OPTIMIZATION OF FUELWOOD PRODUCTION FOR RURAL DEVELOPMENT WITH SPECIAL REFERENCE TO TOBACCO GROWING FARMERS (SOUTH NYANZA - KENYA)

BY

Paul Othim Ongugo

A THESIS SUBMITTED TO THE DEPARTMENT OF BUSINESS ECONOMICS OF FORESTRY, UNIVERSITY OF HELSINKI, AS A PARTIAL FULFILMENT FOR A M.Sc DEGREE IN FORESTRY AND AGRICULTURE

HELSINKI 1985

OPTIMIZATION OF FUELWOOD PRODUCTION FOR RURAL DEVELOPMENT WITH SPECIAL REFERENCE TO TOBACCO GROWING FARMERS (SOUTH NYANZA - KENYA)

BY

PAUL OTHIM ONGUGO

A THESIS SUBMITTED TO THE DEPARTMENT OF BUSINESS ECONOMICS OF FORESTRY, UNIVERSITY OF HELSINKI, AS A PARTIAL FULFILMENT FOR A M.SC. DEGREE IN FORESTRY AND AGRICULTURE

HELSINKI 1985

HELSINGIN YLIOPISTO — HELSINGFORS UNIVERSITET

Tiedekunta/Osasto — Fakultet/Sektion	Laitos — Institution
Maatalous-metsätieteellinen tdk	Metsätalouden liiketieteen laitos Työn ohj.: Prof. M. Keltikangas

Tekijä — Författare
Ongugo, Paul Othim

Työn nimi — Arbetets titel
Optimization of fuelwood production for rural development with special reference to tobacco growing farmers (South Nyanza - Kenya)

Oppiaine — Läroämne
Metsätalouden liiketiede

Työn laji — Arbetets art	Aika — Datum	Sivumäärä — Sidoantal
Pro gradu -tutkielma	5.9.1985	98 s. + 27 liitesivua

Tiivistelmä — Referat

A resource allocation problem was studied, both theoretically and on the basis of an empirical data. South Nyanza district of the Republic of Kenya was chosen as the study area, for personal and technical reasons. The area gives an example of a place where a problem of resource allocation is imminent here tobacco growing has been increasing steadily as a cash crop, while at the same time, sugar cane and cotton, both of which are not covered in this study, are also important cash crops. A bias towards cash crop production has been noted, at the expense of both the food crop production, and the environment, which is degraded due to overexploitation of the wood resource, both for domestic use, and for the increasing demand for tobacco curing.

Data was collected for the inputs and outputs involved in the production of tobacco, maize and fuelwood. Preliminary data analysis was performed using an electronic calculator. The main data analysis was done using the Linear programming (LP) method.

Large systems TEMPO program package, developed for mathematical programming problems was used on the Burroughs B 7800 computer.

The results of the data were tested for sensitivity, using the same computer package.

The study shows that of all the productive resources available in the study area, capital is the most limiting resource, while labour is the most abundant resource.

Tobacco production gives the best returns on capital while fuelwood gives the best results on labour. The maximal net revenue and the optimal land allocation is obtained when the above two resources are allocated in such a way that tobacco production uses both labour and capital intensively while fuelwood uses labour extensively.

With the prevailing conditions of the resources availability in the study area, it is possible to produce fuelwood in all the area left over from the maize and tobacco productions, especially when a maximum ceiling is put on the tobacco crop.

No significant competition for land use was observed amongst the three crops.

Avainsanat — Nyckelord

Säilytyspaikka — Förvaringsställe
Metsätalouden liiketieteen laitos

Muita tietoja — Övriga uppgifter

OPTIMIZATION OF FUELWOOD PRODUCTION FOR RURAL DEVELOPMENT WITH SPECIAL REFERENCE TO TOBACCO GROWING FARMERS (SOUTH NYANZA - KENYA)

BY

PAUL OTHIM ONGUGO

A THESIS SUBMITTED TO THE DEPARTMENT OF BUSINESS ECONOMICS OF FORESTRY, UNIVERSITY OF HELSINKI, AS A PARTIAL FULFILMENT FOR A M.SC. DEGREE IN FORESTRY AND AGRICULTURE

HELSINKI 1985

OPTIMIZATION OF FUELWOOD PRODUCTION FOR RURAL DEVELOPMENT WITH SPECIAL REFERENCE TO TOBACCO GROWING FARMERS (SOUTH NYANZA - KENYA)

BY

PAUL OTHIM ONGUGO

A THESIS SUBMITTED TO THE DEPARTMENT OF BUSINESS ECONOMICS OF FORESTRY, UNIVERSITY OF HELSINKI, AS A PARTIAL FULFILMENT FOR A M.SC. DEGREE IN FORESTRY AND AGRICULTURE

HELSINKI 1985

ABSTRACT

A resource allocation problem was studied, both theoretically, and on the basis of an empirical data. South Nyanza district of the Republic of Kenya was chosen as the study area, for personal and technical reasons. The area gives an example of a place where a problem of resource allocation is imminent, here tobacco growing has been increasing steadily as a cash crop, while at the same time, sugar cane and cotton, both of which are not covered in this study, are also important cash crops. A bias towards cash crop production has been noted, at the expense of both the food crop production, and the environment, which is degraded due to overexploitation of the wood resource, both for domestic use, and for the increasing demand for tobacco curing.

Data was collected for the inputs and outputs involved in the production of tobacco, maize and fuelwood. Preliminary data analysis was performed using an electronic calculator. The main data analysis was done using the Linear programming (LP) method.

Large systems TEMPO program package, developed for mathematical programming problems was used on the Burroughs B 7800 computer.

The results of the data were tested for sensitivity, using the same computer package.

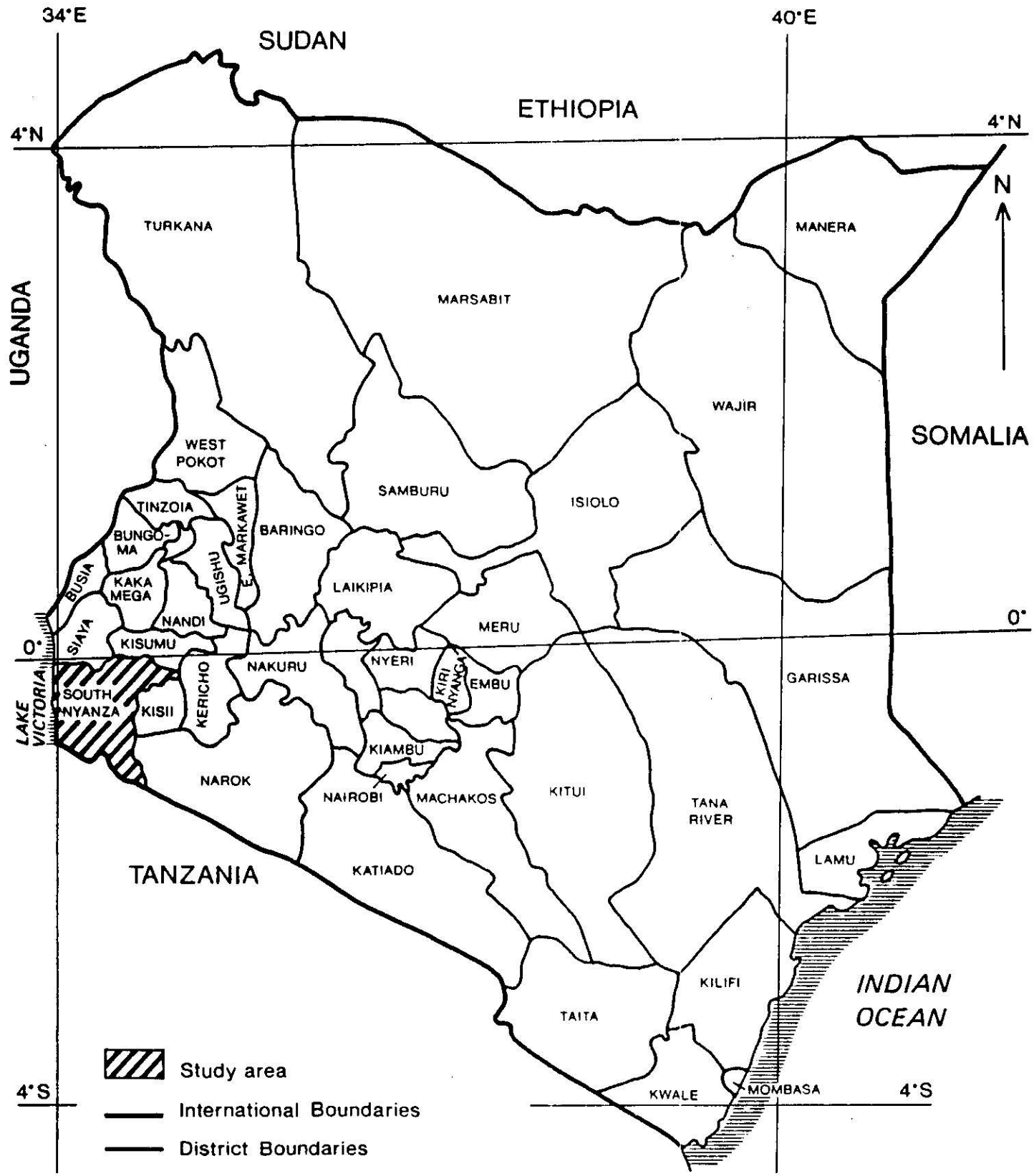
The study shows that of all the productive resources available in the study area, capital is the most limiting resource, while labour is the most abundant resource.

Tobacco production gives the best returns on capital while fuelwood gives the best results on labour. The maximal net revenue and the optimal land allocation is obtained when the above two resources are allocated in such a way that tobacco production uses both labour and capital intensively while fuelwood uses labour extensively.

With the prevailing conditions of the resources availability in the study area, it is possible to produce fuelwood in all the area left over from the maize and tobacco productions, especially when a maximum ceiling is put on the tobacco crop.

No significant competition for land use was observed amongst the three crops.

MAP NO.1 KENYA: ADMINISTRATIVE DISTRICTS; ALSO SHOWING ITS POSITION



Source: South Nyanza District development plan 1983/88
Government Printer - Nairobi

ACKNOWLEDGEMENTS

I am deeply indebted to many people for parts they played in making this thesis a reality. My deepest gratitude goes to my wife, Martabel, and our children, Roxventa and Clifford, who endured the many days and nights, of the two years I was away from home, in Finland, without the loving tenderness of a husband and father respectively.

I wish to acknowledge, especially, the assistance and constant guidance of my supervisor, professor Matti Keltikangas, and my teacher, professor Päiviö Riihinen.

The following people granted me opportunity for fruitful discussion: Prof. Openshaw of Energy initiatives for Africa, Dr. Hossier of Beijer Institute, Mr. Hoekstra of ICRAF and Mrs. Anna-Leena Simula, formerly of Forest department, Nairobi.

During my data collection trip, back in Kenya, Mr. Kaloki and other staff members of BAT (K) Ltd, gave me a lot of assistance in making the data collection process go on smoothly. I herein register my thanks to all tobacco farmers in South Nyanza who were my source of data.

I am grateful to the government of Kenya, which through the Ministry of Environment and Natural Resources (Forest Department), gave me a study leave. I appreciate the kindness of the government of Finland, through FINNIDA, which offered, through the government of Kenya, a scholarship.

My thanks also go to Mrs. Leena Iisalo for typing the manuscript.

To all those whose names do not appear here but gave me assistance, I sincerely say "Thank you all".

Lastly, all those inadequancies and/or excesses hereafter remain the responsibility of the author.

Helsinki, Autumn, 1985

Paul Othim Ongugo

LIST OF TABLES

LIST OF FIGURES/MAPS

LIST OF APPENDICES

LIST OF SYMBOLS

BAT (K) Ltd.	An abbreviation for British American Tobacco in Kenya. It is a limited company.
FINNIDA	An abbreviation for Finnish International Development Agency.
KGGU	An abbreviation for Kenya Grain Growers Union.
Kshs.	Kenyan Shillings. One Kenyan shilling contains one hundred cents. One Finnish Mark = 2.4 Kenyan Shillings (October, 1984), alternatively, one Kenyan Shilling = 0.45 Finnish Marks (October, 1984).

TABLE OF CONTENTS

1. INTRODUCTION

1.1. General

"Forestry sometimes appears as the industry in possession and sometimes as the contendor for land used for agriculture" (McGregor 1962).

In most countries, developed and developing, but more so in the latter, as a result of production growth on constant land areas, and, also due to the differential productivity capacities of different land types and sites, in these areas, less and less or poorer and poorer land is being allocated for forestry development in monocultures, or plantation forestry. It has been stated that, naturally, as man requires food to live, and also due to the fact that economic efficiency is applied in resource allocation, agriculture would have an upper hand in allocative or productive land resources (Barlowe 1962). Apart from the population pressure, Arnold (1978) and McGregor (1962), point out that in any country, land tenure system used has a direct bearing on its land use.

The repercussions of the recent petroleum price-hikes have created a new awareness of the importance of energy for sustained economic and social activities. Such awareness has resulted into the development of energy forests, e.g. in Sweden and Finland, rural afforestation or community forests, as in many developing countries e.g. India, Kenya, South Korea etc.; and the introduction of improved jikos and woodcookstoves (e.g. in Kenya).

For the developing countries, particularly, this awareness has brought attention to the crucial role played by fuelwood (woodfuel, when charcoal is included), in supplying the energy requirements of the rural households, and to some extent, the urban poor.

High levels of fuelwood consumption, though have been linked to deforestation (Digernes 1979), soil erosion (Ekholm 1975),

increased stress on rural women (Fleuret and Fleuret 1979), and increased inequality among inhabitants of rural areas (Reddy 1980).

The major factor affecting forestry and agriculture, resulting into their co-existence being referred to as a competition, is the lack of sound and proper resource allocation, which ensures the optimal production of both the agricultural and forestry products; as it is argued that one cannot be divorced from each other, but must complement each other's existence.

Without endeavoring to list the benefits of each sector, for food is necessary for the sustenance of the human life, and trees are necessary for the continuous and optimal food production. These facts have now been developed to include the system of land use referred to as agroforestry (King 1980, Lundgren 1980).

This interaction can be further underscored by the fact that, in many developing countries, and so, especially in the rural areas, possessing food alone, may not ensure that the food will be eaten (Sanwa 1981). People with food cannot cook it due to lack of fuelwood, the main, and sometimes the only source of energy for cooking and heating in these areas.

Forestry and wood economy in general, when considered with small scale wood processing industries, can be a major driving force in bringing about the development of neglected areas (Riihinen 1980, King 1980, Westoby 1962, and 1969). The Food and Agricultural Organization of the united Nations has undertaken this task in such areas as the Philippines and South Korea (FAO case studies 1979). This has also been done in India and Nigeria (Bon Voisin 1982 and Adeyoju 1975, respectively). Mnzava (1981) also stresses this approach for the savanna areas of Tanzania.

The forestry sector provides both forward and backward linkages in industrial development. Also, through the creation of

supporting services, and commercial activities, an investment in rural afforestation is likely to result into an impact on the local economy (Arnold 1978, the World Bank 1978).

