income during the slack agricultural months, this was not the case. Three reasons can be given for this result: 1) The chief non-farm activities involve weaving, which demands a reasonably long dry period for the input (leaves) to dry. This happens to be the June-October period. 2) For many households these activities are carried out at the end of a day's farm work and do not necessarily have to wait for the end of the season. 3) Some farmers carry forward inventories for sale in a later month.

When non-farm income was arranged according to location and source, charcoal and brewing had the highest income per household of TShs 7840 and 3000, respectively, in Melela. Based on total income however, charcoal and brewing are the chief sources (Table 3-21). In terms of locations, Mangae and Melela are the leading villages in terms of total income from non-farm activities. Again, the chief explanatory factor for the seemingly high non-farm income for some locations seems to be the easy access and availability of the raw materials necessary for mat and basket production.

3.5.3 Income from off-farm sources

As noted in section 3.4.3, off-farm employment was not practiced much in the surveyed villages. Consequently, the corresponding incomes from it were insignificant. Table 3-22 attempts to show the number of man-days per village per annum devoted for off-farm work and the corresponding total income. Wages ranged from TShs 10-20 per day depending on the task and time of the year, and averaged about TShs 15 per man-day.

Table 3-21 Sample farmers: Non-farm annual income (TShs) by source and location, average per involved household, 1983

Source	Kingolwira		Fulwe		Doma		Melela		Mangae	
	No. of Involved House-holds	Average Income	No. of Involved House-holds	Average Income	No. of Involved House-holds	Average Income	No. of Involved House-holds	Average Income	No. of Involved House-holds	Average Income
Mats	2	144	-	-	6	287	8	1500	9	2020
Baskets	4	87.5	-	-	6	277	9	1929	11	2240
Brewing	1	2450	5	352	1	4550	5	3000	4	6634
Charcoal	1	1040	1	6500	-	-	1	7840	-	-
Carpentry	-	-	1	3400	-	-	-	-	-	-

Table 3-22 Sample farmers: Off-farm income by location per household, 1983

Village	No. of Involved Households	Total Annual Income	Average per Involved Household
		TShs	
Kingolwira	4	56	14
Fulwe	2	62	31
Doma	3	113	38
Melela	1	49	49
Mangae	3	104	35
Langali	4	4	150
Total	17	534	31

3.5.4 Income remittances by family members

A common feature in many developing countries is to find family members who work away from home remitting money to the household in which they belong. Such monies can be useful in critical labor demand periods since it can be used to hire labor. It can also be used for food purchases for families who do not produce enough to carry them through the year. Table 3.23 shows the annual remittances for each location. It was not possible to identify the actual delivery time of these remittances. Such information would have been useful in finding out whether the time of arrival corresponds to the period when the family is low on cash, such as the period preceding the harvest.

3.6 Summary

Although land is in abundant supply, fertile land for cultivation is limited. Yields of crops are generally low compared to research station levels and even by standards of other areas in the region. Main crops grown include sorghum, maize, cotton and beans.

The average family size is 2.7 adult equivalents and they cultivate a total of 2.2 ha. Cotton claims the largest amount of labor followed by sesame, beans and sunflower in that order.

The highest allocation of family labor goes to farming followed by non-farm, off-farm and social activities.

The number of families engaged in non-farm activities varies from location to location depending on the availability of the relevant raw materials. Men and women participate more or less equally in the weaving of baskets and mats but charcoal manufacturing and carpentry are performed exclusively by men while women do the brewing.

Table 3-23 Sample farmers: Income remittances by family members per household, 1983

Village	No. of Involved Households	Total Remittances	Average per Involved Households
Kingolwira	3	6000	2000
Fulwe	10	28500	2850
Doma	3	660	220
Langali	4	3400	850
Melela	6	3200	533
Mangae	0	0	0
Total/ Average	26	41760	1606

Non-farm activities are performed intermittently with farming. However, during the non-agricultural months, the number of days used for non-farm activities increases substantially. Mat and basket weaving are the dominant non-farm activities. They are concentrated mainly in Melela and Mangae villages.

Farmer's cash income sources are from non-farm products, farm products--chiefly cotton and sorghum, off-farm employment and family remittances, roughly in that descending order.

The information contained in this chapter will be used extensively in building the linear programming model in the next chapter.

CHAPTER IV

LINEAR PROGRAMMING MODEL

This chapter introduces and discusses the linear programming (LP) model used to analyze the economic activities of the survey farmers. Issues discussed include an overview of the adaptability of linear programming, methodological issues, assumptions of the model, and a discussion of representative households and their limitations. The chapter concludes with a presentation and discussion of the activities and constraints used in the LP analysis.

4.1 Overview

A linear programming model is used in this study to determine the optimum mix of enterprises for farm and non-farm activities. The model seeks to maximize farmer's net cash income subject to some constraints including food security. LP is chosen because it permits a more rapid analysis in contrast to budgeting in determining the relative profitability of enterprises when the number of enterprises under consideration becomes large.

In this study, a number of issues are investigated by use of sensitivity analysis using the LP model. These issues include:

1. the impact of the government mandated minimum area of cotton on farmer's income,
2. the economics of using tractors to prepare cotton and maize land,

3. the impact of hired labor,
4. the effect of increasing the crop yields by 20 percent and crop producer prices by 25 percent,
5. the effect on farmers' cash income of raising the market constraint on non-farm activities, and
6. the impact on farmer's income and employment resulting from the removal of non-farm activities.

Description of the activities and constraints and the justification for choosing them are presented in the appropriate sections.

4.2 Methodological Issues

4.2.1 Introduction

Linear programming typically deals with the problem of allocating limited resources among competing activities in the best possible (i.e., optimal) way. The problem can arise whenever one must select the level of alternative activities that compete for scarce resources. Linear programming uses a mathematical technique to analyze the problem of concern. Because of this, Baumol (1977, p. 72) cautions against indiscriminate application of linear programming results. There is a need to have adequate knowledge of economic theory and the market structure to decide which of the LP results are appropriate to a particular environment.

4.2.2 Assumptions of linear programming

Linear programming has a rigid set of assumptions, which in certain situations constrain the applicability of the linear programming results. Some of the assumptions are:

1. Proportionality - This simply means that if X units of inputs are necessary to produce one unit of output, then 2X units of input will be needed to produce 2X units of output and that the fixed input-output ratio holds for the entire production range.
2. Additivity - It is assumed that there are no interactions between activities. The additivity assumption requires that given any activity levels (X_1, X_2, X_3 . . . X_n) the total usage of each resource and the resulting total output equal the sum of the corresponding input and output quantities generated by each activity conducted separately.
3. Divisibility - Activity units can be divided into any fractional levels so that non-integer values for the decision variables are permissable. Generally, this is not a very limiting assumption because even when the solution is not integer, variables can still be rounded to integer values for many practical purposes.
4. Non-stochastic events (certainty) - All parameters of the model, such as the input/output coefficients (a_{ij}'s), the resource level (b_i's) or right hand sides (RHS) and other variables, such as yields and prices of outputs and inputs, are known with certainty. But in most cases, LP models are formulated to select some future course of action, the parameters being based on a prediction of future conditions; this inevitably introduces some degree of uncertainty.
5. Non-negativity - It is also assumed that the level of the activities and the resource levels is greater than or equal to zero.

However, when assumptions 1 through 4 are violated, variants of LP such as integer programming, quadratic programming, MOTAD and dynamic programming can be employed.

4.2.3 The objective function

Producers, whatever their socio-economic backgrounds, behave as profit maximizers within some constraints (de Wilde 1967; Heyer 1971; Norman 1973). CIMMYT (1977), in its studies in East Africa also concluded that the farmer's objective is to maximize profits subject to obtaining a plentiful supply of food for the family for the entire year.

Mathematical formulation - an ordinary linear program has in principle 3 main features: 1) the objective function to be maximized or minimized; 2) resource constraints; and 3) the activity set.

LP notation - the LP problem is stated in the following form:

$$\text{Maximize } Z = c_1x_1 + c_2x_2 + \ldots + c_n$$

subject to the restrictions:

$$a_{11}x_1 + a_{12}x_2 + \ldots a_{1n}x_n \leq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ldots a_{2n}x_n \leq b_2$$

$$\vdots \qquad \vdots \qquad \vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \qquad a_{mn}x_n \leq b_n$$

$$x_1 \geq 0 \quad i = 1, 2, \ldots, n.$$

In matrix notation, these equations are expressed as:

$$\text{Maximize } Z = c'x$$

subject to the restrictions

$$ax \leq b$$
$$x \geq 0$$

where:

Z = objective function to be maximized

c = n x 1 vector of prices

x = n x 1 vector of activity levels

a = m x n matrix of input/output coefficients

b = m x 1 vector of resource constraints

4.2.4 Smallholder agriculture and linear programming

When attempting to model smallholder agriculture using linear programming some questions arise regarding the assumptions. LP operates under the assumption that the producer wants to maximize or minimize a particular objective function.

A common problem to smallholder agriculture both in developed and developing countries is that social and economic variables are not so easily separable. The usefulness of the model when the objectives are mostly non-economic may be limited. Application of LP techniques in modeling smallholder agriculture has been heavily criticized over the years. Palmer-Jones (1977) questioned the legitimacy of using average input-output coefficients in LP models for several reasons first, because farmers may alter their strategies or technical inputs under different environmental conditions. Second, he challenges the assumption that average inputs will give rise to average outputs. Above all, he questions the application of LP to smallholder farmers in general, particularly with regard to data problems since records are rarely kept and that even when available, their degree of reliability is normally low. Low (1974), however, supports the usefulness of LP in peasant agriculture. He argues that LP models, when carefully formulated, are

able to generate useful information which could not have been obtained by the usual budgeting techniques.

4.3 The Representative Household

4.3.1 Definition and associated problems

Alfred Marshall (1920 p. 264) defined a representative firm as "an average firm which we need to look into in order to see how the economics of the aggregate are performing." Issues have been raised with regard to the extent to which we can trust the results of a representative firm to speak for the aggregate of firms or households. Richard Day (1963), for example, questions the extent to which the component firms have to be alike in order for a single model to represent the aggregate of the individual decision problems without much distortion.

Cost permitting, LP models would be constructed for each individual household or farm in the sample. Such an approach is likely to be prohibitive in terms of costs. However, in areas where there is reasonable homogeneity with respect to major variables such as soil type, availability of inputs, topography, climate, and socio-cultural settings, LP can be used to get generalizable results.

4.3.2 Optimal models versus actual conditions

If we take the farmer to be a real economic man, we should assume that given his level of knowledge, resources and social and cultural constraints, resource usage will be optimized. When optimal solutions derived from an LP model deviate significantly from actual conditions it is important to address the following questions:

1. Is it because of inadequate conceptualization of farm household activities and resources?

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2. Is it because of failure to recognize the significance of additional constraints not included in the model?
3. Is it due to aggregation bias or the poor quality of the input/output coefficients?

Because such deviations do arise researchers are faced with the problem of how closely a model should reflect reality to be useful.

4.3.3 Description of the representative household in the survey areas

Due to the great diversity of the survey areas in terms of rainfall, altitude, temperatures, soils, farm and non-farm activities, it was not possible to aggregate data beyond one village. LP models are presented separately for Melela and Mangae villages. These villages were picked because of their heavy involvement in both farm and non-farm activities. Mangae is a smaller village than Melela in terms of family labor per household and number of crops grown. Combining the two villages would lead to some type of aggregation bias. The representative household was an average of the performance of all the variables of the involved households.

In this study an attempt was made to stratify farms for each crop for each location into small, medium, and large, with the intention of identifying whether there were any differences in labor use between strata. Significant differences did not exist. This could be partly because the difference between "large" and "small" farms is not great.

4.4 Description of the Model

4.4.1 Assumptions regarding key variables

Assumptions with regard to intercropping and labor requirement have been discussed in sections 3.1.3 and 3.2.1 respectively. In this model,

labor that is used in the four activities (i.e., farm, non-farm, off-farm and social activities) is used as a proxy for the total labor available for work. But when the total used for the four activities is less than the labor available, then the number of days available for work was taken as the supply of labor available. These values are used as the right hand side values in the linear programming model.

Yield and area measurement - The yield indicator used is kg per ha. However, bag per ha was a common unit used in the survey areas. The following were the conversions made with regard to the weights of bags of different crops: sorghum 100 kg; beans 90 kg; cassave 50 kg; cotton 40 kg; sunflower 60 kg; sesame 90 kg; and maize 90 kg of kernels. These were averages obtained from farmers' deliveries at the respective buying posts.

4.2.2 Activities in the model

Activities in this model for both villages broadly fall under the following categories:

1. Crop production activities
2. Non-farm activities
3. Tractor hire activities
4. Crop selling activities
5. Non-farm product selling activities
6. Buying activities
7. Labor hiring activities
8. Capital flow activities
9. Social activities

Crop production activities - Columns 1-6 in Table 4-1, present the crop activities for Melela village. Those included were maize, sorghum, sunflower, paddy, beans and cotton. As discussed in the previous chapters, other crops such as bananas, cassava, groundnuts, and a few vegetables can also be seen growing on some farms. Such activities were not included in the model either because of

a) their relatively low competitive nature for the resources--land and labor with crops included in the model. Bananas and cassava are good examples of permanent crops which do not compete for resources with other crops.

b) Their minor importance based on the size of the activities. The crops included in the model were identified as those which adequately depict the important production opportunities available to the family farm. Bananas, for example, usually comprise only a few stands around the household and may require only a day or two for weeding during the entire year.

The input-output coefficients of the crop production activities were derived from the survey data by taking the mean input/output ratios for Melela and Mangae, with the exception of paddy and beans, which were only grown in Melela. The rationale for taking the mean to represent input-output coefficients for each village is that the production patterns and the labor use on various farm and non-farm activities was basically the same in each village.

The activity unit (i.e., the amount of crop production that each unit of activity represented) was one hectare. The weights of these variables in the objective function were zero (Table 4-1). The zero

Table 4-1 Base run: Crop production activities for Melela village[1/]

Row Number	Resource	Unit	A_1 MAIZ	A_2 SORG	A_3 SUNF	A_4 PADY	A_5 BEAN	A_6 COTON	A_7 HIERTR	Sign	RHS
	Objective Function		0	0	0	0	0	0	-600		
R1	TLAND	Ha	1	1	1	1	1	1		≤	3.4
R2	LPADY	Ha				1				≤	.3
R3	LBEAN	Ha					1			≤	.3
R4	LCOTON	Ha						1		≥	.4
R5	JAFL	Man-day	45	16	12	30		30	-45	≤	102
R6	FEFL	Man-day	31	21	35	12		27		≤	71
R7	MAFL	Man-day	15	16	33		71	32		≤	92
R8	APFL	Man-day	31	15	31	30	17	39		≤	115
R9	MYFL	Man-day	24	21	28	60	81	46		≤	127
R10	JUFL	Man-day	24	13	20		120	23		≤	77
R11	JYFL	Man-day	31	17	10		10	36		≤	101
R12	AUFL	Man-day		17	5			46		≤	82
R13	SEFL	Man-day						49		≤	77
R14	OCFL	Man-day	30					1		≤	80
R15	NOFL	Man-day	7.5	15				100		≤	77
R16	DEFL	Man-day	23	22	30	26		36		≤	86
R17	LMT MAIZCOT	Ha	-1					-1	1	≤	0
R18	LMT TRAMAC	Ha							1	≤	2
R21	THIODAN	Kg						1		≤	0
R22	DDT	Kg						1		≤	0
R23	QMAIZ	Kg	315							=	0
R24	QSORG	Kg		510						=	0
R25	QSUNF	Kg			90					=	0
R26	QPADY	Kg				140				=	0
R27	QBEAN	Kg					558			=	0
R28	QCOTON	Kg						336		=	0

[1/] Abbreviations are explained in Appendix A.

coefficients do not imply that the activities have a value of zero. The computation of the values of the activities are handled by transfer rows which interact with buy and sell activities.