1.2. The case of Kenya

Kenya's main development goal in her 4th development plan, 1979/83, was attacking poverty (Kenyan Government 1979), and this goal has been extended into her 5th development plan 1983/88, whose theme is "mobilising locally available resources for equitable development (Kenyan Government 1983). This is to be effected through the new approach to rural development, an approach devised to avoid the urban biased planning which had earlier been prevelent, "the district focus for rural development" (Kenyan Government 1983).

The major constraints to forestry development in rural areas, which is a major driving force in the above goals, are among others, the shortage of land, and the time taken by the forest tree crop to bring returns on investment on an area of land. A small scale farmer has to compare between the present consumption and a deferred consumption when he is deciding on whether to invest in forestry (long term), or in agriculture (short term). (Keltikangas 1969, 1971).

Due to the nature of subsistence farming, the one practiced by the majority of the farmers in this country, this constitutes a major problem. This being so, it is possible to complement the long period of time involved in forestry production with the short period of time involved in agricultural production. Development of the forestry sector as a result of this complementary relationship would help drive the wheels of the rural development machine.

1.3. Literature on rural energy problems

The literature on the rural energy problems in developing countries has been written from three subjective framworks, viz.:

- wood supply/demand situation
- energy supply/demand and
- energy ecosystems.

Writers have focused on single villages, multivillages and regional/national perspectives. There has been a general lack of objectivity, since recommendations have been made, and remedies to the acute rural energy scarcity have been suggested, but these have fallen short of giving exact details as to how the fuelwood, or energy supply for the rural households, and rural areas in general, can be met at the farm household level. This can be observed from different works by the following writers:

These writers who have adressed themselves to the problems of rural energy supply and their consequences, have based their undertakings and/or findings on the work pioneered by the Food and Agricultural Organization (FAO) of the United Nations organization (UNO). These people have done their research work mainly based on the role of wood in the rural economy, in Sudan, Tanzania, Nigeria, India, Nepal, South Africa and Kenya.

Digerness (1977, 1979), documented the pattern of woodfuel (fuelwood and charcoal), use for the village of Bara in Sudan. She argued that excessive reliance on woodfuel resources by the rapidly increasing population of Bara was leading to deforestation, which accelerated desertification, and further decreased potential biomass production. She determined the per caput consumption of fuelwood for the area as 1.3 cubic meters.

Best (1979) carried out thorough rural energy studies. He examined woodfuel, dung and paraffin consumption in three villages in Southern Africa: Malebilbane, Jozahna's Neck and

Mashunka. His results showed that the women of the area spent between eleven and fifteen hours per week collecting fuelwood. He also recorded a marked seasonal pattern in woodfuel consumption. Best's results demonstrated that the availability of fuelwood is a key factor influencing its consumption.

Reddy et al. (1980), provides an example of a multivillage study undertaken from an ecosystem perspective. His results, from a study of energy flows in six south Indian villages showed that firewood (fuelwood) supplied 80 % of the useful energy, but because households collect wood in the form of twigs and branches, fuelwood consumption, according to his findings, did not contribute to deforestation and ensuing soil erosion. This is a case of a study undertaken in an area where there is still a dense to sparse density of the natural forest cover, an area which has not yet experienced the fuelwood shortage syndrome.

Vanhelder (1982) also talked of fuelwood supply from outside the forest areas in the Kenyan highlands. He stressed the fact that most of the fuelwood used in these areas are not from the forests but from the farms.

A more detailed discussion of one village (Ravidranath et al. 1980, Reddy 1980), points to the importance of pastureland in the village ecosystem. The authors point out that agriculture produces only 28 % more biomass than grassland.

Reddy further argues that the solution to the rural energy problem lies in the identification of new alternatives that are accessible to the bulk of the rural population, not just replacement of fuelwood by paraffin, liquid petroleum gas or electricity. A study carried out by French (1980), in India confirmed the impracticability, basing on cost-benefit analysis, of replacing fuelwood with biogas as rural energy supply.

The consumption of fuelwood, or any other fuel, depends on its availability. This has been stated by Earl in 1975. The author carried out a study using the hill people that had seen settled

in the Terai District of Nepal.

Due to its bulkiness, fuelwood may be replaced by charcoal if the distance travelled to collect it becomes long enough (Digernes 1979, Wood et al. 1979). Hoskins (1979) studied the changes in diet to suit the fuelwood availability.

As incomes increase, energy consumption increases (Openshaw 1978). He noted that rural households increase wood consumption as incomes increase, but while supplies are available, they generally do not switch to charcoal consumption. Cecelski et al. (1979) note that energy consumption rises by slightly less than the rise in income. Another interesting observation to add in this respect, is that energy consumption among the poor in urban areas is lower than among the poor in rural areas; this has also been noted by Cecelski et al. (1979). This interesting phenomenon can be explained by two factors:

- The urban poor are extremely poor, and in most cases, are very much poorer than the rural poor; this is true in developing countries' situation, e.g. the case of the "shanti" dwellers found along the Nairobi river valley - Kenya.

- Fuelwood is more easily available, in relative terms, in rural areas, than in urban areas.

Substitution of energy sources occurs primarily because of scarcity of income. When fuelwood becomes increasingly scarce, not only is it used more sparingly, but greater quantities of alternative fuels are consumed. these alternative fuels may be either traditional or commercial in nature. For many rural households, crop residues, plant stalks, and dung serve as the primary alternatives because of limited access to more technologically sophisticated fuels (Wood et al.). When given an increase in income, many households will consume less traditional fuels due to appliance purchases, labour savings and propensity to consume fuels of higher level of sophistication (Openshaw 1978, Briscoe 1979).

Household size influences household and per capita energy consumption levels. Openshaw (1980a), noted from the work of Bialy (1979) and Mwaipopo (1977); both of whom found a high correlation (R^2 = 80 %), between household size and total woodfuel consumption. Arnold (1980) and Maniboy (1979), also found that household size correlates strongly with fuelwood consumption. Fleuret (1978), working in Tanzania, confirmed that while a large household may consume more total energy, than a small household, its per capita consumption may also be lower than that of a smaller household.

Temu (1979), studied fuelwood and other related problems associated with tobacco production in Tabora region, Tanzania. He discussed the effect, which he termed disastrous, which results from the overexploitation of the miombo woodland (indigenous) wood resources.

Among his recommendations for the alleviation of the problem are:

- employment of more efficient wood burning methods in the tobacco curing process

- intensification of the reafforestation of the areas which have been overexploited and made bare of tree resources

- employment of the multidisciplinary approach in the use of the areas' resources.

Mungala (1978), carried out a study on the estimation of the present and future demand for woodfuel in Machakos District, Kenya. He found out that there was no significant difference in household fuelwood consumption between wood rich and wood poor areas, but there was a significant difference between rural and urban areas. He estimated the annual per capita fuelwood consumption in the area to be 1.3 m^3. He further noted a shortfall in the

supply of fuelwood in the area basing on the available supply, growing stock, and annual increment, taking into consideration the above per caput consumption.

Among his suggestions and recommendations for the alteration of the imminent shortfall were:

- intensification of the afforestation programmes in the area,

- improvement on the design of the traditional and otherwise wood burning stoves and "jikos", and

- establishment of village woodlots.

1.4. The study problem

As it can be derived from the above discussion, there is a problem which calls for ways and means through which it should be tackled. This problem of fuelwood supply vis-a-vis the need for food and cash income is looked at both in a wider context, the national level and at the farm level but for the purpose of pinning down this problem, one local setting has been chosen, that is South Nyanza District.

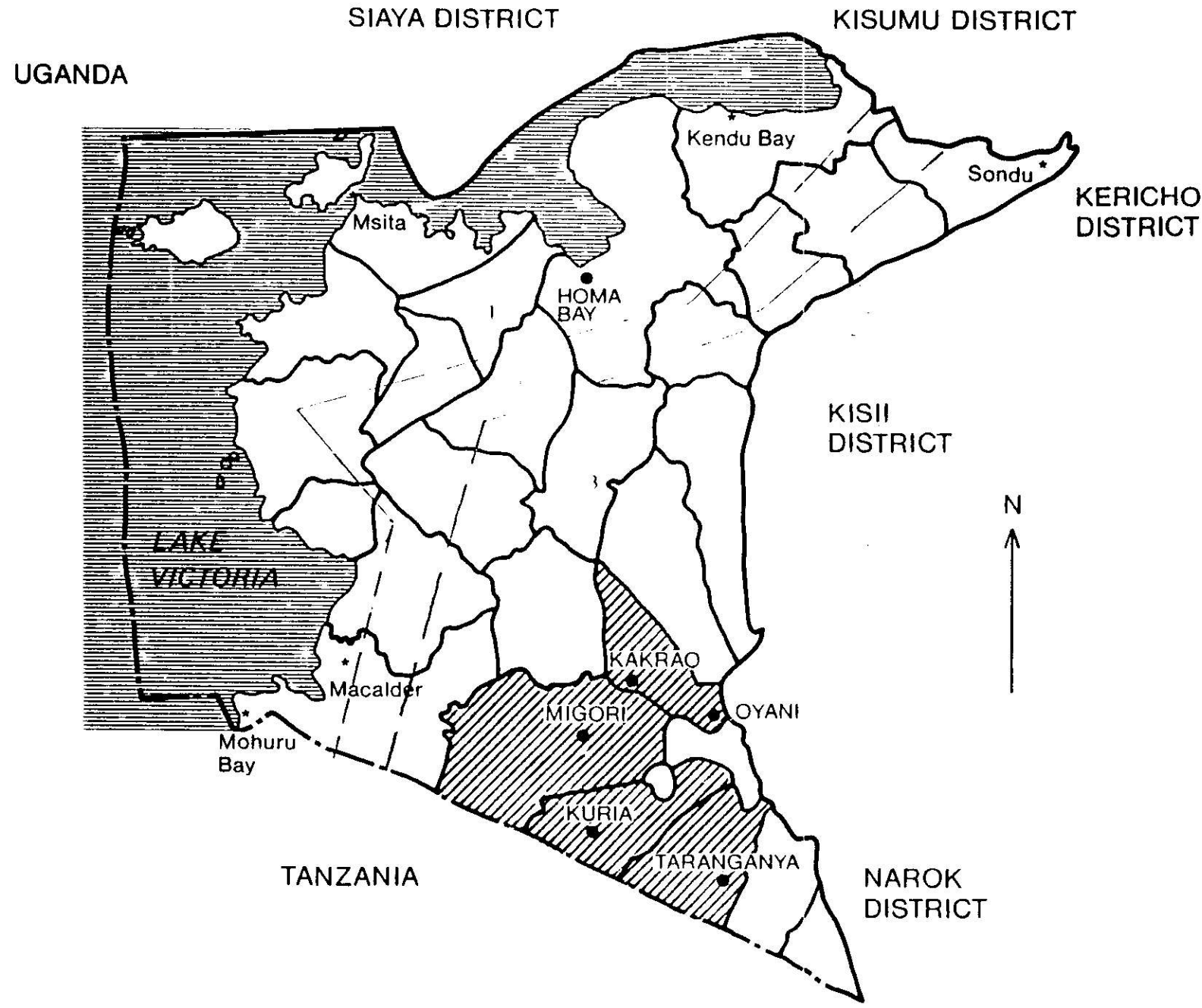
The problem will therefore be discussed in the frames of an actual situation and within a restricted area.

South Nyanza District is found in the south western part of Kenya. The district is bordered by Tanzania to the south, Uganda to the west; it also borders Kisumu, Kisii, Kericho and Narok districts of Kenya. Currently, the district is divided into forty six locations administratively. Politically, the district is divided into seven constituencies (see map No. 1).

Climatically, the district can be divided into three zones,

the upper zone, the middle and the lower zones, according to altitude. The upper zone comprises of the highlands and the lower zone slopes gently until it reaches the lake. The study areas are located on the upper zone (see map No. 2).

MAP NO. 2 SOUTH NYANZA DISTRICT
LOCATION OF THE STUDY AREAS



International boundary
District boundary
Locational boundaries
Study locations
Water of Lake Victoria

1 -Lowlands
2 -Midlands
3 -Highlands

1.5. Study objectives and aims

The purpose of this paper is to study, both theoretically and within an empirical data

> whether it is possible to increase the production of fuelwood in small scale farms without lowering the production of food and cash crops.

The major tenets of the study are that fuelwood production is a necessity just as much as food and cash production, and even to an extent to which its availability could help in assisting the upgrading of the standards of services in the area.

2. BACKGROUND INFORMATION

2.1. General

Out of Kenya's total area of 583 000 km^2 (58.3 million hectares), 13 396 km^2 (1.3 million hectares), is water. 1.4 million hectares, or 2.4 %, is covered by forests (Openshaw 1982, Mathenge 1984, Kenyan Government 1984).

Natural forests cover 1.2 million hectares, and planted forests (man made), 0.2 million hectares, the rest is bushes and scrubland (Openshaw 1982). Woodlots, which are of importance in this thesis, occupy an area of 0.02 million hectares, or 10 % of the total area of the man made forests.

The current growing stock of the forests are 46 690 000 cubic meters, for the planted forests, and 157 252 000 cubic meters, for the natural forests, while the estimated yields are respectively, 1 821 800 cubic meters and 4 609 600 cubic meters.

Kenya can fulfill her industrial wood requirements till the year 2015, after which a deficit is envisaged (Omwami 1983). O'Keefe (1984), estimated a total shortfall in supply/demand for wood, resources as 0.08 million tonnes by 1980, climbing steadily to 6.07 million tonnes by the year 2000. Of this shortfall, the most serious is for fuelwood, which he puts at 5.4 million tonnes, now (1985) climbing to 30.6 million tonnes by the year 2000. It can therefore be seen that fuelwood demand/supply differential is most critical (see table 2.1 and figure 2.1).

Table 2.1. National wood resource supply/demand relationship in Kenya (Millions of tonnes).

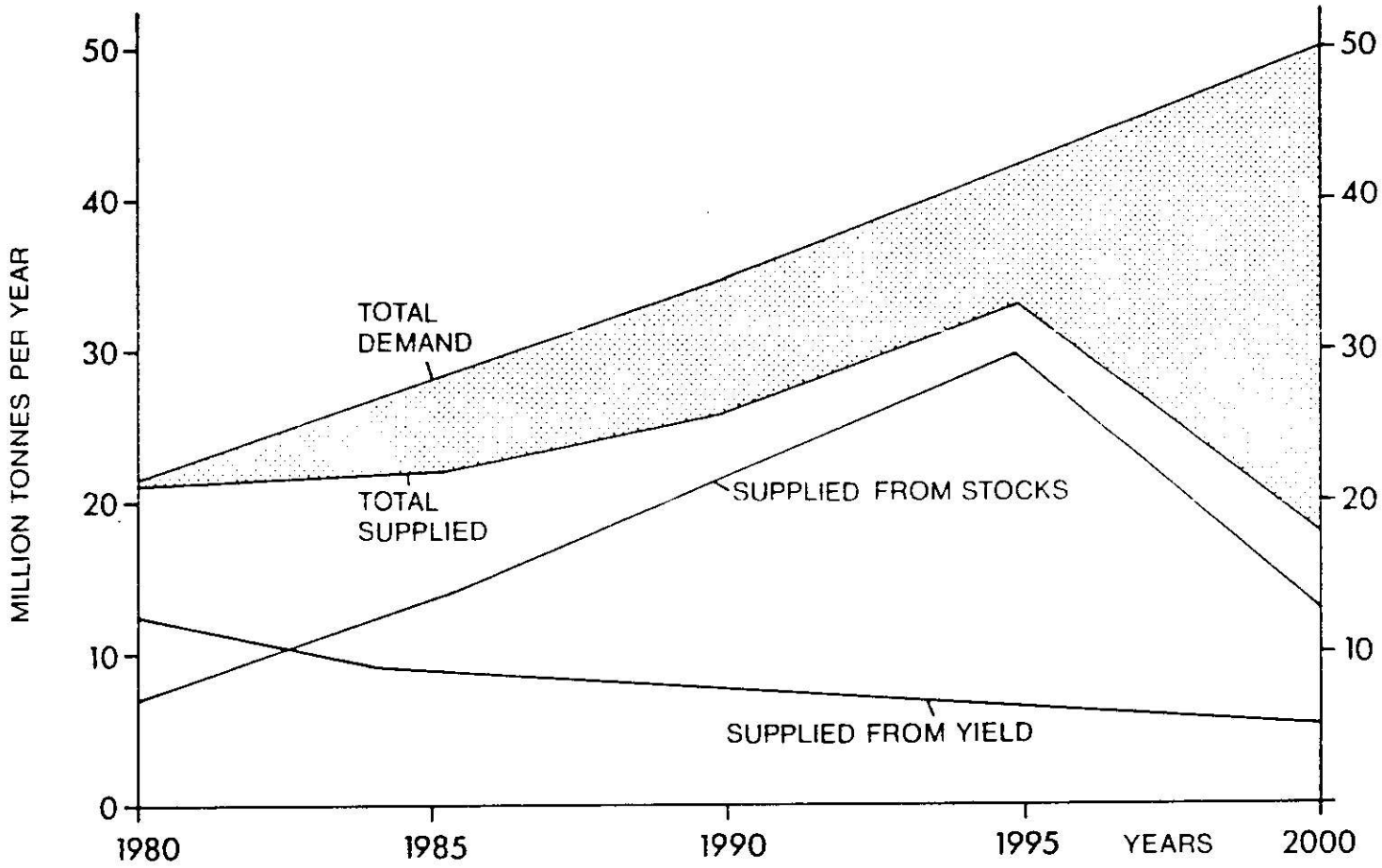
	1980	1985	1990	1995	2000
Demand	20.41	26.42	32.37	41.04	49.74
Supplied					
From yields[x]	11.07	9.41	8.06	6.29	4.97
From stocks[+]	9.26	10.94	13.51	21.62	12.16
Shortfall	0.08	6.07	10.80	13.13	32.61
Standing stock	934.82	885.41	829.36	744.49	674.40

[x]Yields: Net annual production. Only accessible yields service demand.

[+]Stocks: Net reduction in accessible standing stocks service demand when demand exceeds accessible yields.

Source: Energy and Development in Kenya; opportunities and

FIGURE 2.1 NATIONAL WOOD DEMAND AND SUPPLY 1980 AND PROJECTIONS TILL THE YEAR 2000



SOURCE: ENERGY AND DEVELOPMENT IN KENYA

2.2. The Kenyan economy

The Kenyan economy is dominated by agricultural activities, including production of agricultural crops, livestock, forestry, and fishing. It is estimated that the small scale peasant farming sector accounts for about 70 % of the total national population, while about 12 % are nomadic pastoralists (Economic Survey 1984). This thesis focuses on the group forming the 70 %.

1980 energy consumption figures (see table 2.2; Fig. 2.2) in Kenya by the rural population equalled 173 million gigajoules. This is more than half of the total energy resource end use consumption, a level considerably grater than that of any other sector. The rural household sector accounted for 15 million gigajoules of final fuelwood consumption, or, about three quarters of the national total. It is interesting to recall that out of the total Kenyan population of about 18 million people, growing at about 3.9 % per annum, 85 % still live in the rural areas, and these occupy only about 17 % of the total land surface.

In the last 21 years, Kenya has made significant advances in economic development. As indicated in table 2.2 c, real GDP has grown at an average annual rate of 4.9 % (1970 -1 980) (Kenya Economic Survey 1981). In current prices, most sectors grew during the same period at rates of 9 - 17 % per annum. The value of both imports and exports has increased fourfold during the period 1970 - 1979, and thus, the trade balance deficit has also increased by the same amount, from K 49.2 million to K 206.9 million (see table 2.2 and figure 2.2).

Table 2.2. Provincial and national wood supply and demand (million tonnes) 1980.

Source of demand	Central/ Nairobi	Coast	Eastern	North-Eastern	Nyanza	Rift Valley	Western	Total
Local wood fuel demand	2.46	1.94	3.11	0.48	2.51	3.94	1.98	-
Wood fuel demand, other regions	-	-	0.94	0.06	-	1.91	0.30	-
Subtotal woodfuel demand	2.46	1.94	4.06	0.54	2.51	5.85	2.28	19.64
Feedstock demand	0.18	0.01	0.03	-	-	0.51	0.04	0.77
Total demand	2.64	1.95	4.09	0.54	2.51	6.36	2.32	20.41
Source of supply								
Sustainable supply	0.99	1.62	3.06	0.54	0.387	4.17	0.31	11.07
Supply from stocks	1.63	0.33	1.02	-	2.13	2.14	2.00	9.26
Total supply	2.62	1.95	4.08	0.54	2.51	6.31	2.31	20.33
Shortfall	0.02	-	-	-	-	0.05	-	0.08

Source: Energy and Development in Kenya; Opportunities and Constraints.

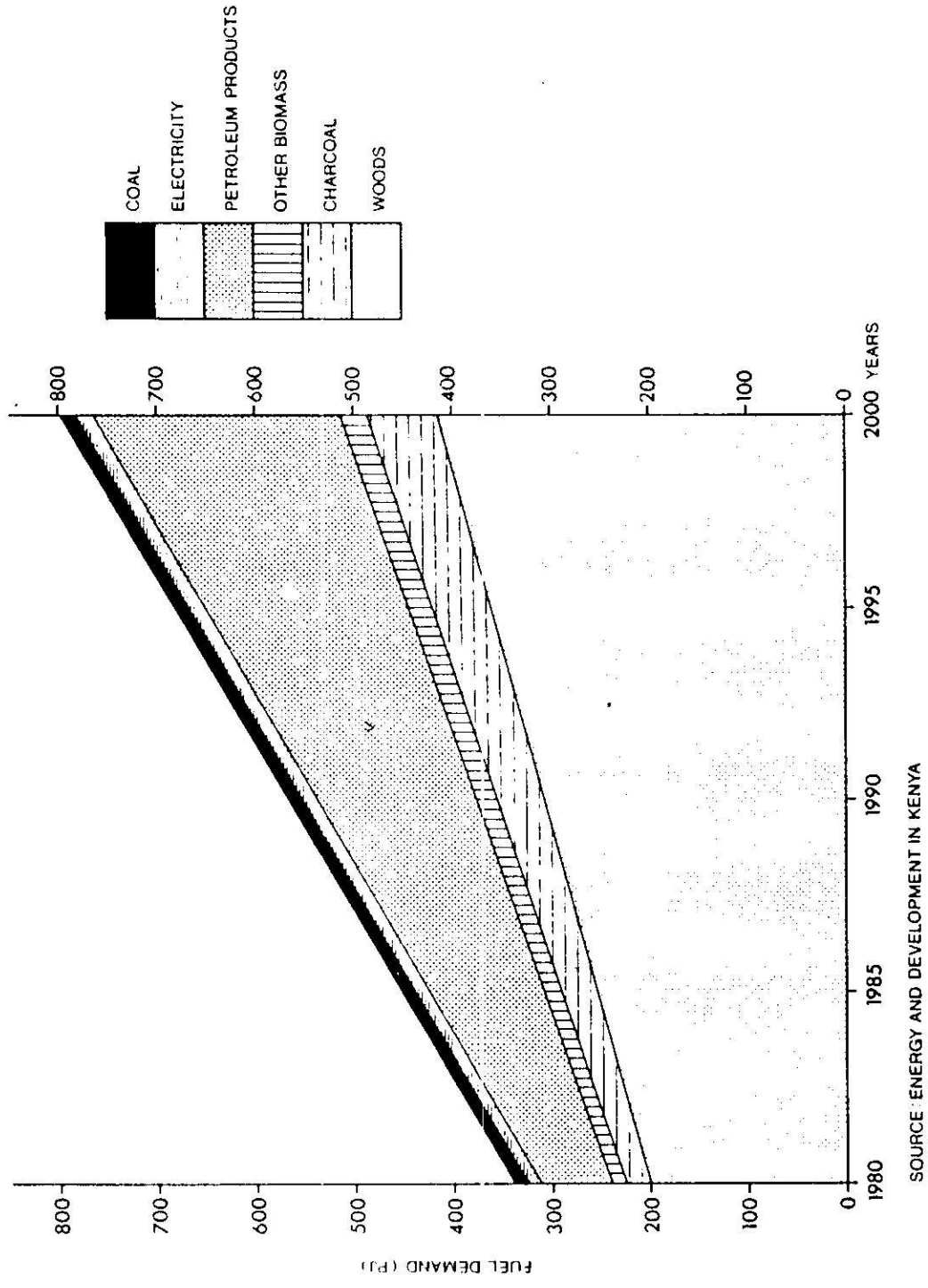


FIGURE 2.2 FORECAST OF END-USE FUEL CONSUMPTION; 1980-2000

SOURCE: ENERGY AND DEVELOPMENT IN KENYA

One major component of this change has been fuel and lubricants imports, which have increased tenfold in value, and from a tenth of total imports in 1970 to a quarter in 1979. At the same time, keydebt service indicators have remained reltively stable. Debt services as a percentage of GNP changed from 2.6 % in 1970 to 2.4 % in 1978, and as a percentage of exports, from 7.9 to 8.3 % (Economic Survey 1981).

Energy related issues, therefore, are significant. As the modern sector has grown, so has commercial energy requirements, too, both for the heavy and the light industries.

As the cost of petroleum and petroleum products price have increased, similarly, the cost of other imports required for development, including machinery and transport equipment, and also, of intermediate goods. On the other hand, increasing quantities of energy and capital inputs are important components of development. Additionally, both the rapid increase in population growth and urbanization, at the rates respectively, of 3.9 % and 7.0 %, per annum, in the last decade, poses some problems and challenges to the Kenyan economy, where stabilization and diversification of the rural economy, expanded food production, and improved conditions of life for the rural population, are desired.

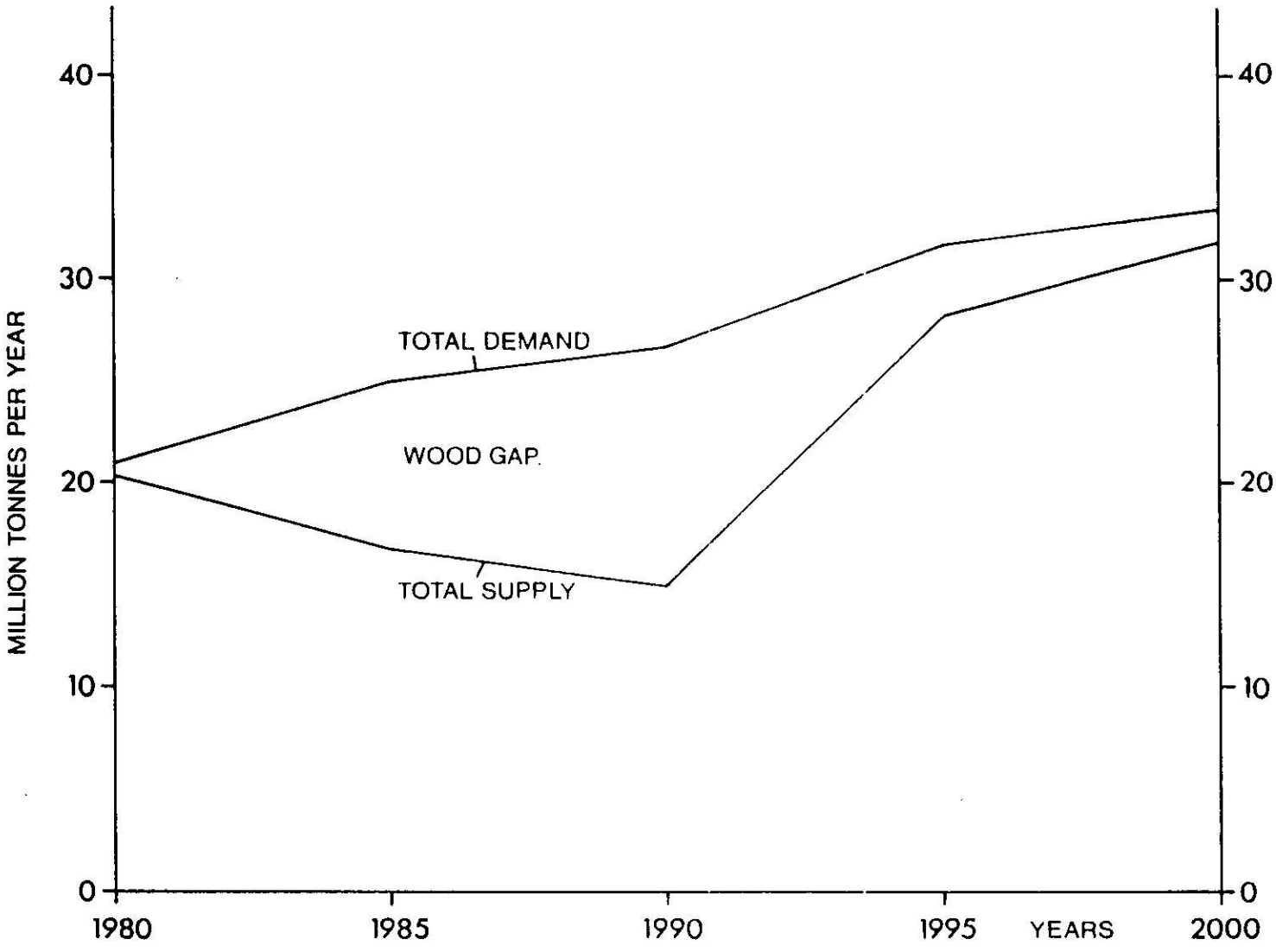
2.2.1. The forestry sector

The major objectives of the Kenyan forestry sector are stipulated in two documents, viz.; sessicnal paper number 1 of 1968, which emphasized the development of forest estates, and the protection of the already existing indineneous forests; the proposed National Forest policy paper of 1982, which in addition to the tenets of the 1968 sessional paper, has recognized the need to promote all types of forestry, thus, forest estates, forestry on

trust lands, forestry on private lands, and tree planting by individuals (Government of Kenya 1968, 1982, 1984). The major constraint which will be met during the implementation of the 1982 policy paper (forestry sector), is the competition for the use of the limited land resources (only 17 % of the total Kenya's land area is suitable for both agriculture and forestry), for agriculture and other land uses, particularly, forestry (Government of Kenya 1984, O'Keefe 1982).