Tractor hire services - Custom hiring of tractor services was practiced by some farmers. Based on the situation in the surveyed areas only maize and cotton were mechanized. The use of tractors refers only to the preparation of the seedbed. The other operations like planting and weeding depend on family labor. It took 45 man-days to prepare a ha of maize or cotton. This is the number of days of labor a household can save by using a tractor for land preparation. Consequently this number was used in the matrix under January as the input/output coefficient for the tractor activity. The objective function coefficient is TShs 600, meaning that the cost of preparing one ha of land by tractor is TShs 600 (Table 4-1).

Consumption activities - Because food markets are unreliable, farmers tend to depend on their own production for their food requirements as much as possible. Consequently, three consumption activities were included in the model--maize, sorghum and beans (Table 4-2). The minimum household consumption needs in KCal and protein per annum were adapted from Latham, (1965) p. 249. Using those figures an average family of Melela would require 4 thousand KCals and 107 kg of protein for the year. The total KCals required are equivalent to 1,100 kg of grain.

Non-farm activities - Three non-farm activities which are typical in the village are included in the model. These are mat making, basket making and brewing. Other non-farm activities were also handled by the farmers but were considered to be of minor importance. A typical family produced 30 mats, 60 baskets and 4 brewings per year (Table 4-3).

Table 4-2 Base run: Consumption activities for Melela farmers[1/]

Row Number	Resource	Unit	A_8 CMAIZ Kg	A_9 SCORG Kg	A_{10} CBEAN Kg	Sign	RHS
	Objective Function		0	0	0		
R19	Min Energy	KCal	3.62	3.35	3.4	≥	4000
R20	Min Protein	Kg	0.1	.09	.22	≥	107
R23	QMAIZ	Kg	1			≤	0
R24	QSORG	Kg		1		≤	0
R27	QBEAN	Kg			1	≤	0
R64	CMAIZ	Kg	1	-1	-1	≤	0
R65	CSORG	Kg	-1	1	-1	≤	0
R66	CBEAN	Kg	- .0909	- .0909	1	≥	0

[1/] Abbreviations are in Appendix A.

Table 4-3 Base run: Non-farm production activities for Melela farmers[1/]

Row No.	Resource	Unit	A_{11} JANMAT	A_{12} FEBMAT	A_{13} MARMAT	A_{14} APRMAT	A_{15} MAYMAT	A_{16} JUNMAT	A_{17} JULMAT	A_{18} AUGMAT	A_{19} SEPMAT	A_{20} OCTMAT	A_{21} NOVMAT	A_{22} DECMAT	A_{23} JANBAS	A_{24} FEBBAS	A_{25} MARBAS	A_{26} APRBAS	A_{27} MAYBAS	A_{28} JUNBAS	A_{29} JULBAS	A_{30} AUGBAS	A_{31} SEPBAS	A_{32} OCTBAS	A_{33} NOVBAS	A_{34} DECMAS	A_{35} BREJAN	A_{36} BREAPR	A_{37} BREJUL	A_{38} BREOCT	Sign	RHS
	Objective Function		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
R5	JANFL	Man-day	5												2																≤	0
R6	FEBFL	Man-day		5												2															≤	0
R7	MARFL	Man-day			5												2														≤	0
R8	APRFL	Man-day				5												2													≤	0
R9	MAYFL	Man-day					5												2												≤	0
R10	JUNFL	Man-day						5												2											≤	0
R11	JULFL	Man-day							5												2										≤	0
R12	AUGFL	Man-day								5												2									≤	0
R13	SEPFL	Man-day									5												2								≤	0
R14	OCTFL	Man-day										5												2							≤	0
R15	NOVFL	Man-day											5												2						≤	0
R16	DECFL	Man-day												5												2					≤	0
R67	MAXMAT	1 mat	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1																	≤	30
R68	MAXBASK	1 basket													-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1					≤	60
R69	MAXBREW	1 brewing																									-1	-1	-1	-1	≤	4
R24	QSORG	Kg																									18	18	18	18	≤	0

[1/] Abbreviations are in Appendix A.

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Non-farm activities can occur in any month in which case they are permitted to compete with crop production.

Crop and non-farm products selling activities - Selling activities include maize, sorghum, sunflower, paddy, beans and cotton. Maize and sorghum are included such that any excess amount beyond the subsistence requirements can be sold. The prices used are official producer prices published by the Ministry of Agriculture for the season. Most selling is carried out immediately after harvest when selling price is normally the lowest. All cotton and sunflower are sold through the official channels.

Selling activities for the non-farm activities may take place the year around. The weights of the variables in the objective function are 50, 32 and 600 which reflect the price per unit for mats, baskets and beer brewing respectively (Table 4-4).

Buying and labor hiring activities - The only crops that demand out of pocket cash expenses for inputs are cotton and maize. If any cotton of good quality is to be harvested, DDT and thiodan must be applied. One ha demands TShs 15 for thiodan and TShs 5.5 for DDT. The model also allows farmers to buy maize, sorghum and beans in the months of January through May in case they run out of reserves before the other harvest season (Table 4-5). The prices per kg are estimated to be one and half times the official selling price. This is the minimum purchase price because at this time it is extremely difficult to get food items from the open market.

A landless class does not exist in the area and hence labor hiring is not common. However 5 man-days of hired labor were permitted in the model in the months of December through July with the exception of June.

Table 4-4 Base run: Selling activities for farm and non-farm activities for Melela farmers[1/]

Row Number	Resource	Unit	A_{39} SMAIZ	A_{40} SSORG	A_{41} SSUNF	A_{42} SPADY	A_{43} SBEAN	A_{44} SCOTON	A_{45} SMATS[2/] JAN	A_{57} SBASK[2/] JAN	A_{69} SBREW[2/] JAN	Sign	RHS
	Objective Function		2.20	1.60	3.55	4.00	5.00	4.04	50	32	600		
R23	QMAIZ	Kg	1									≤	0
R24	QSORG	Kg		1								≤	0
R25	QSUNF	Kg			1							≤	0
R26	QPADY	Kg				1						≤	0
R27	QBEAN	Kg					1					≤	0
R28	QCOTON	Kg						1				≤	0
R29	QMATS	One mat							1			≤	0
R30	QBASK	One mat								1		≤	0
R31	QBREW	One mat									1	≤	0
R39	OCJAN	TShs							-50	-32	-600	≤	1260
R4	OCFEB	TShs										≤	0
R41	OCMAR	TShs										≤	0
R42	OCAPR	TShs										≤	0
R43	OCMAY	TShs										≤	0
R44	OCJUN	TShs					-5.00					≤	0
R45	OCJUL	TShs				-4.00						≤	0
R46	OCAUG	TShs	2.20	-1.6	-3.55			-4.04				≤	0
R47	OCSEP	TShs										≤	0

[1/] Abbreviations are in Appendix A.

[2/] Non-farming activities can take place every month but only January activities are shown.

Table 4-5 Base run: Buying and labor hiring activities for Melela farmers[1/]

Row Number	Resource	Unit	A_{73} BMAIZ[2/] JAN	A_{78} BSORG[2/] JAN	A_{83} BBEAN[2/] JAN	A_{88} BTHIOD	A_{89} BODT	A_{90} HLDEL	A_{91} HJAL	A_{92} HFEL	A_{93} HMAL	A_{94} HAPL	A_{95} HMYL	A_{96} HJYL	Sign	RHS
	Objective Function		-3.3	-2.4	-7.5	-15	-15	-15	-15	-15	-15	-15	-15	-15		
R39	OCJAN	TShs	-3.3	-2.4	-7.5				15						≤	1260
R40	OCFEB	TShs								15					≤	0
R41	OCMAR	TShs									15				≤	0
R42	OCAPR	TShs										15			≤	0
R43	OCMY	TShs				-15	-5.5						15		≤	0
R45	OCJUL	TShs												15	≤	0
R50	OCDEC	TShs						15							≤	0

[1/] Abbreviations are in Appendix A.

[2/] Buying of maize, sorghum and beans stretches for 5 months beginning January but only January activities are shown.

This was the average number of days of hired labor in the village. The minimum wage rate for hired labor is TShs is 17. Typical wage rates paid by the survey farmers were on average TShs 2 less. An average wage of TShs 15 was adopted as the coefficient for this activity in the objective function.

Capital transfer activities - Capital available for use in cash demanding activities was estimated from the receipts accruing from actual crop sales and annual remittances from relatives working outside the home. This capital (TShs 1260) was introduced in the model in January and was allowed to be transferred from one month to the next with the condition that at the end of the year the same or greater amount of capital remains (Table 4-6). In this model no non-farm capital was allowed to supplement the capital needs of the farm and non-farm activities.

Social activities - The obligatory man-days required to attend to certain social activities in the villages were computed monthly and their averages were used as minimum man-days for social activities. These are subtracted from the total number of available man-days. The coefficients of the activities in the objective function are zero (Table 4-7).

4.3.3 Restrictions in the model

Agricultural land restriction - Total land available for farming was limited to the average total land under cultivation per household. This area was 3.4 ha for Mangae village. Paddy as well as beans are restricted to wet valley bottoms. The areas adopted for the RHS are the average for the survey farmers who participated in growing the crops.

Table 4-6 Capital transfer activities for Melela farmers[1/]

Row Number	Resource	Unit	A_{97} TJAN	A_{98} TFEB	A_{99} TMAR	A_{100} TAPR	A_{101} TMAY	A_{102} TJUN	A_{103} TJUL	A_{104} TAUG	A_{105} TSEP	A_{106} TOCT	A_{107} TNOV	A_{108} TDEC	A_{109} TCOL	Sign	RHS
	Objective Function		0	0	0	0	0	0	0	0	0	0	0	0	0		
R39	OCJAN	TShs	-1	1												≤	1260
R40	OCFEB	TShs		-1	1											≤	0
R41	OCMAR	TShs			-1	1										≤	0
R42	OCAPR	TShs				-1	1									≤	0
R43	OCMAY	TShs					-1	1								≤	0
R44	OCJUN	TShs						-1	1							≤	0
R45	OCJUL	TShs							-1	1						≤	0
R46	OCAUG	TShs								-1	1					≤	0
R47	OCSEP	TShs									-1	1				≤	0
R48	OCOCT	TShs										-1	1			≤	0
R49	OCNOV	TShs											-1	1		≤	0
R50	OCDEC	TShs												-1	1	≤	0
R51	End of OC	TShs													1	≥	1260

[1/] Abbreviations are explained in Appendix A.

Table 4-7 Base run: Social activities for Melela farmers[1/]

Row Number	Resource	Unit	A_{110} JASL	A_{111} FESL	A_{112} MASL	A_{113} APSL	A_{114} MYSL	A_{115} JUSL	A_{116} JYSL	A_{117} SUSL	A_{118} SESL	A_{119} OCSL	A_{120} NOSL	A_{121} DEC	Sign	RHS
	Objective Function		0	0	0	0	0	0	0	0	0	0	0	0		
R52	JASL	Man-days	1												=	3
R53	FESL	Man-days		1											=	1
R54	MASL	Man-days			1										=	2
R55	APSL	Man-days				1									=	3
R56	MYSL	Man-days					1								=	2
R57	JUSL	Man-days						1							=	2
R58	JYSL	Man-days							1						=	3
R59	AUSL	Man-days								1					=	1
R60	SESL	Man-days									1				=	4
R61	OCSL	Man-days										1			=	3
R62	NOSL	Man-days											1		=	3
R63	DESL	Man-days												1	=	2

[1/] Abbreviations are explained in Appendix A.

For cotton it is mandatory that each household grow at least 0.4 hectare (1 acre). Failure to do so can lead to a fine of TShs 300 or a 3 month imprisonment or both. A 0.4 ha restriction is therefore introduced into the model. No farmer is allowed to buy or sell land. There was also no evidence of land renting. Such options are thus omitted.

Labor restrictions - Labor is restricted to the average available per month per household. Calculations were carried out as explained in section 3.4.5.1. The row unit is man-days. The available family labor could be supplemented in some months with hired labor up to 5 man-days per month.

Operating capital constraint - Activities that need cash include tractor hire for maize and cotton land, buying of insecticides and paying hired labor. It was difficult to have a basis on which to fix the ceiling of operating capital. To overcome this problem the model is provided with an initial amount which represented the average actual receipts from sales of crops and home remittances (see section 3.5.1.2 and 3.5.4).

Tractor hire limitation - The cost of custom hiring a tractor to prepare one ha of land is TShs 600. Based on survey results the number of ha to be cultivated per household is limited to 2.

Food consumption requirement constraint - Minimum subsistence requirements have been adapted from an earlier study in the same area conducted by the author in the 1978/79 season. Basic requirements include calories and proteins. Calories can chiefly be obtained from maize and sorghum while proteins are mainly from beans. The input/output coefficients of the minimum protein row represents the Kg of protein per Kg of the crop. The RHS represents 4,000 KCal and 107 Kg of protein from

cereals and beans respectively. The model is conditioned such that maize and sorghum contribute equally to the energy requirement. Although required protein can be obtained from sorghum and maize, the model is designed such that at least one-tenth of the total Kg of food consumption comes from beans. This is done to reflect the eating habits of farmers in the survey areas.

Non-farm production and selling constraint - Market outlets for non-farm products mats and baskets, are somewhat limited. Because of this limitation, a constraint on the number of baskets and mats that can be produced and sold is 60 and 30 respectively. For beer brewing, demand for the beer is only from within the village and nearby villages. Brewers are also issued permits from the village council in an attempt to control the amount of beer in the village. Typical household brewed 4 times a year. Therefore this was adopted as the constraint.

Food purchase restriction - Because food markets are unreliable, households are restricted from purchasing no more than 20 percent of their total consumption of maize, sorghum and beans. This means that at least 80 percent of the amount consumed must be produced on the farm.

Social activities restriction - A minimum level of man-days has to be made available to cater to social activities like traditional dances, festivals, funerals, etc. Average man-days per household per month used for these activities in the village are used as constraint levels.

Non-negative restrictions - None of the activities discussed above could be operated at negative levels. This is one of the basic assumptions of LP models.

Limitations of the model - Obviously several activities were omitted from the model. Examples of excluded activities were off-farm jobs;

minor crops, such as cassava, bananas, potatoes and groudnuts; and non-farm activities such as carpentry and charcoal manufacturing. Household duties like cooking and caring for the young, collection of firewood, which can be important, were also omitted. Omissions were based on the assumption that the benefits to be derived from additional activities in terms of precision for planning purposes may not be sufficient to justify the additional costs of expanding the model.

The objective function - This maximizes net cash income from farm and non-farm activities. Net cash income is defined as gross income from farm and non-farm enterprises less cash operating expenses. Gross income is derived from the selling of crops such as cotton, sorghum, maize, sunflower, sesame, beans and paddy. Non-farm products sold include mats, baskets and sorghum beer. Cash expenses include tractor hire service expenses, insecticide purchases, hired labor expenses, and sugar purchases for the brewing of sorghum beer. Resources like family labor and food consumed by the family are not given a value (in terms of TShs) in this objective function.

CHAPTER V

RESULTS OF THE LINEAR PROGRAMMING ANALYSIS

This chapter builds upon the information contained in Chapter III and the model development in Chapter IV. Chapter III was concerned with describing the household characteristics and constraints facing the farmers. In this chapter, two of the six villages (Melela and Mangae) are analyzed in more detail. Linear programming is used to address the profitability, risks and sensitivity of the farm and non-farm enterprises. Melela is the first village analyzed. A base analysis was first run. From the base analysis, several adjustments were made (e.g., dropping the cotton requirement) to determine the impacts of these adjustments.

Melela differs from Mangae in 3 main respects: (1) family size for Melela is larger, hence a larger area is cultivated; (2) paddy and beans are grown in Melela but not in Mangae; and (3) Mangae produces more baskets and mats than Melela. The LP model was modified to reflect these differences and a base analysis was run for Mangae.

5.1 Base Run Analysis Results for Melela

The optimum solution in the base run analysis resulted in a net cash income of TShs 5950. The activities in the optimum solution are as shown in Table 5-1.

Table 5-1 Base run: Farming activities in the optimum solution and in the survey results for Melela farmers, 1983

Type of Activity	Activity	Unit	Optimum Solution	Survey Results
Crop Production Activities	Sorghum	Ha	2.10	1.40
	Maize	Ha	.60	.58
	Cotton	Ha	.40	.60
	Beans	Ha	.20	.20
	Paddy	Ha	.08	.30
	Sunflower	Ha	0	.60
Consumption Activities	Sorghum	Kg	611.1	571.2
	Maize	Kg	509.3	256.0
	Beans	Kg	101.8	89.3
Crop Selling Activities	Sorghum	Kg	390.7	142.8
	Cotton	Kg	134.4	201.6
	Paddy	Kg	11.9	42.0
	Beans	Kg	8.9	22.3
	Sunflower	Kg	0	54.0
Buying Activities	Sorghum	Kg	0	120.0
	Maize	Kg	316.6	110.0
	Thiodan	Kg	.4	1.0
	DDT	Kg	.4	1.0
Hire Labor	February	Man-day	4.9	5.0

5.1.1 Reasonableness of optimum solution results

The crop activities in the optimum solution for Melela are maize, sorghum, beans, paddy and cotton. They use a total of 3.38 ha. This crop enterprise mix appears to be reasonable because it is reasonably close to the survey results. The consumption of 509 kg of maize and 611 kg of sorghum is also close to the actual results. This is approximately equal to 10 bags of grain (1 bag of grain weighs approximately 100 kg) per average family. The model suggests that 0.2 ha of beans be grown, which will enable the consumption of 102 kg of beans. To reflect the actual consumption pattern, the LP model constrained beans to be at least equal to 1/10th of total food consumption. The amount of sorghum produced is more than that required for consumption. Thus, about 1/3 of the sorghum produced is sold. All the cotton and paddy planted is sold. There is a little market surplus for beans, resulting in about 9 kg being sold.

About 317 kg of maize are purchased for consumption compared to 100 kg that were purchased by surveyed farmers. Input purchasing for DDT and thiodan is 0.4 kg reflecting the cotton area of 0.4 ha. However, the surveyed farmers purchased 1 kg of each of the insecticides. This reflects the somewhat higher hectarage of cotton grown by farmers and their use of more insecticide than needed.

With respect to non-farm activities (mat, basket and beer making), the distribution of the number of mats and baskets produced in each of the months differ somewhat from the survey results (Table 5-2). However, the general pattern was maintained in most cases. The number of mats, baskets, and brew making all enter at the maximum allowable production limits. Consistent with the survey results, more mats are made in

Table 5-2 Base run: Non-farm activities in the optimum solution and in the survey results for Melela sample farmers, 1983

Name of Activity	Unit	Optimum Solution Results	Survey Results
January mat production	One mat	4.8	3.5
April mat production	One mat	0	2.0
July mat production	One mat	2.4	0
September mat production	One mat	10.9	5.0
October mat production	One mat	10.5	14.0
November mat production	One mat	0	2.0
December mat production	One mat	1.4	3.5
January basket production	One basket	0	2.5
February basket production	One basket	0	5.0
March basket production	One basket	10.1	0
April basket production	One basket	20.5	15.0
May basket production	One basket	13.3	0
July basket production	One basket	0	4.5
August basket production	One basket	12.8	0
September basket production	One basket	0	12.5
October basket production	One basket	2.9	11.0
November basket production	One basket	.4	6.5
December basket production	One basket	0	3.0
Brew making	One brewing	4	4.5

September and October. This reflects the fact that these are slack months for farm operations. The peak basket production month is April. This is the time when all planting and weeding has ended.

5.1.2 Shadow prices and slacks for the resources and constraints in the model

The optimum solution provides an indication of the opportunity cost or value for each of the resources used by the farmer in the production process. The shadow price (or marginal value product) gives the increment in total profits contributed by an additional unit of the resource. If a resource is not completely utilized, then it is in abundant supply and hence an additional unit of the resource would have no incremental value to the farm.

The optimum solution indicates that the farmer would still gain by utilizing more land if he/she could. This is indicated by the shadow price of TShs 227.8/ha (Table 5-3). The minimum area for cotton advocated by the government results in a reduction in the farmer's net cash income. The MVP of labor indicates that labor is scarce in February and June, with shadow prices of TShs 15 and TShs 14.3 per man-day, respectively. January labor has a MVP of TShs 2.0 per man-day. The value of an additional unit of labor for the remainder of the months is below TShs 1.0 (Table 5-3). The high MVP of labor in February is attributed to planting of almost all crops in that month whereas that of June is due to the weeding of some crops and sowing of beans. The MVPs of labor imply that unless a farmer can hire below or equal to the shadow wage rate, hiring should not be attempted because it will cost more to the farmer than it is worth.

Table 5-3 Base run: Shadow prices for the resources used by sample farmers in Melela, 1983

Resource Constraint	Unit	Shadow Price
All land	Ha	227.8
Cotton land	Ha	-113
January labor	Man-day	2.2
February labor	Man-day	15.0
March labor	Man-day	.73
April labor	Man-day	.73
May labor	Man-day	.73
June labor	Man-day	14.3
July labor	Man-day	.73
August labor	Man-day	.73
September labor	Man-day	.73
October labor	Man-day	.73
November labor	Man-day	.73
December labor	Man-day	.73
Protein minimum requirement	Kg	34.2
Consume beans	Kg	3.3
Maximum grain purchase	Kg	.23
Limit on mat production	One mat	46.3
Limit on basket production	One basket	30.5
Limit on brew making	One brewing	568.2
Social labor January	Man-day	2.2
Social labor February	Man-day	15.0
Social labor June	Man-day	14.3

The results also indicate that the constraint on the minimum protein requirement and bean consumption reduces the net cash income by TShs 34 and TShs 3 respectively for each kg consumed. Protein food sources are highly valued and they would contribute much to the farm income if they were sold instead of being consumed.

Because of the unreliability of food markets, farmers were constrained to the purchase of only 20 percent of the total consumption of grain (sorghum, maize and beans). The shadow price on the maize and sorghum purchase constraint is TShs 0.23 indicating that farmers lose TShs 0.23 at the margin for a kg of grain that has to be produced on the farm instead of being purchased. In other words, if food markets were working, these farmers would have saved by purchasing some of the food rather than producing it.

The production and market constraint for non-farm activities for mat, basket and brewing have MVP's of TShs 46.3, 30.5 and 568.2 respectively. These imply that more of these products could have been profitably produced if market outlets were permitting. The prices of non-farm products are relatively high when compared with the crop prices. By using analytical tools like LP, it is possible for non-farm products to dominate the optimum solution if restrictions are not imposed regarding the maximum amounts to be produced. The restriction on the level of the non-farm activities is put on the basis that markets for the products are limited. The relatively high returns for non-farm products in the area surveyed are caused chiefly by three factors: (1) high prices of the products; (2) a low level of out-of-pocket cash expenses; and (3) the use of slack resources, i.e., family labor in non-agricultural periods.

Labor used for social non-productive activities (in a material sense) in January, February and June has a negative MVP, indicating that farmers could increase their net cash income had they not used their scarce labor on such activities for these particular months.

5.1.3 Cost of producing, hiring, buying or selling activities not in optimum solution

If because of government requirements, ignorance, or other reasons, a farmer undertakes activities not in the optimum solution, it will result in a reduction of the net cash income. Activities that would result in such a situation are indicated in Table 5-4. Mechanization of maize and cotton is not economical. Mechanization involves using tractors to prepare the seed bed. One ha of mechanization would relieve the farmer of approximately 45 days of manual seed bed preparation in January. Since the other operations are not mechanized, cultivating areas by tractors will only create labor problems in other critical periods such as those used for weeding and harvesting. The model indicates that if a farmer hires a tractor to plow one ha of maize or cotton, the net cash income would be reduced by TShs 499. The figure suggests that for a tractor to be custom hired profitably, it must cost TShs 100 (or less) per ha or a nearly 6 fold reduction in the current cost structure. Since mechanization is only partially employed in the production process and since there are also problems related to lack of tractor spare parts, skilled operators, repairmen, and relatively high investment cost, the economics of mechanization is questionable. An alternative technology might be animal traction. However, draught animal cultivation has not been well accepted since its introduction three decades ago. The

Table 5-4 Base run: Cost of forcing in non-optimal activities for sample farmers in Melela, 1983

Type of Activity	Activity	Unit	Value Foregone
Tractor hire	Maize/cotton	Ha	499.0
Selling	Maize	Kg	2.0
	Beans	Kg	2.5
Buying	Sorghum	Kg	1.7
Hired labor	December	Man-day	14.3
	January	Man-day	12.8
	March-May	Man-day	14.3
	July	Man-day	14.3
Non-farm	February mats	Man-day	72.0
	June mats	Man-day	97.6
	January baskets	Man-day	3.0
	February baskets	Man-day	28.5
	June baskets	Man-day	39.0
	January brew	Man-day	6.0

non-adoption has remained an unanswered question and deserves further research.

Hiring labor in most months would result in a reduction of TShs 14.3 in the net cash income for each man-day hired (Table 5-4). As can be seen in Table 5-3, the marginal value product of labor for most months is approximately TSh 0.7. This figure reflects the real value of labor in those periods. However, wage rates in the rural areas are high because of government pressure on those who hire labor not to pay "exploitative" wages. With the minimum rural wage of TShs 17, those who hire cannot deviate much from this figure even in months when the MVP of labor is low.

Regarding non-farm activities, there is a very high opportunity cost to undertaking them in February and June. This is attributed to the enormous amounts of labor required in those months for crop production. Thus, is one more man-day were available in the month of February, it would increase the net cash income by TShs 72 (Table 5-4).

5.2 The Effect of Omitting the Minimum Cotton Requirements of Cotton Area

Cotton, Tanzania's second most important foreign exchange earner, has been identified by farmers as an unprofitable crop, a troublesome crop, etc. Still the government insists that farmers grow a minimum of the 0.4 ha because of the need for foreign exchange.

In this section an attempt is made to find out how removal of the minimum requirement of cotton cultivation would change the enterprise mix on the representative farm. The results indicate that it is financially more profitable for the farmer when the minimum requirement of cotton is omitted. As shown in Table 5-5, the total area cultivated

Table 5-5 Base run: Activities in the optimum solution for the with and without cotton constraint plans for Melela sample farmers, 1983

Activity Name	Unit	Level		Change %
		With Cotton Constraint	Without Cotton Constraint	
Sorghum production	Ha	2.10	1.80	- 14.2
Maize production	Ha	.60	.71	+ 15.0
Cotton production	Ha	.40	.37	- 7.5
Bean production	Ha	.20	.22	+ 10.0
Paddy production	Ha	.08	.30	+275.0
Buy maize	Kg	316.6	286.0	- 9.7
Buy Thiodan	Kg	.4	.37	- 7.5
Buy DDT	Kg	.4	.37	- 7.5
Consume maize	Kg	509.3	510.0	+ .1
Consume sorghum	Kg	611.1	612.4	+ .2
Consume beans	Kg	101.8	102.0	+ .2
Sell sorghum	Kg	390.7	235.3	- 39.8
Sell cotton	Kg	134.4	123.5	- 8.1
Sell paddy	Kg	11.9	42.0	+253.0
Sell beans	Kg	8.9	18.6	+112.3
Hire labor February	Man-day	4.9	3.5	- 28.6
Mat production Jan.	One mat	4.8	3.8	- 37.5
Mat production April	One mat	-	.9	-
Mat production July	One mat	2.4	-	-
Mat production Sept.	One mat	10.9	11.2	+ 2.7
Mat production Oct.	One mat	10.5	11.1	+ 5.7
Mat production Nov.	One mat	-	1.6	-
Mat production Dec.	One mat	1.4	1.4	0
Basket production March	One basket	10.1	11.7	+ 15.8
Basket production April	One basket	20.5	8.0	- 60.9
Basket production May	One basket	13.3	8.7	- 34.6
Basket production July	One basket	15.4	15.4	-
Basket production Aug.	One basket	12.8	16.2	+ 26.6
Basket production Oct.	One basket	2.9	-	-
Basket production Nov.	One basket	.4	-	
Make brew April	One brewing	4	4	0

also reaches the maximum of 3.4 ha. The area planted to different crops is different from the base analysis. Paddy area increases by 275 percent. This large increase is attributed to the fact that paddy and cotton compete for weeding labor. Under this farm plan, maize area increases by 15 percent while that for sorghum decreased by 14 percent. The change is attributed to the nature of demand for family labor in critical months for maize, sorghum and cotton. Bean area also undergoes a 10 percent increase.