Consumption of forest products has on average, been rising in response to the economic transformation which entails development; among other things, increasing construction activities, energy consumption and communication needs. Fuelwood consumption, for instance, increased by 13 % in 1983 over the 1982 figures, while the consumption of industrial wood (sawn timber), increased by 49 % over the same period (Kenyan Government 1984). Fuelwood consumption in Kenya was earlier (1975) estimated to be between 1.0 m^3 and 2.0 m^3 per caput per annum. At the same time, a growth of fuelwood supply at the rate of 2 % suggested that consumption exceeded annual production by the early 1970's, but this was not noticed. Currently, a big gab (see figure 2.2.1.) exists between supply and demand, and the closure of this gap is both an academic and policy problem.

FIGURE 2.2.1 CLOSING THE WOOD GAP WOOD SUPPLY AND DEMAND



SOURCE: ADAPTED FROM ENERGY AND DEVELOPMENT IN KENIA OPPORTUNITIES AND CONSTRAINTS (1984). BEIJER INSTITUTE

2.2.2. The agricultural sector

One of the main objectives on Kenya's development policy during the course of the next decade will be to meet an ever increasing demand for food, stemming from a rapidly expanding population and rising per caput income (Kenyan Government 1981). The agricultural sector continues to be the dominant sector of the economy, contributing more than one third of the total GDP, and employing more than three quarters of the total labour force. Hence, it plays a leading role in Kenya's development. Nearly, all the nations' food requirements will need to be met from domestic production. In 1984 alone, the country imported food valued at about 600 million Kenya shillings.

In addition, the agricultural sector must continue to generate foreign exchange earnings (the sector accounts for about 67 %), to pay for oil, capital equipment and other imports, and at the same time, it must continue to be the major source of new jobs for the rapidly growing labour force.

To return to a position of self-sufficiency in food production (maize) by 1989, production capacity will need to be expanded by at least 4 - 9 % per annum (Kenyan Government 1981); though the expansion of food production has been at the rate of about 2 %.

This expansion has been achieved at the expense of widespread soil erosion, depletion of the nutrient content of the soils and the destruction of indigeneous forests.

The rapid expansion of the population and shortage of unexploited, or the occurrance of poorly utilized arable land, in the main high potential areas, are beginning to expose a potentially dangerous imbalance in the relationship between the national supply and demand for food. This, apart from threatening the sustenance of the

wood economy, is currently undermining the significance of the cash crop production to the country's economy and well-being. This questioning of the trade off between export oriented crop production and food crop production has led to what the author would like to refer to as "the opportunity cost of dying gimmick".

2.3. Forestry and the tobacco industry

The tobacco industry provides an example of land use involving the integration of forestry and agriculture. The tobacco leaves, which are harvested from the tobacco plant (an agriculture crop), must be cured; a process which involves drying, decomposition of chlorophyll until the green colour disappears from the leaves, changes in the nitrogen compounds including the release of ammonia, hydrolysis of starch into sugars, involves the use of fuelwood produced from trees (forest crop); before the leaves are baled and sold to the British-American Tobacco (Kenya limited) company; which is the sole dealer of tobacco in the country.

To cure (a drying process) one tonne of tobacco requires 20 tonnes of fuelwood (BAT/University of Nairobi 1982), though this figure is now much less due to the improvements of the furnace design (Openshaw, Kaloki, personal communications, 1984), this is an equivalent of one hectare of tobacco to one hectare of fuelwood (Mnzava 1981, Temu 1979).

Research and studies on production costs at the farm level has proved that fuelwood is still the most efficient and cheapest energy source for curing tobacco in Kenya (G.T.Z., 1984). The use of the other energy sources, e.g. electricity and petroleum products, is limited by costs, supply regularity and transportation means, as tobacco is produced in the rural areas which are not yet

connected to the national supply grid, and not easy to reach respectively. Technological capacity of the farmers limits the use of such energy sources as coal, biogas, solar, wind and thermal, most of which have not been adequately, at the farm level, facilitated in the country. The use of these, particularly, solar energy, would require back-up systems, the acquirement of which, would need the use of foreign exchange, which is scarce, since tobacco curing is a continuous process.

2.4. The case of South Nyanza

About fifty to one hundred years ago, South Nyanza was densely covered by indigeneous forest. The last traces of these large expanses of forests could be seen till the nineteen fifties. Until late sixtees, scattered forests could be found in some unprotected areas. These are nowadays only available in small protected areas.

The disappearance of the indigeneous tree cover in this area has come about due to the population increase, which has also come with it, the greater requirement for food, grazing land, etc. Due to the introduction of the money economy, activities such as brick making, fish drying, pottery, and, later on, tobacco drying, have resulted into further depletion of the sparsely available natural wood resources. This has been coupled with the demand for firewood for cooking and heating, and poles for construction.

As presently, the demand for wood generally, and fuelwood particularly, in the district, has outstripped the supply to such an extent that wood for construction (including poles) has to be transported from other areas, and fuelwood, for cooking and heating purposes, has to be replaced by dung and crop residues (lakeshore areas). This act deprives the agricultural crops of the mineral

nutrients they require, to such an extent that production has been lowered by at least 50 % (Kenyan Government 1984).

It has been calculated that South Nyanza uses 6 % of the total wood used in the country. Its population grows at the rate of 4 %, and hence the fuelwood, or generally, wood production must grow by at least 4 %, fuelwood being the only source of energy for cooking and heating in this area. It was estimated that by 1980, the district required 1 065 million cubic metres of fuelwood. It has been estimated that to meet the raising demand for fuelwood in the district, 10 000 hectares of Eucalyptus, yielding 120 m^3 of wood per hectare after six years of planting is required by the year 2000. The problem is how this target is to be reached maintaining the nutritional status of the people of this area and, at the same time, making them have their welfare raised through investment process.

3. METHODOLOGY

3.1. Conceptual framework

This study conceives that the Kenyan farming system in question, taken to include tree growing for both fuelwood and other household purposes, has not yet been considered adequately as a business enterprise. This can be attributed to the subsistence nature of the practice, even though this may also not be qualified since even subsistence under the current farming practices may not be guaranteed.

Subsistence (small scale rural based) farmers have a very short time preference, and this has the greatest single influence on their decision making process; when a decision is to be made between growing maize and trees, the growing of maize, which is the main food crop, will always take preference over the growing of trees. A decision involving the production of either tobacco or maize, usually results in the former being chosen due to the substantial cash return which accrues from it; and in this case, the farmers usually forget to consider the fact that they need to be, first of all, self sufficient in food supply, since even when cash is available, food to be purchased with the cash may not be obtainable.

Apart from the aforesaid, it is argued that subsistence farming practice is considered as a family affair. The farm-household uses its meager resources to make a living, and at the same time, obtain a cash return, which it requires for its purchases, and especially, education of its children.

Due to the fact that this is a family undertaking, which is aimed at giving both a living and services, there are usually shortages of, especially, capital, labour, and in some cases, land.

In the study area, labour and capital were found to be the most limiting, and in some cases, land was also found to be a limiting production factor.

The study, therefore does the following:

1) From the input/output data obtained, the study considers the production as it is, per farm and per crop; and this is compared as per farm size.

2) Production from each crop is varied so as to arrive at the maximal production level, after which,

3) a model for the optimal production of one crop, fuelwood, is suggested to be undertaken so as to end up with enough fuelwood (wood crop), for rural development options.

There are major concepts which this study addresses itself to. One is that even though cash economy is important in the farm business undertaking, this should not neglect the fact that food is of an immense importance, since its inavailability cannot always be overcome by the availability of cash. The study has developed a contemporary statement, it is referred to as the opportunity cost of dying. This economic fact has been lightly dealt with in the field of life insurance. Mishan (1971), has dealt with this topic fairly in detail, as it concerns cost-benefit analysis of projects, but he comments that - "the amount of insurance a man takes out may be interpreted as a reflection, inter alia, of his concern for his family and dependants, but hardly as an index of the value he sets on his own life." He further concludes that "For it would not surprise us to discover that, in ordinary circumstances, no sum of money is large enough to compensate a man for the loss of his life".

What the above argument underscores is the importance of

food and hence life. Food sufficiency for the household members is important, and therefore, the importance of maintaining food production at a level which ensures self sufficiency. Forestry, fuelwood production enhances this, while tobacco production, to a certain extent, undermines this, and this is so with many cash crops produced in the developing economies today.

The second concept is that of rural development. Development is taken here to include all those activities which result into an added positive welfare situation of the people of an area; without making other people worse off. Growth, a necessary condition for development, depends on two things: the extra output obtained from scarce resources such as capital, and the economy's capacity to save the incomes paid to the producers of such output, thereby permitting further capital accumulation. High yields on capital, unless saved, are a once-and-for-all boost to incomes and do nothing for sustained growth; this is the nature of farm investment. Low yields, saved to permit more investment, may mean less "efficiency" now, but much more growth later; this is the nature of industrial investment.

The contention of this study is that, since a small scale farmer is a subsistence producer, he must aim at satisfying his food demands. At the same time, he cannot afford to neglect his development; hence his indulgence with the cash crop production. The question is, how do we marry the two production aims; so as to end with growth, and therefore, development? Here is where the importance of fuelwood production becomes critical, as the energy and raw material for a rural based industrial development undertaking.

If we take L to be land, H to be labour, and C to be capital available to the household; and we at the same time, take Z to be maize (food crop), T, to be tobacco (cash crop), and E to be eucalyptus woodlot (industrial raw material/energy supply

source);
then, certain proportions of L, M and C can be combined so as to end up with certain proportions of Z, T and E, the latter being the ingredients necessary for growth and hence development to be attained.

Thus $xL + yM + zC \longrightarrow mZ + nT + pE$

The above would result into a positive increment in the welfare of the household, as is currently the case in the study area.

The problem which is faced is how these resources, land, labour, and capital, can be utilized optimally so that these can result into the above condition, which can further be indicated for the improvement of the welfare state of the household as:

$$xL + yM + zC \longrightarrow mZ + nT + pE \longrightarrow + W_h$$

Where W_h is the positive nature of the resulting welfare state of the household.

After achieving the above, further economic problem should be the strive to make the above the globally obtainable optimum condition.

3.2. Resource allocation models

3.2.1. General

Production factors, or resources, are always scarce and are therefore, in short supply. The shortage is usually experienced, in the case of small scale farmers, in two ways:

Firstly, the scarcity is in the industry as a whole, e.g. the availability of labour and land. Secondly, the scarcity of capital and personnel, which normally effects the individual farmer, or farm household.

Due to the fact that human wants are abundant, and resources are scarce, the main objective of the economic theory is to allocate the scarce resources in such a way that maximum satisfaction is obtained - this can be referred to as the efficiency factor in resource allocation theory.

For the allocation of resources, many methods have been developed. But, for the subsistence farmers, with no knowledge of the science of economics, the allocation is usually done through trial and error method. This trial and error method usually ends up in frustration and unrewarded efforts, as good planning is paramount to the success of any economic activity. Such frustrations have been observed in cases where, due to less efforts being devoted to the production of food crops, has resulted into food shortages in some parts of Kenya, this hunger being aggravated by the lack of fuelwood and the ensuing problems of environmental deterioration.

For a better planning and execution of the small scale farm enterprise, a resource allocation model, which is operational at the farm household level, could assist in a proper and more appropriate decision making process by the farmer.

Models are simplified representations of the reality, which are used for getting replies to questions. Thus, they permit the farmer (manager), to understand his circumstances and to influence them through his decisions. Models also help the manager to ask better questions for his analysis and decision making, and also to reformulate the purpose of his

questions. Models must be simple and operational for them to be of any use to the practicing farmer.

There are many resource allocation and decision making models and criteria respectively. Some of these, discussed in this thesis are linear programming, marginal analysis and net present worth (value), internal rate of return, respectively.

3.2.2. Linear programming

This type of resource allocation model is used when there are two or more competing activities, each of which can be operated at different scales or intensities, with restricting constraints.

Naylor and Vernon (1969) have said that "linear programming is concerned with problems involving the optimization of a linear objective function subject to a set of linear production constraints imposed on the variables of the objective function".

This type of resource allocation model has been used in many resource allocation problems, e.g. Muthoo (1970), Keipi (1977,1978). Dykstra (1984), has shown further, with illustrations, how this kind of resource allocation model can be utilized to aid in decision making.

In this thesis, both the variables and constraints have been drastically reduced both in numbers and magnitudes, for simplicity, and also to make the various factors to be taken into account in such a study managable.

The products are being considered as maize (shelled), tobacco (cured) and fuelwood (as poles); out of the array of products from the farm business. The inputs are taken to be land, labour and capital, assuming entreprenourship.

3.2.3. Marginal analysis

In this study, we consider a multiproduct, multifactor firm; which uses m factors of production to produce p different products. A generalized statement of the production function for the firm is given by

$$Q\ (Z_1, \ldots Z_p, x_1, \ldots x_n) = 0$$

where $z_k = 0$ are products ($k = 1, 2, \ldots, p$)
and

$x_i = 0$ are factors ($i = 1, 2, \ldots, m$).

The dimensions of the Z_k and the x_i are physical units per unit of time. For any given set of factors, x_1, x_2, ..., x_m, there may be several technically feasible sets of products, Z_1, Z_2, ..., Z_p.

The firm is confronted with a perfectly competitive factor input market for each of its factors of production, the total cost C_1 is expressed as a linear function of its factor input quantities:

$$C = C_1x_1 + C_2x_2 + \ldots + C_ix_i + \ldots + C_mx_m$$

where C_i denotes the unit price of the ith factor input. Under perfect competition, the C_i's are fixed and known.

Let us consider that in its production process, the firm transforms any finite number of products. The firm may purchase factors as a monopolistic or perfect competitor, and sell products as a monopolistic or perfect competitor. The factor-product transformation process for the firm is given by

$Q\ (Z_1, \ldots Z_p, x_1, \ldots x_n) = 0$, given earlier.

We say that TR denotes the firm's total revenue function and TC, its total cost equation,

then, $TR = TR(Z_1, \ldots Z_p)$
and $= TC(x_1, \ldots x_n)$

The firms total profit function is then defined as
$= TR - TC$

Since the objective of the firm is to maximize total profit subject to the technical constraints imposed by its production function, then, this is done by calculating points where marginal revenue equals marginal cost for the firm. This can be written as

$$MFC_a = MR_b \frac{dZb}{dZa}$$

where a and b are quantities of product being produced.

3.2.4. Decision making criteria

3.2.4.1. Net present worth (value)

After a farmer has determined his resource allocation, in such a way as to reach a global optimum, using the above resource allocation models, he has to make a decision on what he has to produce.

For the circumvention of this problem, the most widely used decision making criteria, among others, are the net present worth or value, and the internal rate of return.

Generally, the net present worth (value) model may be written as

$$NPV(W) = \sum_{1}^{n} B_n (1 + r)^n - \sum_{1}^{n} C_n (1 + r)^n$$

in which

B_n = total benefits in year n

C_n = total cost in year n

r = discount rate and

n = number of years involved in the production.

3.2.4.2. Internal rate of return (IRR)

The internal rate of return is that rate of interest which gives a compounded sum of expenditures equal to the compounded sum of revenues. Hence, the internal rate of return is that rate of interest which gives a net discounted revenue (NDR), equal to zero.