Maize buying drops by 10 percent while selling of sorghum also declines by 40 percent. On the average the household under "no cotton constraint" buys 10 percent less food as compared to the "with cotton constraint plan." The increased area under paddy and beans causes the selling levels of these crops to increase by 253 and 112 percent respectively. Hiring of labor decreases by 28.6 percent under the "no cotton constraint."

The production pattern of non-farm products within months remains almost the same as in the base analysis with the exception of basket production in July which increases from a level of zero to 15.

5.2.1 Marginal value of resources for the with and without cotton constraint farm plans

As in the base analysis, total land is limiting in the "without cotton constraint farm plan," with a marginal value of TShs 266 per ha. Labor is scarce in all months, with peak scarcities in February and June (Table 5-6). The marginal value of family labor as a rule is worth less under the "no cotton constraint" plan than in the base analysis. The MVP's for the non-farm products are still basically the same. The cost of the maximum grain purchase constraint is 9 percent less than in the

Table 5-6 Marginal value products (MVP's) of selected resources and constraints in the cotton and without cotton constraint farm plans for Melela sample farmers, 1983

Type of Resource	Unit	Marginal Value Product (T... With Cotton Constraint	Without Cotton Constraint
All land	Ha	227.8	226.0
Cotton land	Ha	-113.0	0
Paddy land	Ha	0	17.0
January labor	Man-day	2.2	1.8
February labor	Man-day	15.0	15.0
March-May labor	Man-day	.73	.36
June labor	Man-day	14.3	14.3
July-Dec. labor	Man-day	.73	.36
Min. protein requirement constraint	Kg	- 34.0	-34.0
Bean consumption constraint	Kg	- 3.3	- 3.9
Max mat production	One mat	46.3	48.2
Max basket production	One basket	30.5	31.3
Max brew making	One brewing	568.2	570.0
Max purchase of grain	Kg	.23	.21
Social labor	Man-day	2.2	0
Social labor Feb.	Man-day	15.0	15.0
Social labor June	Man-day	14.3	14.3

cotton constraint plan. This implies that the cost to the farmer of the poorly functioning food markets has decreased under this plan.

5.2.2 Cost of forcing in non-optimal activities for the with and without cotton constraint

Forcing tractor utilization in the optimal solution under the "without cotton constraint plan" would reduce the net cash income by TShs 516 as compared with TShs 499 in the original plan (Table 5-7). The difference is partly attributed to the fact that removal of cotton constraint makes family labor more available. Labor saving technology for land preparation (tractor cultivation for maize) in January may not therefore be as important as would be when the cotton constraint is in place.

As shown in Table 5-7, the cost of pushing in other activities not in the optimal solution with the "without cotton constraint" is basically the same as in the "with cotton constraint plan."

5.3 Sensitivity of the Base Model to Changing Assumptions

This section presents the results of making selected changes in the LP base model. The changes considered involve: (a) relaxing the constraints which restrict the level of production and sale of non-farm products; (b) changing yields and prices; and (c) omission of non-farm products.

5.3.1 Activities in solution

5.3.3.1 Relaxing constraints on non-farm activities

In the base analysis, non-farm product levels are fixed at 30, 60 and 4 units for mats, baskets and brewing respectively. When these

Table 5-7 Cost comparison of forcing in non-optimal activities for the with and without cotton constraint farm plans for Melela sample farmers, 1983

Type of Activity	Unit	Cost of Forcing in an Activity (Tshs)	
		With Cotton Constraint	Without Cotton Constraint
Tractor hire	Ha	499.0	516.9
Selling maize	Ha	2.0	1.9
Buying sorgnum	Ha	1.7	1.6
Hire labor Dec.	Man-day	14.3	14.6
Hire labor Jan.	Man-day	12.8	13.1
Hire labor March-May	Man-day	14.3	14.6
Hire labor July	Man-day	14.3	14.6
Mat making Feb.	Man-day	72.3	73.6
Mat making June	Man-day	96.7	100.7
Basket making Jan.	Man-day	3.0	2.9
Basket making Feb.	Man-day	28.5	29.0
Basket making June	Man-day	39.0	40.3

levels are increased by 25 percent, keeping intact the cotton constraint at 0.4 ha, the net cash income increases by approximately 19 percent. The reduction in sorghum area in this change is approximately equal to the increase in maize area. The distributional pattern of non-farm products across the months is nearly the same as in the base plan with the exception that the levels are higher because of the relaxed constraint. Baskets, which were not produced in July and August, are now being produced (Table 5-8a). Because of the higher profit nature of mats and baskets, no sorghum is sold under the relaxed constraint for non-farm products. Bean selling increases by approximately 43 percent while maize purchases decrease by 24 percent. Labor is not hired under this scenario.

When the restriction on non-farm is relaxed by 50 percent from the original level and the original constraint on cotton of 0.4 ha is maintained, the net cash income increases from TShs 5950 to TShs 7777--an increase of approximately 31 percent. Maize production increases by 40 percent while sorghum and bean production decreases by 33 and 10 percent, respectively. Production of non-farm goods undergoes some rearrangements within the months. Although baskets are produced at the maximum allowable limit of 90, mat production only attains the level of 31.4 although the constraint is at 45. Farmers could have produced more mats had the maximum food purchase constraint not been in place. It would have been more profitable to produce non-farm products and use the month to buy food.

Table 5-8a Sensitivity analyses on the base model: Relaxing constraints on non-farm products and the resulting activities in solution for Melela sample farmers, 1983[1/]

Item	Unit	Base Run Model Results	Restriction on Non-farm Lifted by 25%	Change %	Restriction on Non-farm Lifted by 50%	Change %
Objective fn	Tshs	5950	7076	+18.9	7777	+30.7
Produce maize	Ha	0.60	0.85	+41.7	0.84	+40.0
Produce sorghum	Ha	2.10	1.37	-34.8	1.40	-33.3
Produce beans	Ha	.20	.20	0	.18	-10.0
Produce cotton	Ha	.40	.40	0	.40	0
Produce paddy	Ha	.08	0		0	
Consume beans	Kg	101.8	101.7	-	101.7	-
Consume maize	Kg	509.3	508.5	-	508.5	-
Consume sorghum	Kg	611.1	610.2	-	610.2	-
January mats	One mat	4.8	5.6	+16.7	5.6	+16.7
February mat	One mat	0	0		0	
March mats	One mat	0	4.2		0	
April mats	One mat	0	0		0	
May mats	One mat	0	0		0	
June mats	One mat	0	.6		1.1	
July mats	One mat	2.4	0		0	
August mats	One mat	0	0		7.5	
September mats	One mat	10.9	10.9	0	5.9	-45.9
October mats	One mat	10.5	10.2	-3.0	5.5	-47.6
November mats	One mat	0	2.0		1.9	
December mats	One mat	1.4	3.9	+178.6	3.9	+178.6
January baskets	One basket	0				
February baskets	One basket	0	2.1		1.9	
March baskets	One basket	10.0	3.5	-65.3	14.6	+44.6
April baskets	One basket	20.5	23.5	+14.6	23.6	+15.1
May baskets	One basket	13.3	20.4	+53.4	21.1	+58.6
June baskets	One basket	0	0		0	
July baskets	One basket	0	6.5		16.5	
August baskets	One basket	0	19.0		0	
September baskets	One basket	12.8	0		0	
October baskets	One basket	0	0		12.3	
November baskets	One basket	2.9	0		0	
December baskets	One basket	.4	0		0	
Brewing	One brewing	4	5	+25.0	6	+50.0
Sell beans	Kg	8.9	12.7	+42.7	0	
Sell cotton	Kg	134.4	134.4	0	134.4	
Sell sorghum	Kg	390.7	0		0	
Buy maize	Kg	316.6	241.7	-23.7	245.3	-22.5
Buy sorghum	Kg	0				
Hire labor Feb.	Man-day	4.9	0			

[1/] A dash (-) indicates a change less than 1 percent.

5.3.2.1 Yield and price changes

The effect of increasing crops yields per ha by 20 percent for all crops from the base analysis level is examined. The objective is to determine what would be the level of net cash income if better technology had been used. In this analysis it is assumed that higher yields do not significantly affect labor needed for different cropping operations. A twenty percent increase in yields, thus, increases the net cash income by 13 percent. Area under maize decreases by 28 percent while that of sorghum decreases by 5 percent (Table 5-8b). Area under beans, cotton and paddy increases under this plan with that of paddy and beans being quite substantial. Cotton area surpasses the minimum area of 0.4 ha by approximately 8 percent. Selling of sorghum increases by 38 percent while buying of maize increases by 9 percent.

Non-farm products are still being produced at the maximum allowable limits. The distributional production pattern within months is basically the same with the exception that baskets are now also being produced in July and August.

Selling of crop produce increases by a large margin. Bean selling increases from 9 kg to approximately 59 kg while the buying of maize also goes up by approximately 9 percent. This is offset by the selling of sorghum which increases by 38 percent (Table 5-8b).

Increasing all crop prices by 25 percent results in the net cash income increasing by 5 percent. Minor changes occur in the crop areas for maize, sorghum and beans. The paddy area decreases by 50 percent under this plan. In the case of cotton, the minimum area requirement is not exceeded despite the increase in prices of 25 percent.

Table 5-8b Sensitivity analyses on the base model: Yield and price changes and the resulting activities in solution for Melela sample farmers, 1983[1/]

Item	Unit	Base Run Results	Crop Yields Increased by 20%	Change %	All Crop Prices Increased by 25%	Change %	Cotton Price Increased by 50%	Change %
Objective fn	TShs	5950	6724	+13.0	6269	+ 5	6224	+ 4.6
Produce maize	Ha	0.6	0.4	-28.0	0.6	- 1.7	0.6	0
Produce sorghum	Ha	2.1	2.0	- 5.0	2.2	+ 3.3	2.1	0
Produce beans	Ha	.2	.2	+20.0	.2	- 5.0	.2	- 5
Product cotton	Ha	.4	.4	+ 7.5	.4	0	.4	0
Product paddy	Ha	.1	.3	+27.5	.04	-50.0	.1	-37.5
Consume beans	Kg	101.8	101.7	-	101.8	-	101.8	-
Consume maize	Kg	509.3	508.8	-	509.1	-	509.1	-
Consume sorghum	Kg	611.1	610.5	-	610.8	-	610.9	-
January mats	One mat	4.8	5.3	10.4	5.1	+ 6.2	4.9	+ 2.0
February mats	One mat	0	0		0		0	
March mats	One mat	0	0		0		.7	
April mats	One mat	0	0		0		0	
May mats	One mat	0	3.1		0		0	
June mats	One mat	0	0		0		0	
July mats	One mat	2.4	0		0		0	
August mats	One mat				4.9		4.9	
September mats	One mat	10.9	10.6	- 2.7	10.9	0	10.8	-
October mats	One mat	10.5	9.5	- 9.5	8.1	- 2.4	8.5	- 19.0
November mats	One mat		.1		0		0	
December mats	One mat	1.4	1.4	0	1.0	-28.5	0	
January baskets	One basket	0	0		0		0	
February baskets	One basket	0	0		0		0	
March baskets	One basket	10.1	10.3	+ 2.0	9.8	- 3.0	8.2	-17.4
April baskets	One basket	20.5	19.9	- 2.9	21.0	+ 2.4	20.7	-
May baskets	One basket	13.3	0		14.2	+ 6.7	13.8	+ 3.7
June baskets	One basket	0	0		0		0	
July baskets	One basket	0	16.9		13.7		13.9	
August baskets	One basket	0	12.9		0		0	
September baskets	One basket	12.8	0		0		0	
October baskets	One basket	0	0		1.2		0	
November baskets	One basket	2.9	0		0		0	
December baskets	One basket	.4	0		0		3.5	+775.0
							0	
Sell beans	Kg	8.9	58.8	+561.0	7.1	-20.2	7.4	-16.8
Sell cotton	Kg	134.4	174.3	+29.8	134.4	0	134.7	-
Sell sorghum	Kg	390.7	540.1	+38.2	424.8	+ 8.7	409.0	+ 4.7
Sell paddy	Kg	11.9	50.4	+338.0	6.1	-48.7	7.3	
Buy maize	Kg	316.6	346.3	+ 9.4	323.3	+ 2.0	320.2	+ 1.1
Hire labor Feb.	Man-day	4.9	.6	-88.0	5.0	+ 2.0	5.0	+ 2.0

[1/] A dash (-) indicates a change of less than 1 percent.

The production pattern of non-farm products is still basically the same within the months. There is not much change in the buying of maize or the selling of sorghum. It is to be noted that although the percentage changes in area planted to and the amount sold of paddy is high, the area under paddy and hence the output is still relatively small (Table 5-8b).

Increasing the cotton price by 50 percent causes an increase in the net cash income of approximately 5 percent. There is no change in crop area for maize, sorghum or cotton. The levels of the other activities (non-farm, etc.) do not change greatly. One would have expected some changes in the other activities and in the area planted to cotton. However, these changes do not occur. Therefore, even higher cotton prices are needed if price policy is to reduce these farmers to produce more cotton.

5.3.1.3 Omission of non-farm activities

This analysis omitted non-farm enterprises from the enterprise mix, with the desire to assess their influence on net cash income. With the cotton restraint maintained, net cash income decreased by 96 percent. Maize and sorghum undergo some changes in the area planted (Table 5-8c). The area of maize increases by approximately 27 percent while that of sorghum decreases by approximately 20 percent.

Cotton area now exceeds the minimum requirement by approximately 20 percent. In the case of beans, there is no change in area planted. Selling of sorghum decreases by 49 percent, while maize purchasing decreases by approximately 14 percent. This analysis indicates the significant contribution of non-farm products to the net cash income. Without

Table 5-8c Sensitivity analyses on the base model. Omission of non-farm products and the resulting activities in solution for Melela sample farmers, 1983

Item	Unit	Base Run Results	Non-farm Production Omitted	Change %
Objective fn	Tshs	5950	236	- 96.0
Produce maize	Ha	0.6	.7	+ 26.7
Produce sorghum	Ha	2.1	1.6	- 20.5
Produce beans	Ha	.2	.2	0
Produce cotton	Ha	.4	.5	+ 20.5
Produce paddy	Ha	.1	.3	+ 27.5
Consume beans	Kg	101.8	102.8	-
Consume maize	Kg	509.3	514.4	- 1.0
Consume sorghum	Kg	611.1	617.3	+ 1.0
Sell beans	Kg	8.9	10.1	+ 12.3
Sell cotton	Kg	134.4	155.3	+ 15.6
Sell sorghum	Kg	390.7	234.2	- 49.4
Sell paddy	Kg	11.9	42.0	+252.1
Buy maize	Kg	316.6	273.2	- 13.7
Hire labor February	Man-day	4.9	4.8	- 2.0

the non-farm products, the farmer's cash income is only from the selling of cotton and sorghum and a few kg of paddy and beans (Table 5-8c). The resulting cash income of TShs 236 from farming along is unlikely to meet the farmer's expenditures for foods not produced at the farm (e.g., meats) and non-food expenditures for household members.