Generally, an economic undertaking is profitable at a given rate of interest if NDR = 0.

This statement implies that an investment is profitable when the internal rate of return exceeds the rate of interest which the invester regards as sufficient.

The use of internal rate of return is most important when carrying out a sensitivity analysis. This is an exercise which is done so as to find out how the net discounted revenue or generally, the net present value varies with different rates of interest, since the latter is not usually stable but fluctuates with the position of the economy of a country.

3.2.5. Choice of methodology

For the purposes of the study, linear programming method will be used to develop a resource allocation model.

Since the choice had to be made between linear programming and marginal analysis, linear programming has been chosen for practical reasons, since it lends itself more readily than the marginal analysis method; in such types of problems. It is also a more recent development in the field of resource allocation, than the marginal analysis method.

3.3. Materials and methods

Cash crop (tobacco), food crop (maize) and fuelwood crop (Eucalyptus spp), production and revenue data were collected from thirty households in South Nyanza District (Migori, Kakrao and Kuria areas) of Kenya during the months of September and October 1984. Selection of the thirty farm households was done randomly from a group of about 4 000 farmers.

To arrive at the sample, the following critical factors were taken as the guiding factors in the selection of the farmers.

1) They had to be small scale farmers with land areas varying from 1.0 hectares to 50.0 hectares. The higher value (50.0 ha) was used as the upper limit due to the fact that in the Kuria area, where ten farmers were selected, large areas of land still exist, while the lower limit of 1.0 hectares was used because, apart from the fact that farm sizes are very small in both Migori and Kakrao areas, the growing of tobacco (cash crop), requires that a farmer, apart from growing tobacco on an area of not less than 0.5 ha, must have an additional land for the production of fuel crops as well as the food crops

(Kaloki, Mwabire, Ogulla - personal communications 1984).

2) They had to be engaged in the production of at least the following; one food crop (maize), one cash crop (tobacco) and fuelwood crop (Eucalyptus spp).

3) The fuelwood to be considered were those planted in 1976, so that their harvesting either had been done or was just being done in 1984. This year was taken as the base year as well as the end of rotation year for the fuelwood production, of eight years. No coppices were considered. It was further assumed that thinnings were not done and the rotation age of eight years was when the first and last cuttings on the main crop was undertaken; and

4) These farms had to be accessible.

To end up with the optimal selection, based on the above critical factors, the assistance of the British-American Tobacco (BAT) staff in the study area was relied on, and hence, the farm households were selected based on guided random samples.

For the purposes of the data collection, the farmers i.e. the heads of the farm households were interviewed personally, and answers given were written down on fullscap papers. The use of the pre-prepared data collection sheets proved impossible due to the time factor, and also due to the fact that, in most cases, the farmers relied on memory, as crop production and disposition records are seldomly kept, except in the case of tobacco, and to some extent, fuelwood items, but only on seedlings acquisition for the latter.

Where the heads of the farm households could not get the correct answers, he/she consulted his/her household members.

The data collected may therefore not be exactly accurate, but are deemed authentic, and are truely representative in this area, particularly, and the Kenyan situation, generally, as far as subsistence small scale farming enterprise is concerned.

Input and output data, whose details are given later on in this section, were collected for the three crops, maize, tobacco and fuelwood. Only purchased and measurable inputs and outputs were considered, and to a greater extent, the prevailing market prices were used.

Apart from the above two vital data types, data on the following were also collected:

1) Purchase price, actual or estimated of the oxen used in ploughing and other site preparation activities, in some cases even in transportation; their approximated useful life period and their disposal price(s).

2) Purchase price, actual or estimated, of the jokes, ploughs etc., used, their years of purchase, their useful life period and, where possible, their salvage values.

3) The costs of constructing and equipping the tobacco curing barn(s) (structures), their useful life periods and their salvage values.

4) Estimated price of land for the different areas, as was given by the farm household heads, based on the most recent land sales in the area, and

5) the estimated self employment costs. That is, the farm household members were asked to tell how much, in Kenya shillings they would demand as payment if they were doing all that they were engaged in on behalf of someone else - an employer.

3.3.1. Data obtained

The following data were later extracted from the field interview notes:

a) Farm size (in hectares), crops growing in the farm (all crops), area for each crop grown (in hectares), animals (cattle) kept by the farmer (only mature cattle were considered), and land values. These were then recorded as follows:

Farm No.	Area of farm, ha	Crops grown	Crop areas, ha	Animals kept, No.	Land value, Kshs/ha
01	14.20	Maize	6.00	4	3 000.00
		Sorghum	3.00		
		Coffee	1.00		
		Tobacco	1.10		
		Trees	4.80		
		Total	15.90		
02	30.00	Maize	6.00	8	1 500.00
		Sugar cane	2.60		
		Tobacco	2.00		
		Trees	2.40		
		Total	13.00		
03	28.00	Maize	2.00	4	3 000.00
		Sorghum	1.20		
		Tobacco	1.00		
		Cassava	1.00		
		Beans	1.00		
		Trees	1.00		
		Total	7.20		
04	9.60	Maize	2.00	4	3 000.00
		Tobacco	1.00		
		Cassava	2.40		
		Trees	0.01		
		Total	5.41		
05	8.30	Maize	2.40	6	2 000.00
		Sorghum	2.40		
		Cassava	0.50		
		Tobacco	0.50		
		Trees	1.80		
		Total	7.60		

06	18.30	Maize	2.50	8	1 500.00
		Cassava	0.40		
		Vegetables	0.20		
		Bananas	0.25		
		Sugar cane	4.60		
		Tobacco	1.00		
		Trees	1.20		
		Total	10.15		
.					
.					
.					
30	11.00	Maize	0.80	16	750.00
		Cassava	0.75		
		Bananas	1.50		
		Tobacco	0.80		
		Trees	1.08		
		Total	4.93		

See appendix (i) for the full list.

b) For analysis, only three items, maize, tobacco and trees were considered. For the items, the following data were extracted:

(i) Variable input factors

Farm No.	Crop	Crop area, ha	Crop production costs			
			Item	Unit	Value	Cost (Kshs)
01	Maize	6.00	Seeds	kg		540.00
			Ploughing	MD	42	420.00
			Harrowing	MD	42	420.00
			Planting	MD	42	420.00
			Weeding, 1st	MD	42	420.00
			Weeding, 2nd	MD	42	420.00
			Harvesting	MD	21	210.00
			Transporting	MD	21	210.00
	Tobacco	1.10	Cleaning	MD	16	160.00
			Ploughing	MD	22	220.00
			Planting	MD	38	380.00
			Weeding, 1st	MD	31	310.00
			Weeding, 2nd	MD	16	160.00
			Fertilizing	MD	9	90.00
			Topping	MD	31	310.00
			Suckering	MD	31	310.00
			Harvesting	MD	38	380.00
			Transporting	MD	9	90.00
			Materials - loan Kshs -			2 816.00

	Trees	4.30	Clearing	MD	30	300.00
			Pitting	MD	36	360.00
			Seedlings	No.	11 000	537.50
			Planting	MD	36	360.00
			Weeding	MD	-	-
			Pruning	MD	-	-
			Thinning	MD	-	-
			Harvesting	MD	20	200.00
			Transporting	MD	5	50.00

Labour valued at Kshs 10.00 per day.

02	Maize	6.00	Seeds	kg		
			Clearing	MD	42	420.00
			Ploughing	MD	42	420.00
			Harrowing	MD	42	420.00
			Planting	MD	42	420.00
			Weeding, 1st	MD	42	420.00
			Weeding, 2nd	MD	21	210.00
			Harvesting	MD	21	210.00
	Tobacco	2.00	Clearing	MD	-	2 000.00
			Ploughing	MD	14	350.00
			Harrowing	MD	7	175.00
			Ridging	MD	7	175.00
			Planting	MD	14	350.00
			Weeding, 1st	MD	7	175.00
			Weeding, 2nd	MD	14	350.00
			Fertilizing	MD	7	175.00
			Spraying	MD	1	25.00
			Topping	MD	14	350.00
			Suckering	MD	14	350.00
			Harvesting	MD	30	750.00
			Transporting	MD	30	750.00
			Materials - loan Kshs		-	9 000.00
	Trees	2.40	Clearing	MD	10	250.00
			Pitting	MD	20	500.00
			Seedlings	No.	5 500	468.75
			Planting	MD	20	500.00
			Weeding	MD	-	-
			Pruning	MD	-	-
			Thinning	MD	-	-
			Harvesting	MD	10	250.00
			Transporting	MD	5	125.00

Labour valued at Kshs 25.00 per day.

.
.
.

30	Maize	0.80	Clearing	MD	3	34.95
			Ploughing	MD	14	163.10
			Harrowing	MD	7	81.55
			Seeds	kg	10	50.00
			Planting	MD	7	81.55
			Weeding, 1st	MD	20	233.00
			Weeding, 2nd	MD	20	233.00

		Harvesting	MD	5	58.25
		Transporting	MD	2	23.30
		Tuneshing	MD	2	23.30
Tobacco	0.80	Clearing	MD	10	116.70
		Ploughing	MD	20	233.30
		Harrowing	MD	10	116.70
		Ridging	MD	10	116.70
		Planting	MD	30	350.00
		Weeding, 1st	MD	30	350.00
		Weeding, 2nd	MD	30	350.00
		Fertilizing	MD	5	58.30
		Spraying	MD	5	58.30
		Topping	MD	14	163.30
		Suckering	MD	14	163.30
		Harvesting	MD	21	245.00
		Transporting	MD	5	58.30
		Curing	Kshs	-	600.00
		Materials - loan	Kshs	-	1 843.15
Trees	1.08	Clearing	MD	-	-
		Ploughing	MD	-	-
		Pitting	MD	-	250.00
		Seedlings	No.	4 000	202.50
		Planting	MD	-	200.00
		Weeding	MD	-	50.00
		Pruning	MD	-	20.00
		Thinning	MD	-	-
		Harvesting	MD	-	50.00
		Transporting	MD	-	20.00

Labour for farm No. 30 costed at Kshs 11.67 per day.

For complete list of these, see appendix (ii).

(ii) Fixed production factor items (inputs)

Farm	Oxen			Plough			Jokes			Curing barn	
No.	No.	Cost Kshs	Age Yrs	No.	Cost Kshs	Age Yrs	No.	Cost Kshs	Age Yrs	No.	Cost Kshs	Age Yrs
01	4	4400.00	5	1	690.00	2	2	100.00	2	1	3212.00	6
02	4	5200.00	5	1	700.00	3	2	150.00	6	1	1000.00	5
03	4	3600.00	7	1	175.00	25	2	50.00	25	1	1476.00	4
04	4	4400.00	5	1	400.00	2	2	170.00	2	1	2100.00	
.												
.												
.												
30	4	4400.00	5	1	400.00	2	2	170.00	2	1	2100.00	2

See appendix (iii).

All the above were market prices at the time of purchase.

(iii) Physical outputs

Farm No.	Farm area, ha	Crop: Maize Area, ha	Maize kgs	Tobacco Area, ha	Tobacco kgs	Trees Area, ha	Trees No.of poles
01	14.20	6.00	900	1.10	2020	4.80	1000
02	30.00	6.00	2700	2.00	4200	2.40	1000
03	28.00	2.00	2070	1.00	1369	1.00	250
04	9.60	2.00	1170	1.00	2700	0.01	437
05	8.30	2.40	-	0.50	900	1.80	500
06	18.30	2.50	2520	1.00	3000	1.20	872
.							
.							
.							
30	11.00	0.80	2340	0.80	1733	1.08	420

See appendix (iv).

(iv) Monetary outputs (revenues).

Farm No.	Farm area, ha	Crop	Crop area, ha	Production, Kshs
01	14.20	Maize	6.00	1 800.00
		Tobacco	1.10	35 350.00
		Trees	4.80	15 000.00
02	30.00	Maize	6.00	4 800.00
		Tobacco	2.00	58 800.00
		Trees	2.40	13 000.00
03	28.00	Maize	2.00	3 420.00
		Tobacco	1.00	20 535.00
		Trees	1.00	5 800.00
.				
.				
.				
30	11.00	Maize	0.80	5 200.00
		Tobacco	0.80	31 020.00
		Trees	1.08	8 400.00

See appendix (v).

4. DATA ANALYSIS

4.1. Preliminary analysis of data

Preliminary data analysis was performed for the variable inputs (costs), fixed inputs (costs) and the outputs (revenues). This was done for each farm and for each crop. A per hectare analysis was also done for the farms and the crops.

The main aims of the preliminary data analysis were:

1) To get for the variable inputs:

   a) The total land area of all the farms, the total for every crop and their average values.

   b) The total labour requirement for each farm and for each crop.

   c) The other variable inputs e.g. seeds (maize) and seedlings (trees) for each crop, per farm and per hectare.

2) To obtain the values of the total fixed costs per farm and per crop; and then on a per hectare basis. These were done particularly for the following fixed inputs:

   a) oxen
   b) ploughs
   c) jokes and
   d) curing barn

3) To determine the outputs, both physical and monetary, on the farms and also for each crop; and

4) To calculate the net revenue for each farm and for every crop.

4.1.1. Variable inputs (costs)

These were considered for the three items, i.e. maize, tobacco and trees; as follows:

4.1.1.1. Labour and land

The units of measure for labour inputs were mandays (MD). These were priced using the cost of hired labour. Where only family labour was employed in the farm, the price paid for the hired labour in the next farm was used. This was done so that the current labour market in the area was in effectly, the one used.

Each farm was effectively operated on labour provided by three people (adults), working for six hours per day for two hundred and twenty days a year; labour rests either on saturdays or sundays and on public holidays. According to the government regulations (see Ministry of Labour Regulations - Republic of Kenya), labour must be paid for these days, hence, payment is based on thirty days.

Calculations were done on the actual farm situation and on a per hectare basis.

4.1.1.2. Seeds

The production of maize involves the procurement and use of seed maize, in addition to other inputs.

Farmers in this area obtain their seed maize from three sources:

a) Hybride maize is purchased from the farm input stores e.g. KFA (now KGGU); or other co-operative stores e.g. Victoria Union - Homabay. In this case, the purchase price was used.

b) Seed maize is also obtained from the maize saved from the last season's harvest. In this case, the seed maize was valued at the price at which maize was selling at that time of planting and

c) Seed maize can also be purchased from the neighbouring farmers. In this case, the price at which the seed maize was purchased, was the one used.

This explains the variations in the cost of the seed maize.

4.1.1.3. Seedlings

The production of tobacco and fuelwood involves the use of tobacco and tree seedlings respectively.

The tobacco seedlings are provided as part of the materials loan (i.e. seedlings are provided by the company). This is indicated as other capital inputs. The other capital inputs (materials loan) has an interest of 11 % p.a. reduced to 8 % per annum, taking into consideration that the tobacco production cycle takes only eight months (Ogulla/Mwambire, personal communications, 1984).

Tree seedlings are obtained from four sources:

a) From the British American Tobacco (BAT) Comapny, which charges between Kshs 7.50 and Kshs 13.00 per 100 seedlings, depending on the distance and number purchased.

b) Seedlings are also obtained from the government, i.e. forest department tree nurseries which are available in the district. There are eleven fully government operated tree nurseries.