5.3.2 Marginal value products (MVP) of resources

One of the strengths of linear programming is the ability to give the value of a resource or constraint at the margin, i.e., the contribution of an additional unit of the resource to the objective function, in this model, net cash income. The scarcity of resources is therefore reflected by the LP model. If a resource is in abundant supply, then an additional unit of it will not add to the net cash income.

5.3.2.1 Relaxing restraints on non-farm activities

Raising the production constraint on non-farm products by 25 percent under the constrained cotton situation increases the negative MVP on cotton greatly (Table 5-9a). This means that since more income could be obtained from non-farm products, the sacrifice that is made by diverting resources to cotton production is even greater. In this analysis, all the other types of land--total land, paddy land and bean land have an MVP of zero.

Labor scarcity increases significantly under this scenario in almost all months. The MVP increases from less than TShs 1.0 to approximately TShs 9 in almost all months (Table 5-9a). The MVP of labor in all months is still less than the wage rate of TShs 15, implying that it is not economic to hire labor under this situation.

Table 5-9a Sensitivity analyses on the base model: Marginal value products (MVP) of resources under different levels of non-farm products for Melela sample farmers, 1983

Item	Unit	MVP of the Base Model	Restriction on Non-farm Lifted by 25%	Change %	Restriction on Non-farm Lifted by 50%	Change %	Omission of Non-farm Activities	Change %	Slack Labor	
		Tshs	Tshs		Tshs		Tshs		Man-days	
Total land	Ha	227.8	0		0		270.2	+18.6		
Paddy land	Ha	0	0		0		109.8			
Bean land	Ha	0	0		0		0			
Cotton land	Ha	-113.1	-3098.9	-2640	-3416.2	-2920	0			
January family labor	Man-day	2.2	11.6	+ 427	12.4	+ 464	0		15.9	
February family labor	Man-day	15.0	9.3	- 38	10.2	- 32	15.0	0	0	
March family labor	Man-day	.7	9.3	+1174	10.2	+ 947	0		22.6	
April family labor	Man-day	.7	9.3	+1174	10.2	+ 947	0		33.8	
May family labor	Man-day	.7	9.3	+1174	10.2	+ 947	0		15.9	
June family labor	Man-day	20.3	9.3	- 54	10.2	+ 49	20.9	-	0	256.5
July family labor	Man-day	.7	9.3	+1174	10.2	+ 49	0		28.2	
August family labor	Man-day	.7	9.3	+1174	10.2	+ 49	0		29.9	
September family labor	Man-day	.7	9.3	+1174	10.2	+ 49	0		51.4	
October family labor	Man-day	.7	9.3	+1174	10.2	+ 49	0		53.6	
November family labor	Man-day	.7	9.3	+1174	10.2	+ 49	1.8	+146.0	0	
December family labor	Man-day	.7	9.3	+1174	10.2	+ 49	0		5.2	
							0			
Min. protein require.	Kg	-34.3	-52.2	- 52	-55.4	- 62	-32.5	+ 5.2		
Consume beans	Kg	- 3.8	- 2.8	+ 26	- 3.0	+ 21	- 4.0	- 5.2		
Max mats	One mat	46.3	3.3	- 93	0					
Max baskets	One basket	30.5	13.3	- 56	12.0	- 61				
Max brewing	One brewing	568.2	521.6	- 8	516.8	- 8				
January social labor	Man-day	- 2.2	-11.6	- 427	-12.4	- 464	0			
February social labor	Man-day	-15.0	- 9.3	+ 38	-10.0	- 49	-15.0	0		
March social labor	Man-day	- .7	- 9.3	-1174	-10.0	- 49	0			
April social labor	Man-day	- .7	- 9.3	-1174	-10.0	- 49	0			
May social labor	Man-day	- .7	- 9.3	-1174	-10.0	- 49	0			
June social labor	Man-day	-20.3	- 9.3	+ 54	-10.0	- 49	-20.9	0		
July social labor	Man-day	- .7	- 9.3	-1174	-10.0	- 49	0			
August social labor	Man-day	.7	- 9.3	-1174	-10.0	- 49	0			
September social labor	Man-day	.7	- 9.3	-1174	-10.0	- 49	0			
October social labor	Man-day	.7	- 9.3	-1174	-10.0	- 49	0			
November social labor	Man-day	.7	- 9.3	-1174	-10.0	- 49	0			
December social labor	Man-day	.7	- 9.3	-1174	-10.0	- 49	0			
Max purchase grain	Kg	.23	.95	+ 313	1.07	+ 365	.13	-43.0		

Despite the increase in the level of non-farm products, each of the products still have positive MVP's associated with the market constraints. However, the MVP's decrease by 93 percent, 56 percent and 5 percent for a mat, a basket and brewing, respectively. These results appear logical since if more of something is available, then at the margin it is likely to have less value.

The MVP's of social labor in the respective months have a higher negative value, implying that the opportunity cost of using a man-day for non-productive activity (in a material sense) is higher under these circumstances.

The cost of the maximum food grain purchase constraint increases by approximately 300 percent. This implies that the cost to the farmer of not being able to purchase food is now greater. If food markets were assured, he/she would concentrate on non-farm activities and buy the food with the income from non-farm product sales. Thus, the figure implies that at the margin, kg of sorghum or maize that he/she has to produce because of unreliable market costs him/her TShs 0.95.

Relaxing the constraint on non-farm products by 50 percent makes the cost of forcing the minimum cotton area into solution even higher (Table 5-9a). The MVP of labor in almost all months is almost the same as in the case where the limit on non-farm products was increased by 25 percent.

The MVP of a mat is now zero, whereas that of a basket and brewing have gone down by 61 and 8 percent, respectively compared to the base run model. Opportunity cost for social labor in the respective months is not much different from the preceding plan where the levels of non-farm products were increased by 25 percent (Table 5-9a). The cost to

the farmer of restricting him/her on the level of food that can be purchased in this analysis is even higher. A kg of maize and/or sorghum that is produced on the farm instead of bought now reduces the net cash income by TShs 1.07.

5.3.2.2 Omission of non-farm activities

With the omission of non-farm products and keeping the cotton constraint in place, the total land constraint has an MVP of TShs 270 per ha while that of paddy land is approximately TShs 110 per ha. With the exception of February, June and November, the labor in the rest of the months has an MVP of zero (Table 5-9a). The total surplus days per annum is 256.5. Based on the total man-days available for work in the year, (953 man-days--see Table 3-19e) it is evident that 27 percent of the labor is used in three non-farm activities--mat and basket weaving and brewing.

Because the farmer has been cut off from producing non-farm activities, the opportunity cost of producing food instead of buying decreases by 43 percent (Table 5-9a).

5.3.2.3 Price and yield changes

When crop yields are increased by 20 percent, the MVP for total land increased by 56 percent (Table 5-9b). This appears logical because an increase in yields increases the value of land. Cotton land has an MVP of zero, and therefore additional land for cotton production would add nothing to the net cash income. The MVP's of non-farm products market constraints remained the same as in the base plan despite the increase in crop prices. This is an indication that non-farm activities are able to effectively use resource not needed for crop production. The MVP of

Table 5-9b Sensitivity analyses on the base model: Marginal value products (MVPs) under different price and yield levels for Melela sample farmers, 1983[1/]

Item	Unit	Base Run MVP	Crop Yield Increases by 20%	Change %	All Crop Prices up by 25%	Change %	Price of Cotton Increased by 50%	Change %
Total land	Ha	227.8	354.4	+56	465.9	+104	59.4	- 74
Paddy land	Ha	0	6.0		0	0	0	
Bean land	Ha	0	0		0	0	0	
Cotton land	Ha	-113.1	0		-382.1	-238	0	
January family labor	Man-day	2.2	2.0	- 9	1.8	- 18	3.4	+ 55
February family labor	Man-day	15.0	15.0	0	15.0	0	15.0	0
March family labor	Man-day	.7	.6	-18	0		1.8	+147
April family labor	Man-day	.7	.6	-18	0		1.8	+147
May family labor	Man-day	.7	.6	-18	0		1.8	+147
June family labor	Man-day	20.3	24.1	+19	25.2	+ 24	19.9	+ 2
July family labor	Man-day	.7	.6	-18	0		1.8	+147
August family labor	Man-day	.7	.6	-18	0		1.8	+147
September family labor	Man-day	.7	.6	-18	0		1.8	+147
October family labor	Man-day	.7	.6	-18	0		1.8	+147
November family labor	Man-day	.7	.6	-18	5.5	+653	4.5	+516
December family labor	Man-day	.7	.6	-18	0		1.8	+147
Min. protein require.	Kg	-34.3	-33.4	+ 3	-40.9	- 19	-35.3	- 3
Consume beans	Kg	- 3.8	- 3.9	- 3	- 5.0	- 32	- 3.7	+ 3
Max mats	One mat	46.3	47.0	+ 2	50.0	+ 8	40.6	- 12
Max baskets	One basket	30.5	30.8	-	32.0	+ 5	28.2	- 8
Max brewing	One brewing	568.2	568.8	-	564.0	-	563.7	-
January social labor	Man-day	- 2.2	- 2.1	+ 5	- 1.8	+ 18	-3.4	- 55
February social labor	Man-day	-15.0	-15.0	0	-15.0	0	-15.0	0
March social labor	Man-day	- .7	- .6	+18	0	-	- 1.8	-147
April social labor	Man-day	- .7	- .6	+18	0		- 1.8	-147
May social labor	Man-day	- .7			0		- 1.8	-147
June social labor	Man-day	-20.3	-24.1		-25.2	- 24	-19.9	+ 2
July social labor	Man-day	- .7	- .6	+18	0		- 1.8	-147
August social labor	Man-day	- .7	- .6	+18	0		- 1.8	-147
September social labor	Man-day	- .7	- .6	+18	0		- 1.8	-147
October social labor	Man-day	- .7	- .6	+18	0		- 1.8	-147
November social labor	Man-day	- .7	- .6	+18	0		0	
December social labor	Man-day	- .7	- .6	+18	0		- 1.8	-147
Max purchase grain	Tshs	.23	.17	-26	.39	+ 70	.28	+ 22

[1/] A dash (-) indicates a change of less than 1 percent.

the maximum food grain purchase constraint decreases by 26 percent. With an increase in yield there is more output and hence more food grain available. Restricting the purchase level in this case costs the farmer less.

When prices for all crops are increased by 25 percent, the MVP on total land area increases by 104 percent. This reflects a rise in the value of the land because of the increase in price of what is produced on it. The minimum cotton requirement has an MVP in this analysis of TShs 382--a decrease of 238 percent from the base run.

Increasing the price of cotton alone by 50 percent decreases the MVP of total land area by 74 percent. All other types of land--cotton, paddy and bean land--have an MVP of zero. An additional unit of labor in most months is now worth a bit more than double what it was in the base run. The MVP of the food marketing constraint is 22 percent higher than in the base run (Table 5-9b). With food market permitting, this suggests that it would have been more profitable for the farmer to use the income derived from cotton to buy grain rather than producing it on his own farm.

5.3.3 Cost of involving activities not in the optimal solution

5.3.3.1 Relaxing restrains on non-farm activities

In this section, results indicate the reduction that would be observed in the net cash income if an activity not in the optimal solution were forced into solution. Comparisons are made with the base analysis.

Restraining cotton area at a minimum of 0.4 ha while increasing the limit of non-farm products by 25 percent decreases the cost forgone in forcing in a tractor hire service by 85 percent (Table 5-10a). This

Table 5-10a Sensitivity analyses on the base model: Cost of forcing in activities not in optimal solution under various levels of non-farm activities for Melela sample farmers, 1983

Item	Unit	Base Run Model	Non-farm Constraint Lifted by 25%	Change %	Non-farm Constraint Lifted by 50%	Change %	Omission of Non-farm Activities	Change %
		TShs	TShs		TShs		TShs	
Tractor hire	Ha	499.2	76.7	-85	40.2	-92	600.0	+20
February mat production	Man-day	72.1	9.3	-87	10.0	-86	0	
June mat production	Man-day	97.6	0		0		0	
January basket production	Man-day	0	4.6		4.9		0	
February basket production	Man-day	3.0	0		0		0	
June basket production	Man-day	39.1	0		0		0	
Hire labor December	Man-day	14.3	5.7	-60	5.0	-65	15.0	+ 5
Hire labor January	Man-day	12.8	3.4	-73	2.6	-1020	15.0	+ 5
Hire labor March	Man-day	14.3	5.7	-60	5.0	-65	15.0	+ 5
Hire labor April	Man-day	14.3	5.7	-60	5.0	-65	15.0	+ 5
Hire labor May	Man-day	14.3	5.7	-60	5.0	-65	15.0	+ 5
Hire labor July	Man-day	14.3	5.7	-60	5.0	-65	15.0	+ 5

is because increasing the level of production of non-farm products increases the demand for labor. Thus, labor-saving technology becomes more economically attractive in this circumstance. Forcing in labor hiring in the months of December through May and in July is now less detrimental to the net farm income. This is because labor has become relatively more scarce (Table 5-10a). Increasing non-farm product levels by 50 percent reduces the cost of forcing in certain non-optimal activities. The penalty associated with custom hire of tractor service is reduced to TShs 40. Omission of non-farm activities makes the cost of forcing in a tractor to prepare a ha of land to be TShs 600. This implies that even in the most critical time periods there is still surplus labor. Forcing labor hiring in most months would reduce the net cash income by TShs 15 for each man-day. Omitting non-farm products frees more labor for use, resulting in no need to hire extra labor.

5.3.3.2 Crop yields and price changes

Increasing crop yields by 20 percent increases the cost of forcing in non-farm products in some months (Table 5-10b). Under this situation, if mats and baskets are produced in June, the net cash income will decrease by 20 percent compared to the base run. The cost of forcing in non-farm activities in January, June and November increases even more when crop prices are increased by 25 percent (Table 5-10b).