Seedlings are purchased as follows from these tree nurseries:

(i) 1 - 99 at 0.25 Kenya shillings per tree.
(ii) ≧ 100 at 7.50 Kenya shillings per 100 trees.

c) Community owned tree nurseries have mushroomed in the area since 1980. From these tree nurseries, seedlings can be purchased at various prices, depending on demand and supply balance.

d) Farmers also raise their own tree seedlings. Where the farmer raised his/her own seedlings, these were costed according to the labour and other inputs used. The cost of tree seedlings, therefore, varied a great deal.

4.1.1.4. Other capital inputs

The capital input, which involved the production of tobacco alone, is a loan, which is provided to the tobacco farmers, at an interest of 8 % per 8 months. It is given in the form of materials. The materials include fertilizers, seedlings, chemicals for protection against insects and diseases, spraying pumps, knives for pruning, topping and suckering, flue pipes, wire mesh, weld mesh, and field note

books.

4.1.2. Fixed inputs

The preliminary treatment of the fixed inputs, apart from the treatment of the ensuing outputs (revenues), posed a major difficulty in this study. Various ways and methods have been considered through discussions held in the two seminars, earlier presented on this paper, and also, outside the seminar halls (see acknowledgements).

After considering these methods of treatment, the data on these were treated as here outlined:

4.1.2.1. Animal power, oxen

Production of crops and/or fuelwood (wood) involves site preparation activities; the most common of which is ploughing.

For site preparation, three forms of power may be employed. These are human power, animal power or machine power, used separately or as a combination of either two or all of the three.

Costing of mechanical power is not very difficult, since, this is normally done on the price of machine working hours, inclusive of the operating costs, machine purchase price, its working life, and its salvage value after depreciation.

While human power costing even poses a more complex situation, dealing with animal power costing may be taken as exhibiting an intermediate costing problem complexity.

For the purpose of this study, these animals (oxen)

engaged in the production process may be considered as machines. They, therefore, have their purchase price, this being considered at the age at which they start being engaged in work which is at the age of five years (n_5). Their operating costs are the feeding costs (cd), which include the feed itself and the costs of the attendant, or herder. Their depreciation period, or working life (L_w), is taken as being ten years. This implies that their salvage value is determined at the age of fifteen years (n_{15}); these are shown on the diagram below.

As with all fixed inputs, there is always money tied up with them during their operating life - i.e. the interest charged on the capital tied up in them must also be included in all such calculations. In this particular case, this is taken as 8 %, this being the interest charged on other capital involved in other inputs in this study; the interest is indicated as r %.

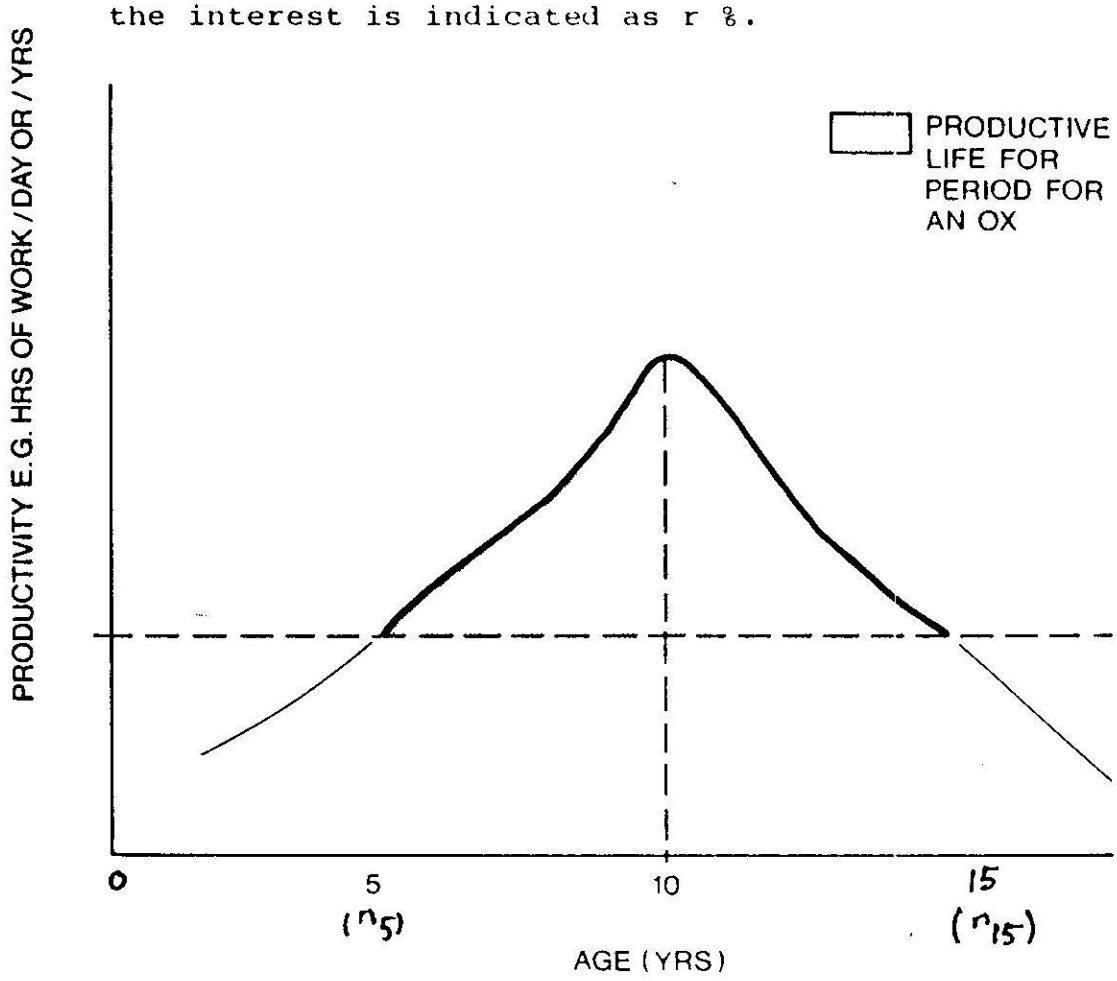


Fig. 4.1.2.1. Diagram showing the working life of an ox.

There are two further peculiarities involved in dealing with this problem in the study area: firstly, no feed is purchased, the animals graze freely on the farm land and drink river, lake, dam or well water free of charge. The animals are though taken care of by a cattle herder, who takes them out each day and brings them back, hence the feeding cost is considered as the salary of the herder. In the study area, this was found to be Kenya shillings 256.00 per month.

Secondly, even though the animals (oxen) reach the end of their productive life at the age of fifteen, at this age, disposal age, they usually have higher value than at the age of five. This is so because at this age, they are sold for beef production.

These two peculiarities have their effects on the calculations:

(i) The feeding costs, i.e. operating costs are not dependent on the number of animals but on the number of oxen used for ploughing since the salary paid to the herder (attendant), is not based on the number of animals he is looking after, but is paid as per the farm household.

(ii) The salvage values for the oxen are higher than the purchase price, this is quite the opposite in machine costing. The increment was taken to be Kshs 200.00, for the purpose of this study.

As an example of how the calculations were done, for the oxen costing, the following will suffice:

Number of animals	=	8	(N_a)
Number of oxen	=	4	(N_{ox})
Age at purchase	=	5 years	(N_5)
Purchase price	=	Kshs. 1'000.00	(P_{n_5})
Price at age 15 years	=	Kshs. 1 200.00	($P_{n_{15}}$)
Working life	=	10 years	(L_t)
Operating costs	=	?	(CF)

$$C_d = \frac{P_{n_5} - P_{n_{15}}}{L_t} + \frac{P_{n_5} + P_{n_{15}}}{2} (1 + r) \quad \ldots (1)$$

CF may now be obtained by the formula

$$CF = \frac{\frac{P_{n_5} - P_{n_{15}}}{L_t} + \frac{P_{n_5} + P_{n_{15}}}{2} (1 + r) \quad \ldots (2)}{N_{ox}}$$

Using the above formulae (1) and (2), in this example:

$$C_d = \frac{1000 - 1200}{15} + \frac{1000 + 1200}{2} (1.08) = 1174.70$$

$$CF = \frac{1174.70}{4}$$

CF = 293.68 Kenyan shillings.

See table 4.1.2.1. for details of the results.

Table 4.1.2.1. Fixed costs (CF) calculation for animal power.

Farm No.	No. of animals	No. of oxen for ploughing	Purchase price Kshs.	Selling price Kshs.	Feeding costs (cd) Kshs.	Fixed costs (CF) Kshs.
01	4	4	4400.00	5200.00	7020.00	452.11
02	4	4	5200.00	6000.00	7020.00	452.11
03	4	4	3600.00	4400.00	7020.00	452.11
04	4	4	4400.00	5200.00	7020.00	452.11
05	6	4	5300.00	6100.00	4680.00	283.63
06	8	4	4000.00	4800.00	3510.00	199.39
07	4	2	2600.00	3000.00	7020.00	452.11
08	7	4	2400.00	3200.00	4011.43	214.10
09	9	2	3000.00	3400.00	3120.00	197.98
10	3	2	3000.00	3400.00	9360.00	647.25
11	5	2	4000.00	4400.00	5616.00	377.69
12	8	4	4000.00	5200.00	3510.00	199.39
13	7	4	5200.00	6000.00	4011.43	235.49
14	4	2	3000.00	3400.00	7020.00	478.77
15	10	4	6000.00	6800.00	2808.00	148.84
16	5	4	3800.00	4600.00	5616.00	351.02
17	7	4	4400.00	5200.00	4011.43	235.49
18	4	2	2600.00	3000.00	7020.00	478.77
19	4	2	2500.00	2900.00	7020.00	478.77
20	3	2	3000.00	3400.00	9360.00	647.25
21	13	4	7200.00	8000.00	2160.00	102.19
22	10	4	6000.00	6800.00	2808.00	148.84
23	10	4	4800.00	5600.00	2808.00	148.84
24	6	2	7200.00	7600.00	4680.00	233.63
25	10	4	4000.00	4800.00	2808.00	148.84
26	5	4	4280.00	5080.00	5616.00	351.02
27	6	4	2400.00	3200.00	4680.00	283.63
28	5	4	6000.00	6800.00	5616.00	351.06
29	7	4	4000.00	4800.00	4011.43	235.49
30	16	4	4400.00	5200.00	1755.00	73.03
x	2	2	3600.00	4000.00	14040.00	957.55
y	2	2	3000.00	3400.00	14040.00	957.55
z	2	2	4000.00	4400.00	14040.00	957.55

4.1.2.2. Ploughs and jokes

In order to utilize animal power in site preparation work, a plough (for filling) and a joke (for harnessing the oxen), are required. These implements are considered as fixed inputs and their working life is taken as ten years, with an interest rate of 8 % p.a. charged on their use, i.e. the use of the capital tied in them. The scrap value of these assets, for practical reasons, may be taken as equivalent to zero.

Annuity method of depreciation was used in the calculations so as to determine the cost of these assets.

To employ the use of the annuity method of depreciation, the annuity factor must be determined. This can be obtained by the formula:

$$\frac{Vx0.0p(1.0p)^n}{(1.0p)^n - 1}$$

where V = net value of the asset
p = rate of interest in %
n = life expectancy,
or Vx annuity factor.

The annuity factor can be worked out, or obtained from tables.

Since the interest rate charged on these assets is 8 % p.a. and their life expectancy is 10 years, the annuity factor, as obtained from tables is 0.15.

Hence as an example:
A plough purchased in 1980, at the cost of Kshs. 500.00 would be valued at:

500.00 - 0.00 = 500.00 (0.15)

= 75.00.

See table 4.1.2.2. below.

Table 4.1.2.2. Fixed costs attached to using ploughs and jokes per year.

Farm No.	Plough			Joke		
	Purchase price, Kshs	Disposal price, Kshs	Depreciation cost with interest/yr. Kshs	Purchase price, Kshs	Disposal price, Kshs	Depreciation cost with interest/yr. Kshs
01	690.00	0.00	103.50	100.00	0.00	15.00
02	700.00	0.00	105.00	150.00	0.00	22.50
03	175.00	0.00	26.25	50.00	0.00	7.50
04	400.00	0.00	60.00	170.00	0.00	25.50
05	500.00	0.00	75.00	180.00	0.00	27.00
06	100.00	0.00	15.00	100.00	0.00	15.00
07	450.00	0.00	67.50	140.00	0.00	21.00
08	450.00	0.00	67.50	60.00	0.00	9.00
09	350.00	0.00	52.50	65.00	0.00	9.75
10	300.00	0.00	45.00	65.00	0.00	9.75
11	885.00	0.00	132.75	180.00	0.00	27.00
12	600.00	0.00	90.00	170.00	0.00	25.50
13	250.00	0.00	37.50	171.00	0.00	25.65
14	800.00	0.00	120.00	260.00	0.00	39.00
15	300.00	0.00	45.00	50.00	0.00	7.50
16	300.00	0.00	45.00	150.00	0.00	22.50
17	500.00	0.00	75.00	135.00	0.00	20.25
18	500.00	0.00	75.00	60.00	0.00	9.00
19	110.00	0.00	16.50	65.00	0.00	9.75
20	120.00	0.00	18.00	90.00	0.00	13.50
21	400.00	0.00	60.00	190.00	0.00	28.50
22	500.00	0.00	75.00	122.00	0.00	18.30
23	360.00	0.00	54.00	50.00	0.00	7.50
24	150.00	0.00	25.50	40.00	0.00	6.00
25	150.00	0.00	25.50	68.00	0.00	10.20
26	560.00	0.00	84.00	150.00	0.00	22.50
27	600.00	0.00	90.00	200.00	0.00	30.00
28	600.00	0.00	90.00	250.00	0.00	37.50
29	600.00	0.00	90.00	130.00	0.00	19.50
30	700.00	0.00	105.00	180.00	0.00	27.00
Tot.	13100.00	0.00	1971.00	3791.00	0.00	568.65
Aver.	436.67	0.00	65.70	126.37	0.00	18.96

4.1.2.3. Curing barn

Tobacco production involves the construction and use of a structure called a curing barn. This structure, which is practically a house fitted with pipes inside, is usually constructed using poles, mud and grass. Burnt mud blocks and corrugated iron sheets may be used.

In the study area, these structures are constructed using poles, both on the walls and on the roofs, mud, burnt or raw, on the walls and on the floor, and either grass or corrugated iron sheets on the roofs.

These structures, it was gathered from the farmers, can stay for upto twenty five years, with repair work being done annually on them. The BAT people consider them to be usable for only five years. For the purpose of this study, a useful life period of ten years has been chosen. After ten years, the curing barns have zero scrap value.

Since the construction of these structures involve the use of money, an interest rate of 8 % is used in depreciating them using the annuity method.

One question which may be asked is: "Why should these structures be depreciated while normally, being buildings, they should actually appreciate in value with time?"

This question is quite reasonable, but one has to accept that:

(i) These are usually temporary structures.

(ii) Due to the use, their condition deteriorates. The tobacco curing involves passing hot air through pipes in these structures, and this process leads to rapid deterioration of these structures.

As an example of what has been done:

If a curing barn was constructed in 1980, at a cost of Kshs. 3 000.00, its value after ten years would be Kshs. 00.00, and it would depreciate at

3 000.00(0.15) = 450.00 Kenya shillings per annum.

See table 4.1.2.3. below.

Table 4.1.2.3. Fixed costs attached to using curing barns per year.

Farm No.	Barn construction costs, Kshs	Barn scrap value, Kshs	Barn depreciation value, Kshs/yr.
01	3212.00	0.00	481.80
02	1000.00	0.00	150.00
03	1476.00	0.00	221.40
04	2100.00	0.00	315.00
05	1000.00	0.00	150.00
06	1700.00	0.00	255.00
07	3200.00	0.00	480.00
08	3500.00	0.00	525.00
09	2286.00	0.00	342.50
10	3000.00	0.00	450.00
11	3000.00	0.00	450.00
12	2800.00	0.00	420.00
13	3840.00	0.00	576.00
14	4375.00	0.00	656.25
15	2500.00	0.00	375.00
16	3410.00	0.00	511.50
17	3000.00	0.00	450.00
18	2060.00	0.00	309.00
19	3100.00	0.00	465.00
20	4800.00	0.00	720.00
21	2465.00	0.00	369.75
22	2660.00	0.00	399.00
23	1500.00	0.00	225.00
24	120.00	0.00	18.00
25	4400.00	0.00	660.00
26	4960.00	0.00	744.00
27	4165.00	0.00	624.75
28	295.00	0.00	44.25
29	2365.00	0.00	354.75
30	1265.00	0.00	189.75
Totals	73654.00	0.00	11932.70
Averages	2455.13	0.00	397.76

4.1.3. Outputs (revenues)

Treatment of revenues, as with other inputs, is another major consideration, since these must be made comparable in their time span. Revenue from the fuelwood (trees) component of the production comes after a period of eight years, which is the most reasonable financial rotation in fuelwood production. For the purpose of this study, revenue from the two ensuing coppices have not been included, even though it is realized that this will result into higher inputs values, since the production of the coppices does not involve any secondary inputs. The omission has been due to the fact that the two coppices come at too far away periods in the future, i.e. at years sixteen and twenty four, for the first and second coppices, respectively.

Revenues from the maize and tobacco production come within a period of one year; maize taking about six months, and tobacco, about eight months.

To make these revenues come at par, the following has been done:

a) The fuelwood production has been taken as a going concern in which there are equal eight plots, making up eight hectares, with the first hectare planted in 1976, and the last one in 1984, replacing the one planted in 1976 and cut in 1984.

b) The net revenues accruing from the fuelwood component, were divided into eight parts, so as to get the amounts for one year period, which would be comparable to those obtained from the tobacco and maize production.

c) Revenues from both tobacco and maize were considered as they are, since their production processes take about one year.

To make them comparable both inputs and outputs were considered for a period of one year only.

Due to the fact that the farmers could not tell exactly how much of the maize produced by them were consumed on the farm, this was later on calculated using Bothal, Gibbs and Simmons (1970) method; basing on the fact that one farm household had an average of seven members.

For this number of people, the maize requirement per year was found to be 731.00 kilogrammes. This was the maize production which was assumed as having been consumed by these farm household members per farm. This amount of maize requires 0.41 hectares of land to produce in this area; and fetches Kshs. 1 242.70 (1984 prices).

4.2. Results of the preliminary analysis of data

4.2.1. Labour and Land inputs

These are shown on table 4.2.1. The average amount of labour available per farm per year was found to be 600 mandays. The amount of labour required in the production of one hectare of each of the crops varied;

maize - 106.20 mandays
fuelwood - 109.93 mandays and
tobacco - 324.00 mandays.

The average cost of labour was found to be Kenyan shillings 8.75 per manday.

The land area available per farm was between 3.20 hectares and 50.00 hectares. The average farm size for the thirty farms studied was found to be 15.36 hectares. Price of land per hectare varied between Kenyan shillings 6 000.00 and Kenyan shillings 750. The average land price per

hectare was found to be Kenyan shillings 1 360.00.

Table 4.2.1. Labour and land inputs.

Farm No.	Area of farm, ha	Maize Area, ha	Maize Labour requirements (MD) Total	Maize Labour requirements (MD) MD/ha	Tobacco Area, ha	Tobacco Labour requirements (MD) Total	Tobacco Labour requirements (MD) MD/ha	Fuelwood Area, ha	Fuelwood Labour requirements (MD) Total	Fuelwood Labour requirements (MD) MD/ha	Labour costs Kshs/Day	Labour costs Total	Land value, Kshs/ha
01	14.20	6.00	252	42	1.10	253	230	4.80	1052	219	10.00	15570.00	2000.00
02	30.00	6.00	252	42	2.00	159	80	2.40	65	27	10.00	4760.00	2000.00
03	28.00	2.00	123	62	1.00	216	216	1.00	146	146	6.70	3249.50	2000.00
04	9.60	2.00	85	43	10..	221	221	0.01	13	130	10.00	3190.00	1500.00
05	8.30	2.40	90	38	0.50	126	252	1.80	86	48	20.00	6040.00	1800.00
06	18.30	2.50	219	88	1.00	593	593	1.20	143	119	8.30	7926.50	2000.00
07	4.10	1.50	129	86	0.50	407	814	1.20	345	288	10.00	8810.00	2000.00
08	8.30	2.00	353	177	0.75	491	655	1.20	370	308	6.70	8133.80	1500.00
09	19.30	0.80	184	230	0.75	362	483	0.12	3	25	10.00	5490.00	1000.00
10	3.20	1.20	104	87	0.50	362	724	0.50	5	8	10.00	4710.00	1000.00
11	50.00	2.50	101	40	0.80	119	149	0.80	121	151	6.70	2284.70	1000.00
12	12.50	2.10	97	46	1.00	128	128	0.01	2	200	10.00	2270.00	1000.00
13	5.42	2.08	152	73	0.75	115	153	0.80	36	45	10.00	3030.00	2000.00
14	25.00	0.40	26	65	1.00	176	176	2.20	65	30	5.00	1385.00	2500.00
15	10.40	4.20	220	52	1.25	208	186	1.20	134	112	5.00	2310.00	1500.00
16	6.70	1.25	131	109	0.50	312	624	1.20	132	110	6.70	3852.00	2500.00
17	13.60	1.25	152	122	1.00	235	235	1.40	113	81	8.30	4150.00	2500.00
18	5.60	1.25	105	84	1.00	208	208	0.40	35	88	6.30	2192.40	1500.00
19	7.90	2.00	229	115	0.50	256	512	0.80	100	125	6.30	3685.50	2000.00
20	20.70	1.70	177	104	1.00	568	568	2.00	134	92	6.70	6224.30	2500.00
21	20.00	1.00	188	188	0.75	133	177	1.40	100	71	13.30	5599.30	1000.00
22	11.00	2.00	244	122	0.75	193	257	0.90	126	140	10.00	5630.00	1000.00
23	11.00	0.40	51	128	0.75	150	200	3.20	250	78	8.30	2465.10	500.00
24	30.00	0.40	88	220	0.80	222	278	1.50	150	100	5.00	2300.00	500.00
25	25.80	0.50	82	164	0.75	186	248	0.80	100	125	10.00	3680.00	500.00
26	8.00	1.00	88	88	0.80	209	261	-	-	-	8.30	2465.10	500.00
27	6.00	0.40	58	145	1.10	329	299	0.50	84	168	8.30	3909.30	500.00
28	12.00	0.20	30	150	0.75	185	247	1.04	156	150	8.30	3079.30	500.00
29	25.00	1.00	147	147	0.50	145	290	0.40	25	63	13.30	4216.10	1000.00
30	11.00	0.80	102	128	0.80	204	255	1.08	55	51	11.70	4223.70	1000.00
Total	460.92	52.83	4259	3135	25.65	7087	9719	36.36	4196	3298	262.50	138610.40	40800.00
Aver.	15.36	1.76	141.10	106.2	0.86	236.23	324	1.21	139.87	109.93	8.75	4620.35	1360.00

4.2.2. Summary of variable inputs (costs)

These are shown on table 4.2.2. On a per hectare basis, the following were found to be the variable costs attached to the production of each crop:

maize - Kenyan shillings 1 034.45
tobacco - Kenyan shillings 1 245.19 and
fuelwood - Kenyan shillings 1 079.66.

Table 4.2.2. Summary of variable costs.

Farm No	Maize Labour (Kshs)	Maize Seeds (Kshs)	Maize Total (Kshs)	Ha Total	Labour (Kshs)	Crop Tobacco Others (Kshs)	Total (Kshs)	Ha Total	Labour (Kshs)	Seed-lings (Kshs)	Total (Kshs)	Ha, total (Kshs)	Total (Kshs)	Per ha (Kshs)
01	2520.00	540.00	3060.00	510.00	2530.00	3041.30	5571.30	5064.30	10520.00	1560.00	12080.00	2515.00	20711.30	8089.80
02	2520.00	540.00	3060.00	510.00	1590.00	9720.00	11310.30	5660.00	650.00	650.00	1300.00	540.80	15670.00	6710.80
03	820.00	180.00	1000.00	503.30	1440.00	3367.60	4807.60	4807.60	973.30	325.00	1298.30	1298.30	7105.90	6608.90
04	850.00	100.00	950.00	450.00	2210.00	3412.80	5622.80	5622.80	130.00	52.00	182.00	1625.00	6754.80	7697.30
05	1800.00	42.00	1842.00	775.50	2520.00	2234.00	4754.00	9503.00	720.00	585.00	2305.00	1235.00	8901.00	11568.50
06	1825.00	40.00	1865.00	749.30	4941.70	3026.40	7968.10	7968.10	1191.70	300.00	1491.70	1241.70	11324.80	9959.10
07	1290.00	50.00	1340.00	893.30	4070.00	1944.00	6014.00	12028.00	3450.00	281.00	3731.25	3130.00	11085.25	16051.30
08	2353.30	360.00	2713.30	1360.00	3273.30	2834.80	6108.10	8146.40	2466.70	225.00	2691.70	2240.80	10159.80	11747.20
09	1340.00	50.00	1390.00	2362.00	3620.00	1075.70	4695.70	6264.30	30.00	25.50	55.50	462.50	6641.20	9089.30
10	1040.00	18.00	1058.00	885.00	3620.00	1075.70	4695.70	9391.40	50.00	25.50	55.50	125.00	5809.20	10401.40
11	673.30	100.00	773.30	306.70	793.30	-	793.30	993.30	806.70	150.00	956.70	1194.20	2523.30	2494.20
12	970.00	721.00	1044.00	495.20	1230.00	2540.00	3820.30	3820.30	20.00	7.50	27.50	2325.00	4891.80	6640.50
13	1520.00	92.50	1612.50	774.50	1150.00	2592.00	3742.00	4986.00	360.00	20.00	380.00	475.00	5734.50	6235.50
14	130.00	37.00	167.00	417.50	880.00	3335.00	4215.00	4215.00	325.00	412.50	737.50	337.50	5119.50	4970.00
15	1100.00	185.00	1285.00	304.00	1040.00	4320.00	5360.00	4386.00	670.00	150.00	820.00	685.00	7465.00	5375.00
16	873.30	225.00	1098.30	906.70	2080.00	3024.00	5104.00	10208.00	880.00	160.00	1040.00	866.60	7242.30	11981.30
17	1266.70	375.00	1641.70	1316.70	1958.30	5054.40	7012.70	7012.70	941.70	262.50	1204.20	862.50	9858.60	9191.00
18	665.00	50.00	715.00	572.00	1317.00	2592.00	3909.30	3909.30	221.70	75.00	296.70	744.80	4921.00	5226.10
19	1450.30	100.00	1550.30	778.30	1621.30	1379.20	3000.50	6001.10	633.30	150.00	783.30	979.20	5334.10	7758.60
20	1130.00	279.00	1459.00	857.40	3786.70	2678.40	6465.10	6465.10	1226.70	375.00	1601.70	800.30	9525.30	8123.30
21	2506.70	50.00	2556.70	2556.70	1773.30	2209.90	3983.20	5306.50	1333.30	265.50	1595.80	1134.20	8135.70	8897.40
22	2440.00	100.00	2540.00	1420.00	1930.00	2209.90	4139.90	5516.50	1260.00	153.35	1418.35	1575.90	9098.25	8512.40
23	425.00	25.00	450.00	1129.20	1250.00	2519.40	3769.40	5025.90	2083.30	500.00	2583.30	806.25	6282.15	6961.35
24	440.00	50.00	490.00	1225.00	1110.00	2141.10	3251.10	4066.40	750.00	500.00	1250.00	833.30	4991.10	6124.70
25	820.00	100.00	920.00	1840.00	1860.00	3024.00	4884.00	6512.00	1000.00	75.00	1075.00	1343.75	6879.00	9695.75
26	733.30	50.00	783.30	733.30	1741.70	2980.30	4722.50	5901.00	-	-	-	-	5505.30	6684.30
27	483.30	50.00	533.30	1333.30	2741.70	3348.00	6089.70	5535.30	700.00	75.00	775.00	1550.00	7398.00	8458.60
28	250.00	20.00	270.00	1350.00	1541.70	2592.00	4133.70	5514.30	1300.00	195.00	1495.00	1437.50	5898.70	8301.30
29	1960.00	58.00	2018.00	2018.50	1933.30	3024.00	4957.30	9911.70	333.30	75.00	408.30	1027.50	7393.60	12960.70
30	1190.00	125.00	1315.00	1649.55	2530.00	1990.60	4370.60	5463.30	641.70	202.50	844.20	732.50	6529.30	7895.35
Tot.	37935.20	6585.50	42000.70	31033.45	60363.60	84211.60	149270.90	190728.40	35668.40	7833.85	44483.50	37355.60	233881.25	250512.8
	1264.51	219.52	1400.02	1034.45	2012.12	2807.05	4975.70	6357.61	1188.95	261.13	1482.78	1245.19	7796.04	8350.4

4.2.3. Summary of fixed inputs

These are shown on table 4.2.3. One hectare of each crop produced had the following fixed costs attached to them:

maize - Kenyan shillings 654.70
tobacco - Kenyan shillings 1 052.46
fuelwood - Kenyan shillings 654.70.

Table 4.2.3. Summary of fixed costs.