When the cotton price is increased by 50 percent, the cost of forcing in tractor hire service decreases by approximately 11 percent. The cost of forcing in non-farm products in the busy agricultural months increases even further. Because more labor is required to attend to cotton,

Table 5-10b Sensitivity analyses on the base model: Cost of forcing in activities not in optimal solution under yield and price changes for Melela sample farmers, 1983[1/]

Item	Unit	Base Run Model	Crop Yield Increases by 20%	Change %	All Crop Prices up by 25%	Change %	Cotton Price Increases by 50%	Change %
		TShs	TShs		TShs		TShs	
Tractor hire	Ha	499.1	506.9	+ 7.8	518.8	+ 3.9	445.7	-10.7
February mat production	Man-day	72.1	72.6	-	80.5	+11.6	70.1	- 2.8
June mat production	Man-day	97.6	117.3	+20.2	125.9	+28.9	90.4	- 7.3
January basket production	Man-day	3.0	2.9	- 3.3	3.6	+16.7	3.1	+ 3.3
February mat production	Man-day	28.5	28.8	+ 1.0	30.0	+ 5.2	26.2	- 9.1
June mat production	Man-day	39.0	46.9	+20.2	50.3	+28.2	36.2	- 7.2
November basket production	Man-day	0	0		11.1		5.2	
November mat production	Man-day	0	0		27.7		13.0	
Hire labor December	Man-day	14.2	14.4	+ 1.4	15.0	+ 5.7	13.1	- 7.7
Hire labor January	Man-day	12.7	12.9	+ 1.6	13.2	+ 3.9	11.5	- 9.4
Hire labor March	Man-day	14.3	14.4	-	15.0	+ 4.9	13.1	- 8.4
Hire labor April	Man-day	14.3	14.4	-	15.0	+ 4.9	13.1	- 8.4
Hire labor May	Man-day	14.3	14.4	-	15.0	+ 4.9	13.1	- 8.4
Hire labor July	Man-day	14.3	14.4	-	15.0	+4.9	13.1	- 8.4

[1/] A dash (-) indicates a change of less than 1 percent.

which now has a higher price, the cost of forcing in hired labor in most months decreases by approximately 8 percent.

5.4 Linear Programming Results for Mangae Farmers

This section presents LP results for Mangae village sample farmers. These base run results are compared with those of Melela village. The structure of the LP matrix for Mangae farmers is basically the same as that of Melela. The adjustments made are as follows:

1. Land available for cultivation is now 3 ha.
2. Paddy and bean production activities are omitted.
3. Levels of energy and protein are now 2,680 KCal and 72 kg for energy and protein respectively.
4. An increase in the level of the constraint of mat and basket production to 40 and 70 units respectively.
5. Omission of tractor hire services.
6. Levels of social activity days (see Table 3-18).
7. Level of available labor by month.
8. Crop yields (see Table 3-3).

5.4.1 Activities in solution for Mangae sample farmers

The net cash income in the optimal solution for Mangae sample farmers is TShs 5899.8 as compared to TShs 5950 for Melela. The closeness of these figures despite their differences in farm size, family size, etc., can be explained by the fact that although Mangae has no market surplus for sorghum (due in part to smaller farm size), the yield for cotton and hence the total output sold from the 0.4 ha is higher than that of Melela. Also for Mangae, the level of baskets and mats production is higher than for Melela.

A total of 1.98 ha are cultivated compared with 3.38 ha for Melela. The total kg of food consumed are 773.4 compared with 1122.2 kg in the case of Melela (Table 5-11). In terms of crop products sales, it is only cotton that is sold in Mangae. In Mangae, approximately 155 kg of maize are purchased to supplement home-grown food.

As for non-food activities, mats are produced in all months except January, October and December. The peak month for mat production is May. This is the time when farmers are waiting to harvest the crop. Basket production for Mangae is concentrated in January, February and December.

5.4.2 Base run results: shadow prices of resources/ constraints for Mangae farmers and their comparison with Melela sample farmers, 1983

As Table 5-12 depicts, shadow prices for Mangae have somewhat different values from those of Melela farmers. Land in general has no marginal value. Making a farmer to grow 0.4 ha of cotton is more detrimental to the net cash income than it is for Melela farmers. The results imply that growing a ha of cotton at the margin will reduce the net cash income by TShs 1691. Labor in all months has a marginal value product of TShs 7.5 per man-day. For most months, labor at the margin for Mangae is thus worth 10 times more than labor in Melela. It is implied therefore that if wage rates were below TShs 7.5 per man-day, it would be economic to hire labor (Table 5-12).

In contrast to Melela, the minimum energy requirement constraint has a negative marginal value. It means that at the margin, for every KCal consumed by the family a reduction of TShs 1.2 occurs to the net cash income. The "maximum grain purchase" constraint has a value of .74--three times that of Melela. This means that farmers in Mangae

Table 5-11 Base run results: Comparison of activities in solution for Melela and Mangae sample farmers, 1983

Activity	Unit	Level	
		Melela	Mangae
Produce sorghum	Ha	2.10	1.00
Produce maize	Ha	.60	.58
Produce cotton	Ha	.40	.40
Produce beans	Ha	.20	0
Produce paddy	Ha	.08	0
Consume sorghum	Kg	611.1	316.7
Consume maize	Kg	509.3	386.7
Consume beans	Kg	101.8	70.0
Sell sorghum	Kg	390.7	0
Sell cotton	Kg	134.4	180.8
Sell paddy	Kg	11.9	0
Sell beans	Kg	8.9	0
Buy maize	Kg	316.6	155.1
Buy Thiodan	Kg	.4	.4
Buy DDT	Kg	.4	.4
Buy beans			70.0
Hire labor Feb.	Man-day	4.9	0
January mat production	One mat	4.8	0
February mat production	One mat	0	5.0
March mat production	One mat	0	9.0
April mat production	One mat	0	3.1
May mat production	One mat	0	11.3
June mat production	One mat	0	4.9
July mat production	One mat	2.4	.4
August mat production	One mat	0	2.6
September mat production	One mat	10.9	3.6
October mat production	One mat	10.5	0
November mat production	One mat	0	.4
December mat production	One mat	1.4	0
January basket production	One basket	0	13.7
February basket production	One basket	0	19.8
March basket production	One basket	10.1	0
April basket production	One basket	20.5	0
May basket production	One basket	13.3	0
June basket production	One basket	0	0
August basket production	One basket	12.8	0
October basket production	One basket	2.9	0
November basket production	One basket	.4	0
December basket production	One basket	0	36.5
Brew making	One brewing	0	4.0

Table 5-12 Base run results: Comparison of shadow prices of resources/constraints for sample farmers of Melela and Mangae, 1983

Resource/Cons	Unit	Shadow Price (Tshs) Melela	Mangae
All land	Ha	227.8	0
Cotton land	Ha	-113.0	-1691.4
January labor	Man-day	2.2	7.5
February labor	Man-day	15.0	7.5
March labor	Man-day	.73	7.5
April labor	Man-day	.73	7.5
May labor	Man-day	.73	7.5
June labor	Man-day	14.3	7.5
July labor	Man-day	.73	7.5
August labor	Man-day	.73	7.5
September labor	Man-day	.73	7.5
October labor	Man-day	.73	7.5
November labor	Man-day	.73	7.5
December labor	Man-day	.73	7.5
Minimum energy requirement	KCal	0	-1.2
Protein min. requirement	Kg	34.2	0
Consume beans	Kg	3.3	6.0
Maximum grain purchase	Kg	.23	.74
Limit on mat production	One mat	46.3	12.5
Limit on basket production	One basket	30.5	17.0
Limit on brew making	One brewing	568.2	532.6

undergo more losses than their counterparts in Melela because of being forced to produce 80 percent of their food requirements. Food markets permitting, farmers would find it more profitable to produce non-farm products, sell them and buy food. The marginal value products of mats and baskets are lower for Mangae than for Melela.

5.4.3 Cost of forcing in activities not in the optimal solution for Mangae farmers

Production of one ha of sunflower would reduce the net cash income by TShs 1230. It is not profitable to grow maize and sorghum beyond the amount required for consumption. If, say, a farmer is forced to sell maize and sorghum it would result in reducing the net cash income by TShs 4 for each kg sold for maize and TShs 0.5 for each kg of sorghum sold (Table 5-13).

If a farmer in Mangae attempts to hire labor in December or May, a reduction in the net cash income equivalent to the full wage of labor would be experienced. Hiring in the months of January, February and April would reduce net cash income by TShs 7.5 for each man-day.

5.5 Summary

Area cultivated in the optimal farm plan was 3.38 and 1.98 ha for Melela and Mangae respectively. These areas were comparable to actual survey results, particularly in the case of Mangae. Sorghum, maize and cotton dominate as chief crops in the two villages. Where market surplus was achieved, farmers preferred to sell sorghum and buy maize.

The minimum area requirement for cotton tended to have a negative effect on farmers income. The situation was more detrimental to Mangae farmers than to Melela farmers. Cotton was not unprofitable at all

Table 5-13 Base run results: Cost comparison of forcing in non-optimal activities in solution for Melela and Mangae sample farmers, 1983

Activity	Unit	Value Forgone (Tshs) Melela	Mangae
Sunflower	Ha	0	1230.0
Tractor hire (maize/cotton)	Ha	499.0	0
Sell maize	Kg	2.0	4.1
Sell beans	Kg	2.5	0
Sell sorghum	Kg	0	.5
Hire labor December	Man-day	14.3	15.0
Hire labor January	Man-day	12.8	7.5
Hire labor February	Man-day	0	7.5
Hire labor March	Man-day	14.3	0
Hire labor April	Man-day	14.3	7.5
Hire labor May	Man-day	14.3	15.0
Hire labor July	Man-day	14.3	0
January mats	Man-day	0	0
February mats	Man-day	72.0	0
June mats	Man-day	97.6	0
January baskets	Man-day	3.0	0
February baskets	Man-day	28.5	0
March baskets	Man-day	0	0
April baskets	Man-day	0	0
May baskets	Man-day	0	0
June baskets	Man-day	39.0	0
July baskets	Man-day	0	0
August baskets	Man-day	0	0
September baskets	Man-day	0	0
October baskets	Man-day	0	0
November baskets	Man-day	0	0

levels of hectarage. When the constraint was omitted, cotton appeared in solution at a lower hectarage. Cotton area was more sensitive to yield than to price increases. When the price of cotton was increased by 50 percent and the constraint omitted, other variables remaining constant, the minimum cotton area was not exceeded. However, area under cotton surpassed the minimum by 7.5 percent when yields increased by 20 percent.

Non-farm products were relatively more profitable than their farm counterparts. They entered the solution at the maximum allowable limits. Their production was spread throughout the year but production was concentrated more in the non-agricultural months. A high opportunity cost was incurred when non-farm activities were conducted in the agriculturally busy months. Non-farm employment played a significant role in both villages with respect to employment and income. In Melela, for example, approximately 27 percent of the household labor was employed in non-farm activities, contributing approximately 96 percent ofthe annual farm cash income.

With the exception of the case when non-farm activities were omitted from the solution, labor had a positive marginal value product in all months. However, labor hiring was only economical in the month of February in the case of Melela. As for Mangae, it was not economic to hire labor in any month. Labor for social activities in agriculturally busy months reduced net cash income by a value equal to its MVP.

Tractor custom hiring was not profitable. The cost of hiring a tractor would have to be at most TShs 100 if it were to be economical.

The analysis also indicated that farmers would have been better off if food markets were working better. Farmers experienced reduction in

their net cash income when they were constrained to produce most of the food they needed. The poor functioning of food markets affected Mangae farmers even more seriously because of their increased specialization in non-farm activities. Food markets permitting, they would have benefitted more by concentrating on non-farm products and later using the income from non-farm to purchase food.

The LP analyses for the 2 villages revealed that aggregation would lead to erroneous results. Although the villages were only 19 km apart, the optimal solutions were significantly different.

CHAPTER VI

CONCLUSIONS AND POLICY RECOMMENDATIONS

This chapter draws on the survey results and the model results of the two villages to suggest areas of improvement in employment, output, and income of farmers in the survey area. The chapter illustrates what policy makers can learn from a study of this type. The chapter ends by some policy recommendations based on the study.

6.1 Background

Tanzania, a country of approximately 20 million people, has 80 percent of the population in rural areas. Agriculture is the backbone of the national economy. Recent trends indicate that agriculture is having problems. It is no longer able to provide adequate employment for the growing population. The growth in agricultural output and income has also fallen behind the growth in population. It has been established by FAO and USDA that Sub-Saharan Africa is the only region in the world where per capita food consumption has fallen over the last two decades. Tanzania exemplifies this trend.

Because of the lack of technological development in irrigation, agriculture is seasonal--depending almost exclusively on the mercy of rains. Farmers work effectively on agricultural production for only 7-8 months. The seasonality is even more pronounced in areas which are over-populated, drought-stricken or infested with tsetse flies. Tsetes flies severely limit the maintenance of livestock, which help smooth the

monthly labor utilization. For the above reasons it would be wrong to depend only on agriculture in some areas in the country. A two-pronged strategy aimed at promoting agricultural as well as non-agricultural employment is suggested.

6.2 Study Design and Data Analyses

The objective of this study was to provide information on the existing farm and non-farm rural employment in the lowland areas of Morogoro District and to delineate areas in which improvement is possible. More specifically, this study focused on four objectives: 1) identification and description of the cropping system currently being employed, with attention been given to resource availability and utilization; 2) identification of the non-farm production activities and examination of their use of household resources and the returns to these activities; 3) identification of constraints facing producers of farm and non-farm products; 4) development of a linear programming model for the purpose of analyzing specific factors affecting employment and incomes of farmers including the minimum mandated area for cotton production, different producer prices, improved labor hiring arrangements, mechanization and the effect of increasing the quality of marketing arrangements for both farm and non-farm products.

Data necessary for the study were obtained by interviewing 90 farm households in six villages. Fifteen households were randomly selected from each of the six villages. Data collection was supervised by the author. Six enumerators were utilized for a twelve-month period beginning January 1983. Information collected included labor availability and utilization by crops, cultural practices used, crop yields, the use of

non-labor inputs, resource use in non-farm enterprises, the output generated by non-farm enterprises and the availability of inputs and outputs.

Tools used for data analyses for all the six villages included cross-tabulations and averages. More detailed analyses of two villages, Melela and Mangae, which were actively involved in non-farm activities, were carried out by static linear programming models. The linear programming models were structured to fit the objectives of farmers. The objective function maximized net cash income subject to meeting food consumption requirements for the household family for the whole year. The consumption basket which would provide the needed calories and protein comprised maize, sorghum and beans. Activities in the model included crop production, selling and buying activities, and production and selling of non-farm products. Linear programming was chosen in part because of its ability to give an optimum solution over a range of alternative activities and also because of its superiority over budgets in identifying resource scarcities in particular months. Sensitivity analyses were carried out from the base runs to evaluate the effects of making certain changes.

6.3 Survey Results

6.3.1 Resource use

The analysis of crop husbandry practices indicates that farmers in the study area are still tied to traditional methods of farming for most crops except cotton. The hand hoe is still the main tool employed in breaking the ground. This limits the area that can be cultivated. Improved agricultural technology, including improved seed varieties, fertilizer use, and application of pesticides, has not been adopted by these

farmers to a major degree. Survey results indicate that on average a person cultivates approximately 0.8 ha (2 acres) while model results for the 2 villages indicate that 1.2 and 1.4 ha per person for Melela and Mangae, respectively, would be optimal.

In the model villages (Melela and Mangae), the marginal value product of labor is positive in every month. However for most months the values are quite low. With the exception of February in Melela, when the MVP of labor is equal to the actual wage rate, all other MVP's are below the ongoing wage rates. In the case of Mangae, the MVP of labor is exactly half the wage rate of TShs 15 per day. Since labor is adding less to total profits than it costs, it is not economical to hire labor. Rural wages are loosely fixed by government at TShs 17. Also government propaganda discourages wage labor.

Capital requirements for crop production and non-farm activities are not limiting. This is because for most crops, inputs used are not purchased. The level of mechanization is low. However, farmers have shown great interest in employing tractors. The limited availability of private tractor hire services has sharply increased the cost of this input to an average of TShs 600 per ha. As a result, many farmers remain compelled to rely on the hand hoe. Given the hardness of the soil, the seasonality of crop production and the incidence of labor bottlenecks, this severely limits the size of the cropping system. However, as the LP results indicate, the cost of hiring a tractor service for one ha has to be one-sixth of the current rate for it to be economical. Even if the supply of tractor services were to be increased, it will take a long time before the price goes down to that level. Since it is not reasonable to expect tractor hire services to be supplied at TShs 100/ha

without a subsidy, it is fair to conclude that given current cropping technology and factor prices, tractors will not be economically viable.

Fertilizer is used in only one of the six villages in the study. Increased use of fertilizer will come slowly because of the following reasons: (1) most of these areas are semi-arid with a high probability of a long dry season. Application of chemical fertilizer to moisture-deficient areas may do more harm than good. Thus, even if expected profit from using them is positive, because of rainfall uncertainty it is risky to use fertilizer and risk averse farmers may refrain from doing so. (2) Soils differ considerably even within a few km. If fertilizer is to be applied profitably, then recommended dosages must be location-specific. Given the current research, resource base, and infrastructure, it will take time before fertilizers are extensively adopted.

6.3.2 Crop enterprise mix

In the survey zone, farmers are cultivating almost equal areas of maize and sorghum. LP models for the two villages indicate, however, that sorghum is more profitable, and hence more is cultivated in the optimal farm plans generated by the LP. Efforts to improve bean and paddy production in the survey area should be even more location-specific because they require pockets of lands which retain moisture for a long time.

In terms of profitability, the cotton mandated minimum hectarage is a concern to farmers in the survey areas. In the western cotton zone, cotton competes favorably with other crops. In the eastern zone, where this study is based, this is not the case. Some of the reasons for the low cotton profitability are: (1) Several crops make more efficient use

of the limited amounts of the available family labor. From the farmer's standpoint, there is little difference between a cash and a food crop because both can be sold for cash. (2) The price of cotton is simply not as attractive as that of other crops like maize, sorghum and beans, when the costs of production are considered. (3) Yields are low in part because of: (a) more insect pests, attributed to better breeding conditions in the eastern than in the western zone; (b) more preference given to maize and sorghum, leading to delayed weeding and harvesting of cotton. Low yields and relatively low prices make cotton unprofitable.

6.3.3 Non-farm products

A significant role is played by non-farm activities in some of the villages in the survey areas. The LP models for the two villages indicate that 27 percent of household labor is used in the production of non-farm products and that this contributes over 90 percent of the annual family cash income. The chief non-farm products from the zone are mats, baskets, brew, charcoal, carpentry and tailoring products. These farmers have received little advisory or marketing assistance from the Small Industries Development Organization (SIDO). Criticism that SIDO has concentrated more on the urban formal groups, since its establishment in 1972, appears to be valid based on the results of this study. The marketing constraints for non-farm products imposed on the model indicated that farmers could have increased their income substantially in the constraint was relaxed, e.g., through assistance from SIDO in marketing the products outside the area.

Non-farm activities have developed particularly in villages where the raw materials necessary for their manufacturing are plentifully

available. This is particularly the case for the weaving industry--baskets and mats.

6.4 Policy Recommendations and Suggestions for Future Research

6.4.1 Introduction

Tanzanian agriculture is at a cross-roads. A high optimism for reform exists. The optimism arises from the fact that many of the problems facing the sector are domestically solvable. Besides the non-controllable factors such as drought, low prices for export crops, and high energy prices, government economic policies have contributed significantly to the poor performance of the agricultural sector. Studies by Hyden (1980); Amani (1981); Ellis (1982); and the World Bank (1983) have attempted to show how better policies could have led to more efficient employment of human resources, leading to higher output and income. It is now common knowledge that the discouragement of private entrepreneurship by the Arusha Declaration, which among other things called for socialist agricultural production, has highly punished agriculture. Socialism and the socialist government has yet to develop an effective set of agricultural policies to deal with a set of structural, institutional and human resource constraints. As Eicher (1982) has pointed out, Tanzania under its socialist mode of production underestimated the vast amount of information, managerial and administrative skills required to achieve socialist agricultural objectives. For a decade and a half, even the smallholder sector has remained unstable due to the confused state of government objectives, particularly those relating to ownerhsip. The peasant entrepreneur has been forced to question: How many hectares can I own without being classified as an "exploiter?" Can I hire labor? If I can, how

much can I hire and not violate the labor laws? Such questions have remained unanswered for many years and the uncertainty has contributed to the decline in agricultural production. Such problems are starting to be resolved by the Tanzanian Agricultural Policy of 1982. Yet even with this, many questions regarding ownership remain unanswered.

6.4.2 Crop production and marketing

1. Individual freedom of farmers in growing what they believe to be profitable has been considerably curtailed. This is clearly the case for cotton producers. Morogoro farmers recognize that cotton production is unprofitable. Yet they are forced to grow it or they face imprisonment, a fine, or both. This study recommends abolishing the minimum mandated cotton hectarage in Morogoro Region. Farmers who feel that they can profitably grow any given hectarage of any given crop should be allowed to do so.

2. In an attempt to increase yields and total output, research on drought resistant crops, particularly sorghum and short-term maize varieties should be encouraged. This is justified by the fact that: (a) these are semi-arid areas that experience a long dry season in most years; (b) farmers are already familiar with the husbandry practices of such crops making adoption of improved varieties easier.

3. Intra- and inter-village district regional movement of grain by private individuals should be liberalized. This would allow food to move freely from surplus to deficit areas at minimum costs. This study has indicated that in the villages of Melela and Mangae farm families can benefit more by specializing in non-farm activities and using the income from these activities to buy food. At the same time, research directed towards the improvement of the marketing channels is needed.

4. Results of the LP for the two villages indicate that labor is limiting in all months when non-farm activities are in place. This is particularly the case in the planting and weeding periods. Two approaches could be undertaken to increase labor supply in critical periods. First, the government should encourage the hiring of labor by restoring confidence in the fact that being hired for a wage has an economic and social justification. Although a landless class does not exist, some individuals could still make themselves available on days when they are not involved on their own farms. Second, the government could synchronize school holidays with the busiest times in the agricultural season. Based on the analyses of the farm labor data, 60 percent of the children, age 11 to 16 years, attend school. This group is normally not available for farm work. While the value of their contribution may be relatively low because of their ages, their help in specific activities such as weeding and sorting cotton can be substantial.

5. Based on the LP results, the use of tractor does not appear profitable. This is partly attributed to: (a) the high cost of tractor hire services; (b) the partial mechanization which involves only the preparation of the seedbed without mechanization of the consequent farm operations such as weeding and harvesting. Whereas greater availability of tractor services would reduce the custom hire charges and hence reduce farm costs, tractors are imported goods and foreign exchange is always limiting. Consideration should therefore be given to small powered illage implements and animal traction. However, research into the socio-economics of animal traction is needed. Animal cultivation has recently caught the interest of many politicians and policy makers. It is seen as a substitute for expensive tractors. Surprisingly, questions as to why

adoption has not previously been achieved in many parts of the country have not been asked. Whereas tractors would need oil, repairs and housing, many more factors need to be considered when we deal with animals. Availability of feeds, clean water for drinking, terrain, animal diseases, and animal/human social interactions are some of the factors that need examining.

6.4.3 Non-farm products

1. The scope of development of rural non-farm activities depends *interalia* on a variety of factors--local resources, skills, and availability of markets. Based on the survey, farmers who are also involved in the non-farm activities are not being reached by the services of SIDO. Thus far, attention has been paid mainly to urban groups. Considering the limited absorptive capacity of the agricultural sector and the profitability of non-farm enterprises, a need exists to promote the existing non-farm employment and also to identify new forms of non-farm employment opportunities. Exploring markets beyond the rural and urban markets of the District should be considered.

2. Special programs for training young rural workers in small-scale manufacturing skills should be launched.

3. Non-farm activities should be prompted by providing technical assistance in the areas of quality control, raw material procurement and marketing.

4. Charcoal will continue to be the main source of energy for the rural and urban poor. The resulting deforestation will gradually affect the stability and quality of the ecosystem. Effective policies to guide, advise, and control the small-scale charcoal manufacturers are needed.

New areas of research are also suggested by the study and the author's personal experience. These are:

a) Research into factors beyond the availability of raw materials which make non-farm activities more favorable in some areas than others would be desirable.

b) Research is needed to analyze the backward and forward linkages of non-farm rural products and the farm sector.

c) Research is needed to explore the possibility of using sisal fibre in the manufacture of mats and baskets by rural households. Given the replacement of sisal fibre with synthetics on the world market, the government should promote greater domestic utilization of the fibre. Alternatively, the economics of importing the synthetic fibre to make mats and baskets for domestic and foreign markets could also be explored.

6.5 Limitations of the Study

Although collection of data covered only one production year, the author is convinced that this was a normal year. The seriousness of the limitations of linear programming is also noted. As stated earlier in the text, linear programming is essentially a mathematical tool and this sometimes limits application of its results. The objective function assumed in the study was that of farmers maximizing net cash income subject to meeting minimum food requirement. However, farmers' objectives are in the real world quite complex and myriad, oftentimes very difficult to model. Decisions of farmers are in fact revised continuously all the year round and hence the objective function may change from time to time through the year.

Due to data limitations, the study does not consider the effect of timeliness of farm operations on the farmers' net cash income such as possible effects of late planted cotton. Also, apart from the food security aspect, the study does not consider other risk factors such as yield, price and institutions on farmers' net cash income.

Some activities were omitted because: (1) they were not considered to be important in influencing the decision process; and (2) the model had to be maintained at a reasonable size. However, sometimes such minor activities turn out to be important due to changing tastes or changing government policies. In such a situation the optimum solution suggested by the model may cease to hold.

APPENDICES

APPENDIX A

ABBREVIATIONS IN THE LINEAR PROGRAMMING MODEL AND THEIR EXPLANATIONS

Explanation of Abbreviations in the LP Matrix

Activities

Column No.	Activity	Complete Heading
A1	MAIZ	Grow Maize
A2	SORG	Grow Sorghum
A3	SUNF	Grow Sunflower
A4	PADY	Grow Paddy
A5	BEAN	Grow Beans
A6	COTTON	Grow Cotton
A7	HIRETR	Hire Tractor
A8	CMAIZ	Consume Maize
A9	CSORG	Consume Sorghum
A10	CBEAN	Consume Beans
A11	JANMAT	Make Mats January
A12	FEBMAT	Make Mats February
A13	MARMAT	Make Mats March
A14	APRMAT	Make Mats April
A15	MAYMAT	Make Mats May
A16	JUNMAT	Make Mats June
A17	JULMAT	Make Mats July
A18	AUGMAT	Make Mats August
A19	SEPMAT	Make Mats September
A20	OCTMAT	Make Mats October
A21	NOVMAT	Make Mats November
A22	DECBAS	Make Mats December
A23	JANBAS	Make Baskets January
A24	FEBBAS	Make Baskets February
A25	MARBAS	Make Baskets March
A26	APRBAS	Make Baskets April
A27	MAYBAS	Make Baskets May
A28	JUNBAS	Make Baskets June
A29	JULBAS	Make Baskets July
A30	AUGBAS	Make Baskets August
A31	SEPBAS	Make Baskets September
A32	OCTBAS	Make Baskets October
A33	NOVBAS	Make Baskets November
A34	DECBAS	Make Baskets December
A35	JABREW	Make Brew January
A36	APBREW	Make Brew April
A37	JBREW	Make Brew July
A38	OCBREW	Make Brew October
A39	SMAIZ	Sell Maize
A40	SSORG	Sell Sorghum
A41	SSUNF	Sell Sunflower
A42	SPAD	Sell Paddy
A43	SBEAN	Sell Beans
A44	SCOTON	Sell Cotton
A45	SMATJAN	Sell Mats January

Activities Cont'd

Column No.	Activity	Complete Heading
A57	SBASKJAN	Sell Baskets January
A69	SBREWJAN	Sell Brew January
A73	BMAIZJ	Buy Maize January
A78	BSORGJ	Buy Sorghum January
A83	BBEANJ	Buy Beans January
A88	BTHIOD	Buy Thiodan
A89	BDDT	Buy DDT
A90	HLDEL	Hire Labour December
A91	HJAL	Hire Labour January
A92	HFEL	Hire Labour February
A93	HMAL	Hire Labour March
A94	HAPL	Hire Labour April
A95	HMYL	Hire Labour May
A96	HJYL	Hire Labour July
A97	TJAN	Transfer Capital January
A98	TFEB	Transfer Capital February
A99	TMAR	Transfer Capital March
A100	TAPR	Transfer Capital April
A101	TMAY	Transfer Capital May
A102	TJUN	Transfer Capital June
A103	TJUL	Transfer Capital July
A104	TAUG	Transfer Capital August
A105	TSEP	Transfer Capital September
A106	TOCT	Transfer Capital October
A107	TNOC	Transfer Capital November
A108	TDEC	Transfer Capital December
A109	TCOL	Transfer Capital Column
A110	JASL	January Social Labour
A111	FESL	February Social Labour
A112	MASL	March Social Labour
A113	APSL	April Social Labour
A114	MYSL	May Social Labour
A115	JUSL	June Social Labour
A116	JUSL	July Social Labour
A117	AUSL	August Social Labour
A118	SESL	September Social Labour
A119	OCSL	October Social Labour
A120	NOSL	November Social Labour
A121	DESL	December Social Labour

Row No.	Constraint	Complete Explanation
R1	TLAND	Total Land
R2	LPADY	Paddy Land
R3	LBEAN	Bean Land
R4	LCOTON	Cotton Land
R5	JAFL	January Family Labour
R6	FEFL	February Family Labour
R7	MAFL	March Family Labour
R8	APFL	April Family Labour
R9	MYFL	May Family Labour
R10	JUFL	June Family Labour
R11	JYFL	July Family Labour
R12	AUFL	August Family Labour
R13	SEFL	September Family Labour
R14	OCFL	October Family Labour
R15	NOFL	November Family Labour
R16	DEFL	December Family Labour
R17	LMT MAIZCOT	Limit Tractor Hire to Maize and Cotton
R18	LMT HA/TRACT	Limit Area to be Cultivated by Tractor
R19	MIN ENERGY	Minimum Energy Required/Year
R20	MIN PROTEN	Minimum Protein Required/Year
R21	THIOD	Thiodan Usage
R22	DDT	D.D.T. Usage
R23	QMAIZ	Quantity of Maize Produced
R24	QSORG	Quantity of Sorghum Produced
R25	QSUNF	Quantity of Sunflower Produced
R26	QPADY	Quantity of Paddy Produced
R27	QBEAN	Quantity of Bean Produced
R28	QCOTON	Quantity of Cotton Produced
R29	QMATS	Quantity of Mats Produced
R30	QBASK	Quantity of Baskets Produced
R31	QBREW	Quantity of Brew Produced
R32	LMT HDEL	Limit December Hired Labour
R33	LMT HJAL	Limit January Hired Labour
R34	LMT HFEL	Limit February Hired Labour
R35	LMT HMAL	Limit March Hired Labour
R36	LMT HAPL	Limit April Hired Labour
R37	LMT HYML	Limit May Hired Labour
R38	LMT HJYL	Limit July Hired Labour
R39	OC JAN	Operating Capital January
R40	OC FEB	Operating Capital February
R41	OC MAR	Operating Capital March
R42	OC APR	Operating Capital April
R43	OC MAY	Operating Capital May
R44	OC JUN	Operating Capital June
R45	OC JUL	Operating Capital July
R46	OC AUG	Operating Capital August
R47	OC SEP	Operating Capital September
R48	OC OCT	Operating Capital October
R49	OC NOV	Operating Capital November
R50	OC DEC	Operating Capital December
R51	END OPC	End of Operating Capital
R52	JASL	Social Labour for January

Row No.	Constraint	Complete Explanation
R53	FESL	February Social Labour
R54	MASL	March Social Labour
R55	APSL	April Social Labour
R56	MYSL	May Social Labour
R57	JUSL	June Social Labour
R58	JYSL	July Social Labour
R59	AUSL	August Social Labour
R60	SESL	September Social Labour
R61	OCSL	October Social Labour
R62	NOSL	November Social Labour
R63	DESL	December Social Labour
R64	CMAIZ	A Constraint That Maize Be Consumed
R65	CSORG	A Constraint That Sorghum Be Consumed
R66	CBEAN	A Constraint That Beans Be Consumed
R67	MAXMAT	Maximum Mats That Can Be Produced
R68	MAXBAS	Maximum Baskets That Can Be Produced
R69	MAXBREW	Maximum No. of Brews That Can Be Produced
R70	MAXBUY	Maximum Purchase of Maize and Sorghum
R71	MAXBUY	Maximum Purchase of Beans

APPENDIX B

LABOR REQUIREMENT IN MAN-DAYS BY CROP BY MONTH BY VILLAGE PER AVERAGE AREA CULTIVATED AND PER HA FOR ACTUAL NUMBER OF HOUSEHOLDS INVOLVED

Table B-1. Labor requirement in man-days by crop by month by village per average area cultivated and per ha for the actual number of households involved, 1983[1/]

Crop	Village	JAN				FEB				MAR				APR				MAY				JUN				JUL				AUG				SEP				OCT				NOV				DEC			
		HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha	HH/ mo	L/ HH	Ha/ mo	L/ Ha
Sorghum	Kingabwa	8	14.3	1.6	224	8	24.5	1.6	24.9	9	8.3	1.2	8.2	4	15.1	1.6	23.3	3	23.4	.6	122	0	0	0	0	5	24.4	1.6	18	5	17	2.8	24.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Doma	2	35.5	1.6	44.3	3	10.6	2	16	1	12	.4	30	0	0	0	0	0	0	0	0	1	8	.4	20	1	8	.4	20	2	17	1.6	21.2	0	0	0	0	0	0	0	0	1	18	.4	45	1	4	.4	10
	Melela	8	11.7	1.4	16.4	4	11.5	1.2	13.8	11	11.7	1.4	14.6	8	20.4	1.2	17.5	4	23.5	.7	15.7	2	12.5	.2	9.6	6	31.5	.8	24.4	12	25.5	1.7	18	3	3.0	.5	4.8	0	0	0	0	0	0	0	0	8	19	.9	16
	Mangae	8	11.2	1.2	21.9	9	11.4	1.4	23.3	14	15	1.0	21.1	12	11.6	1.2	17.6	10	21.4	.8	24.7	6	11	.4	16.7	8	9.6	.6	15.7	6	13	.5	16	0	0	0	0	0	0	0	0	1	24	.8	20	12	20	.9	28
Beans	Kingabwa	1	20	.6	33.3	1	28	.6	46.6	1	11	.6	18.3	0	0	0	0	0	0	0	0	0	0	0	0	1	44	.6	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fuma	0	0	0	0	0	0	0	0	4	9.8	.8	44.1	3	8	.6	40	3	10.6	.6	53.3	0	0	0	0	5	6.8	1	34	1	4	.2	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Longali	3	8.3	1.3	20	4	10.2	1.6	25.6	2	9	.5	36	7	23.4	2	82	12	17.7	3.1	54.4	7	9	2.4	26.4	9	10.1	2.4	40.4	0	0	0	0	0	0	0	0	0	0	0	0	6	9	2	24	3	9	.9	31
	Melela	0	0	0	0	0	0	0	0	4	10.1	.6	71.6	4	3.5	.8	18	3	19	.7	114	1	12	.1	120	1	2	.2	10	0	0	0	0	0	0	0	0	5	.1	1	50	0	0	0	0	1	20	.2	100
Paddy	Kingabwa	5	11.8	1.4	11.1	7	11.5	2.1	25.1	5	11.8	5.3	15.6	6	15	3.4	24.4	0	0	0	0	0	0	0	0	3	18	2.6	20.7	3	10	.7	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fuma	2	15	.6	30	3	11	1	57	1	14	.4	35	3	33	1.6	64	2	20	.8	50	4	34	2	68	2	23	.6	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	35	2.4	73
	Doma	2	9	.4	45	1	4	.2	20	1	10	.2	50	1	12	.2	60	0	0	0	0	1	6	.2	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	.2	75
	Melela	1	12	.4	30	2	3.5	.6	11.6	0	0	0	0	1	12	.4	30	2	18	.6	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	9	1	26
Millet	Fuma	12	20.5	7.4	32.5	8	22.7	5.2	35	10	17.3	6.8	26.1	4	31.7	2.4	52.4	1	12	.4	30	6	20	3.8	34.5	9	11.4	5.4	32.7	6	14.5	3.8	36	0	0	0	0	0	0	0	0	0	0	0	0	6	19	3	33
	Doma	7	15.8	4.2	26.4	1	8	1.5	5.2	6	10	4.4	40	6	13	4.7	154	0	0	0	0	1	20	1.5	133	2	11	.8	21.5	7	19	5.4	38	0	0	0	0	0	0	0	0	1	12	1.5	5	9	35	4	26

1/ HH/Mo = No. of households involved per month.

2/ L/HH = Labor in man-days involved per month per household.

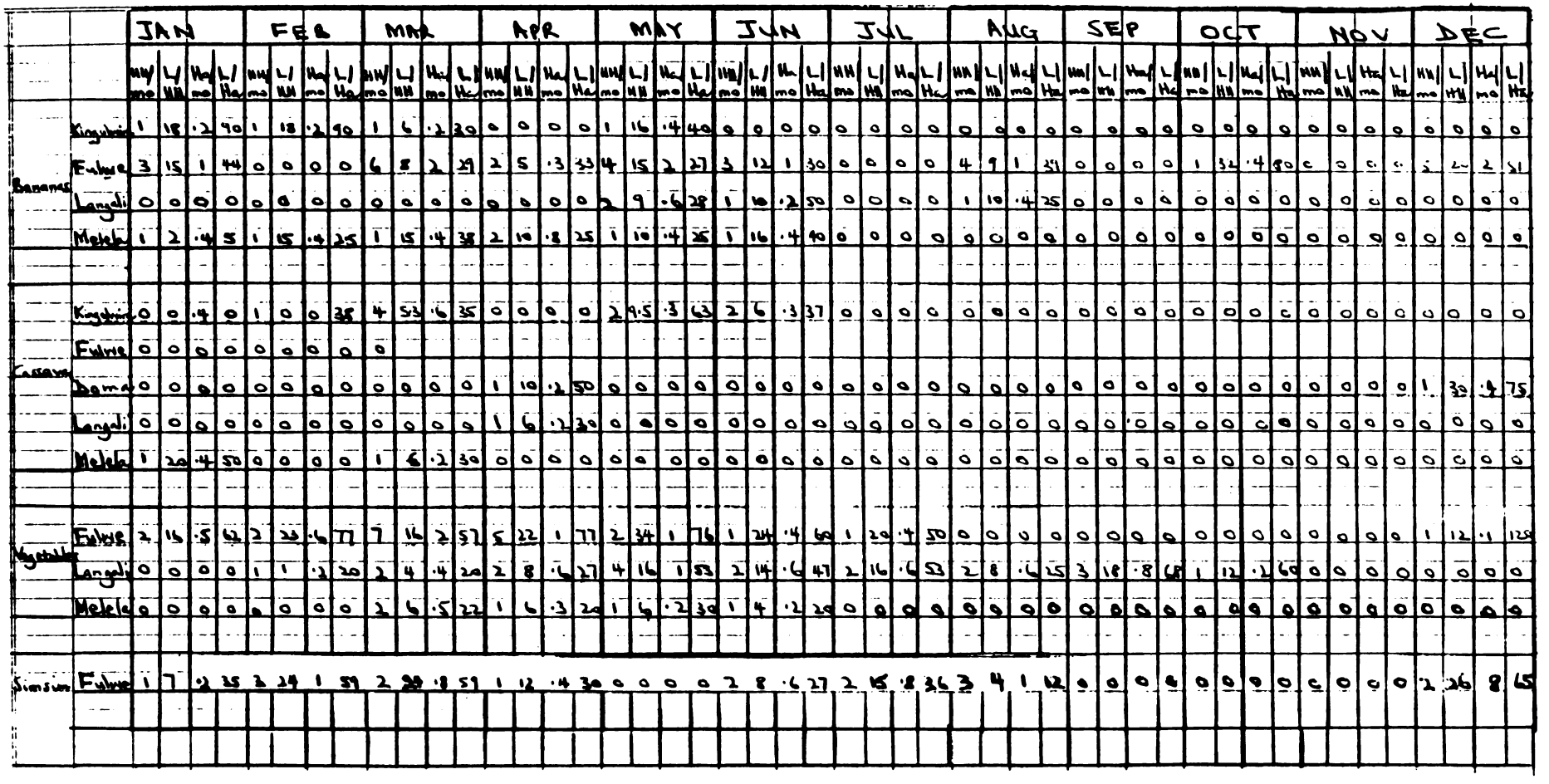
3/ Ha/Mo = Hectares cultivated per month per household.

4/ Labor required in man-days per ha.

Table B-1 (Continued)

Crop	Village	JAN				FEB				MAR				APR				MAY				JUN				JUL				AUG				SEP				OCT				NOV				DEC			
		HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha	HH/mo	L/HH	Ha/mo	L/Ha
Maize	Kinghum	10	18	10	18	13	19	9	28	14	8	11	10	14	11	9	17	1	12	.8	7.5	1	6	.8	8	13	14	11	16	3	21	3	19	0	0	0	0	5	16	6	13	5	17	4	21	3	15	3	15
	Fulwe	12	21	12.9	23	10	27	11	28.5	10	14	8	15	4	16	3	20	5	15	4	19	11	20	12	184	4	18	7	10	0	0	0	0	0	0	0	0	0	0	0	0	1	29	1.2	19	10	26	7	38
	Langeli	8	165	10	15	2	19	2	17	8	245	8	21	9	265	10	23	7	19	8	18	0	0	0	0	1	8	1.6	5	2	10	1.3	15	4	17	4	17	5	17	6	16	10	24	10	22	11	19	11	19
	Melela	2	20	.8	49	1	24	.3	30	3	14	2.4	17	4	13	3	19	2	5	1	8	5	9	3	19	0	0	0	0	2	20	2	20	0	0	0	0	0	0	0	0	0	0	0	0	6	15	4	26
	Monge	8	18	4	43	6	15	3	33	11	6	5	14	13	19	6	44	4	16	2	39	11	15	5	35	0	0	0	0	0	0	0	0	0	0	0	0	1	24	.4	60	1	6	.4	15	11	14	5	32
	Dome	9	9	6	19	9	17	7	20	4	11	4	12	7	12	5	16	0	0	0	0	0	0	0	0	3	17	3	18	4	19	3	21	1	4	.4	10	2	9	.8	23	7	20	6	23	8	19	6	24
	Kinghum	1	24	.4	60	2	23	.8	58	1	4	.4	10	2	8	.8	20	0	0	0	0	1	8	.4	20	1	10	.4	25	1	5	.4	13	1	8	.4	20	0	0	0	0	0	0	0	0	1	4	.4	10
	Fulwe	1	13	.2	45	2	21	.6	70	1	21	.4	53	0	0	0	0	0	0	0	0	1	6	.2	30	0	0	0	0	1	9	.4	23	0	0	0	0	0	0	0	0	0	0	0	0	1	6	.4	15
Sunghum	Dome	1	3	.2	15	1	10	.6	17	2	12	1.4	16	4	10	2	20	2	15	1	30	0	0	0	0	3	12	1	30	1	10	.8	13	0	0	0	0	0	0	0	0	1	15	.8	19	2	15	.6	48
	Melela	3	9	1	23	2	14	2	18	3	6	1	16	3	14	2	24	1	8	.4	45	1	8	.4	20	1	24	1	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Monge	1	24	.4	60	1	22	.4	55	1	20	.4	50	1	15	.4	38	1	5	.4	13	1	8	.4	20	0	0	0	0	1	4	.4	10	0	0	0	0	0	0	0	0	0	0	0	0	1	24	.4	60
	Kinghum	8	15	8	44	6	13	3	29	6	7	3	14	5	18	2	40	3	19	2	35	1	6	.4	15	2	26	1	60	5	26	2	57	4	22	1	62	1	36	.4	90	0	0	0	0	1	18	.4	45
Cotton	Fulwe	5	21	3	40	12	25	6	50	10	22	5	51	4	11	2	37	9	5	5	9	2	8	.8	19	5	15	2	31	10	28	5	56	9	23	5	44	1	30	.4	75	0	0	0	0	2	31	1	61
	Dome	8	13	3	31	7	15	3	37	8	10	3	26	5	13	2	29	3	9	1	22	1	14	.4	35	3	15	1	38	7	15	3	36	4	19	2	46	3	19	1	41	1	44	.4	10	0	0	0	0
	Melela	3	16	2	24	5	9	2	13	3	10	2	19	5	24	3	38	1	18	.4	45	2	8	2	10	1	36	.8	45	6	32	4	54	4	26	2	58	0	0	0	0	0	6	0	0	3	17	2	34
	Monge	8	17	4	37	8	21	4	41	14	23	7	49	8	19	4	40	12	23	6	48	7	17	3	37	6	15	3	28	14	18	7	38	9	29	4	48	0	0	0	0	0	0	0	0	5	22	3	41

Table B-1. (Continued)



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