Farm No.	Crop: Maize Oxen Kshs	Maize Ploughs + jokes Kshs	Maize Total Kshs	Maize Ha Kshs	Tobacco Oxen Kshs	Tobacco Ploughs + jokes Kshs	Tobacco Curing barn Kshs	Tobacco Total Kshs	Tobacco Ha Kshs	Fuelwood Oxen Kshs	Fuelwood Ploughs +jokes Kshs	Fuelwood Total Kshs	Fuelwood Ha Kshs	Total Kshs	Ha Kshs
01	452.11	118.50	570.61	570.61	452.11	118.50	481.30	1052.41	1052.41	452.11	118.50	570.61	570.61	2193.63	2193.63
02	452.11	127.50	579.61	579.61	452.11	127.50	150.00	729.61	729.61	452.11	127.50	579.61	579.61	1888.83	1888.83
03	452.11	33.75	485.86	485.80	452.11	33.75	221.40	707.26	707.26	452.11	33.75	485.86	485.86	1678.98	1678.98
04	452.11	85.50	537.61	537.61	452.11	85.50	315.00	852.61	852.61	452.11	85.50	537.61	537.61	1927.83	1927.83
05	452.11	102.00	554.11	554.11	452.11	102.00	150.00	704.11	704.11	452.11	102.00	554.11	554.11	1812.33	1812.33
06	452.11	30.00	482.11	482.11	452.11	30.00	255.00	737.11	737.11	452.11	30.00	482.11	482.11	1701.33	1701.33
07	957.55	88.50	1046.05	1046.05	957.55	88.50	480.00	1526.05	1526.05	957.55	88.50	1046.05	1046.05	3618.15	3618.15
08	452.11	76.50	528.61	528.61	452.11	76.50	525.00	1053.61	1053.61	452.11	76.50	528.61	528.61	2109.83	2109.83
09	957.55	62.25	1019.80	1019.80	957.55	62.25	342.50	1362.30	1362.30	957.55	62.25	1019.80	1019.80	3401.90	3041.90
10	452.11	54.75	506.86	506.86	452.11	54.75	450.00	956.86	956.86	452.11	54.75	506.86	506.86	1970.38	1970.38
11	452.11	159.75	611.86	611.86	452.11	159.75	450.00	1061.86	1061.86	452.11	159.75	611.86	811.36	2180.58	2180.58
12	957.55	115.50	1073.05	1073.05	957.55	115.50	420.00	1493.05	1493.05	957.55	115.50	1073.05	1073.05	3207.96	3207.96
13	452.11	63.15	515.26	515.26	452.11	63.15	576.00	1091.26	1091.26	452.11	63.15	515.26	515.26	2523.57	2523.57
14	452.11	159.00	611.11	611.11	452.11	159.00	656.25	1267.36	1267.36	452.11	159.00	611.11	611.11	2489.58	2489.58
15	452.11	52.50	504.61	504.61	452.11	52.50	375.00	879.61	879.61	452.11	52.50	504.61	504.61	1888.83	1888.83
16	957.55	67.50	1025.05	1025.05	957.55	67.50	511.50	1536.55	1536.55	957.55	67.50	1025.05	1025.05	3586.65	3586.65
17	957.55	95.25	1052.80	1052.80	957.55	95.25	450.00	1502.80	1502.80	957.55	95.25	1052.30	1052.80	3608.40	3608.40
18	957.55	84.00	1041.55	1041.55	957.55	84.00	309.00	1350.55	1350.55	957.55	84.00	1041.55	1041.55	3433.65	3433.65
19	452.11	26.25	478.36	478.36	452.11	26.25	465.00	943.36	943.36	452.11	26.25	478.36	478.36	1900.07	1900.08
20	452.11	31.50	483.61	483.61	452.11	31.50	720.00	1203.61	1203.61	452.11	31.50	483.61	483.61	2170.83	2170.83
21	452.11	88.50	540.61	540.61	452.11	88.50	369.75	910.36	910.36	452.11	88.50	540.61	540.61	1991.58	1991.58
22	957.55	93.30	1050.85	1050.85	957.55	93.30	399.00	1449.85	1147.85	452.11	93.30	1050.85	1050.85	3551.55	3551.55
23	452.11	61.50	513.61	513.61	452.11	61.50	225.00	738.61	738.61	452.11	61.50	513.61	513.61	1765.83	1765.83
24	452.11	31.50	483.61	483.61	452.11	31.50	18.00	501.61	501.61	452.11	31.50	483.61	483.61	1468.83	1468.83
25	452.11	35.70	487.81	487.81	452.11	35.70	660.00	1144.81	1447.81	452.11	35.70	487.81	487.81	2123.43	2123.43
26	452.11	106.50	558.61	558.61	452.11	106.50	744.00	1302.61	1302.61	452.11	106.50	-	-	1861.22	1861.22
27	452.11	120.00	572.11	572.11	452.11	120.00	624.75	1196.86	1196.86	452.11	120.00	572.11	572.11	2341.08	2341.08
28	452.11	127.50	579.61	579.61	452.11	127.50	44.25	623.86	623.86	452.11	127.50	579.61	579.61	2356.08	2356.08
29	452.11	109.50	561.61	561.61	452.11	109.50	354.75	916.36	916.36	452.11	109.50	561.61	561.61	2039.58	2039.58
30	452.11	132.00	584.11	584.11	452.11	132.00	189.75	773.86	773.86	452.11	132.00	584.11	584.11	1942.08	1942.08
Totals	17101.38	2539.65	19641.03	19641.03	17101.38	2539.65	11932.70	31573.73	31573.73	17101.38	2539.65	19641.03	19641.03	68393.50	68393.50
Averages	570.05	84.66	654.70	654.70	570.05	84.66	397.76	1052.46	1052.46	570.05	84.66	654.70	654.70	2279.78	2279.78

4.2.4. Summary of physical outputs

These are shown on table 4.2.4. One hectare of each of the three crops produced products as follows:

maize - 2 156.38 kilogrammes
tobacco - 2 209.15 kilogrammes
fuelwood - 2 050.20 poles.

The unit prices for each of the outputs were found to be:

maize - Kenyan shillings 2.07 per kilogramme of shelled maize
tobacco - Kenyan shillings 15.83 per kilogramme of baled tobacco
fuelwood - Kenyan shillings 18.30 per cut and trimmed pole.

Table 42:4 Physical outputs.

Farm No.	Farm area, ha	Crop: Maize Area, ha	Maize Total, kgs	Maize Kgs/ha	Maize Kshs/kg	Tobacco Area, ha	Tobacco Total, kgs	Tobacco Kgs/ha	Tobacco Kshs/kg	Fuelwood Area, ha	Fuelwood Total poles	Fuelwood Poles/ha	Fuelwood Kshs/pole
01	14.20	6.00	1631	271.83	1.87	1.10	2020	1836.40	17.50	4.80	1000	208	15.00
02	30.00	6.00	3431	571.83	1.76	2.00	4200	1750.00	14.00	2.40	1000	417	13.00
03	28.00	2.00	2301	1400.50	1.70	1.00	1369	1369.00	15.00	1.00	250	250	23.20
04	9.60	2.00	1901	950.50	1.47	1.00	2700	2700.00	16.50	0.01	437	4700	8.00
05	8.30	2.40	731	304.58	1.70	0.50	900	1800.00	16.50	1.80	500	278	16.50
06	18.30	2.50	3251	1300.40	1.70	1.00	3000	3000.00	17.00	1.20	872	727	20.00
07	4.10	1.50	1631	1087.33	1.56	0.50	1300	2600.00	18.00	1.20	1000	833	16.00
08	8.30	2.00	3431	1715.50	1.94	0.75	1600	2133.00	18.00	1.20	1000	833	16.00
09	19.30	0.80	1631	2038.75	1.37	0.75	1800	2400.00	17.50	0.12	1248	10400	6.00
10	3.20	1.20	731	609.17	1.70	0.50	650	1300.00	16.50	0.50	1342	2684	13.00
11	50.00	2.50	1331	532.40	2.06	0.80	700	875.00	15.00	0.80	2000	2500	10.00
12	12.50	2.10	3131	1490.95	2.31	1.00	1600	1600.00	15.00	0.01	100	10000	24.00
13	5.42	2.03	2981	1433.17	1.42	0.75	1800	2400.00	17.30	0.80	4000	5000	15.00
14	25.00	0.40	5231	13077.50	1.10	1.00	2000	2000.00	16.00	2.20	2308	1049	16.25
15	10.40	4.20	2351	599.76	1.75	1.25	2000	1600.00	15.00	1.20	1000	833	10.00
16	6.70	1.25	947	757.60	7.01	0.50	1600	3200.00	17.00	1.20	1000	833	8.40
17	13.60	1.25	3431	2744.80	2.99	1.00	3100	3100.00	18.00	1.40	1000	714	15.00
18	5.60	1.25	1631	1304.80	1.68	1.00	1500	1500.00	15.00	0.40	1500	3750	20.00
19	7.00	2.00	2081	1040.50	1.68	0.50	1400	2800.00	14.00	0.80	2000	2500	10.00
20	20.70	1.70	4331	2547.65	2.13	1.00	2000	2000.00	14.00	2.00	800	1600	22.50
21	20.00	1.00	1631	1631.00	1.50	0.75	1958	2611.00	15.00	1.40	3500	2500	12.00
22	11.00	2.00	4331	2547.65	2.13	1.00	2000	2292.00	12.00	0.90	2262	4524	15.00
23	11.00	0.40	1541	3852.50	1.33	0.75	2057	2743.00	15.00	3.20	1029	322	28.00
24	30.00	0.40	1931	4827.50	2.20	0.80	2667	3334.00	16.00	1.50	2000	1333	18.88
25	25.80	0.50	1181	2362.00	2.00	0.75	1400	1867.00	16.00	0.80	200	250	50.00
26	8.00	1.00	1311	1311.00	2.18	0.30	1521	1901.00	17.50	-	-	-	-
27	6.00	0.40	1271	3177.50	3.01	1.10	2054	1867.00	16.50	0.50	1200	2400	10.00
28	12.00	0.20	731	3655.00	1.70	0.75	1560	2080.00	16.00	1.04	1000	962	13.00
29	25.00	1.00	1631	1631.00	1.50	0.50	1375	2750.00	19.70	0.40	1000	2500	10.00
30	11.00	0.80	3071	3838.75	2.10	0.80	1733	2166.00	19.70	1.08	420	389	20.00
Totals	460.92	52.83	62684	64691.27	62.09	25.65	59641	66274.40	474.90	36.36	37208	61506	548.75
Aver.	15.36	1.76	2089.47	2156.38	2.07	0.86	1988.03	2209.15	15.83	1.21	1240.27	2050.20	13.30

4.2.5. Net revenues for the farms

These are shown on table 4.2.5. These are revenues for the sampled farms as were actually calculated.

Table 4.2.5. Net revenues for the farms.

Farm	Total costs (Kshs)			Total revenues (Kshs)			Net revenues (Kshs)			Net revenues (Kshs)
No.	Maize	Tobacco	Fuelwood	Maize	Tobacco	Fuelwood	Maize	Tobacco	Fuelwood	Farm
01	3630.61	6623.71	12650.61	3042.70	35350.00	15000.00	-587.91	28726.29	2349.39	30487.77
02	3639.61	12039.61	1879.61	6042.70	58800.00	13000.00	2403.09	46760.39	11120.35	60283.83
03	1485.36	5514.86	1734.16	4762.70	20535.00	5800.00	3276.84	15020.14	4015.84	22312.82
04	1487.61	6475.41	719.61	2302.70	44550.00	3496.00	1315.09	38074.59	2776.39	42166.07
05	2396.11	5458.11	2359.11	1242.70	14850.00	8250.00	-1153.41	9391.89	5390.89	13629.37
06	2347.11	8705.21	1973.81	5442.70	51000.00	5000.00	3095.55	42294.79	3026.19	48416.53
07	2386.05	7540.05	4777.30	2542.70	23400.00	30000.00	156.65	15859.95	25222.70	41239.30
08	3241.91	7161.71	3220.31	6642.70	28800.00	16000.00	3400.79	21638.29	12779.69	37818.77
09	2909.80	6058.00	1075.30	3042.70	31500.00	7488.00	132.90	25442.00	6412.70	31987.60
10	1564.36	5652.56	562.36	1242.70	10725.00	17446.00	-322.16	5072.44	16883.64	21633.92
11	1385.16	1355.16	1568.56	2742.70	10350.00	20000.00	1357.54	8994.84	18431.44	28783.82
12	2117.05	5313.35	1100.55	7242.70	24000.00	2400.00	5125.65	18686.65	1299.45	25111.75
13	2127.76	4833.26	1453.05	4242.70	31500.00	60000.00	2114.94	26666.74	58546.95	87328.63
14	778.11	5482.36	1252.76	5742.70	32000.00	37500.00	4964.59	26517.64	36247.24	67729.47
15	1789.61	6239.61	1324.61	4122.70	30000.00	10000.00	2333.09	23760.39	28675.39	54768.87
16	2123.35	6640.55	2065.05	6642.70	27200.00	10000.00	4519.35	20559.45	7934.95	33013.75
17	2694.50	8515.50	2257.00	10242.70	55800.00	8100.00	7548.20	47284.50	5843.00	60675.70
18	1756.55	5259.35	1338.21	2742.70	22500.00	16200.00	986.15	17240.15	14861.79	33088.09
19	2028.66	3943.86	1261.66	3492.70	19600.00	20000.00	1464.04	16056.14	18738.34	36258.52
20	1942.61	7668.71	1142.31	9242.70	28000.00	18000.00	7300.00	20331.29	16857.69	44489.07
21	3097.31	4893.56	2136.41	2442.70	29370.00	22680.00	-654.61	24476.44	20543.59	44365.42
22	3590.85	5589.75	2469.20	5962.70	20628.00	33930.00	2371.85	15038.25	31460.80	48870.90
23	963.61	4508.01	3096.91	2052.70	30855.00	20800.00	1089.09	26346.99	17703.09	45139.17
24	973.61	3752.71	1733.61	4242.70	42672.00	33750.00	3269.09	38919.29	36015.39	78204.77
25	1407.81	6031.81	1562.81	2367.70	22400.00	10000.00	959.89	16368.19	8437.19	25765.27
26	1341.91	6025.11	-	3942.70	26617.50	-	2600.79	20592.39	-	23193.18
27	1105.41	7286.56	1347.11	1442.70	33891.00	24000.00	337.29	26604.44	22652.89	49574.62
28	849.61	4757.56	2078.61	1242.70	24960.00	10300.00	393.09	20202.44	8225.39	28745.12
29	2579.61	5373.66	1324.66	2442.70	27037.50	10000.00	-136.91	21213.84	9675.34	29752.27
30	1399.11	5144.46	1423.31	3442.70	31020.70	19000.00	4543.59	25876.24	17571.65	47991.52
Totals	61641.73	180844.63	63439.57	125826.00	890461.70	512140.00	64184.23	709617.07	448700.43	1222501.73
Aver.	2054.72	6028.15	2114.65	4194.20	29682.00	17071.00	2139.47	23653.90	14956.68	40750.06

4.2.6. Net revenue per hectare per crop

Average net revenues were calculated per hectare of each crop. These are shown on table 4.2.6.

Table 4.2.6. Net revenues per hectare for the farms.

Farm No.	Total costs (Kshs) Maize	Tobacco	Fuelwood	Total revenues (Kshs) Maize	Tobacco	Fuelwood	Net revenues (Kshs) Maize	Tobacco	Fuelwood	Net revenue (Kshs) Farm
01	1080.61	6117.21	3085.61	507.12	32137.00	3120.00	-573.49	26019.79	34.39	25480.69
02	1089.61	6389.61	1120.41	1007.12	24500.00	5421.00	- 82.49	18110.39	4300.59	22328.49
03	989.16	5514.36	1784.16	2381.35	20535.00	5300.00	1392.19	15020.14	4015.84	20428.17
04	987.61	6475.41	2162.61	1401.35	44550.00	34600.00	413.74	38174.59	32437.39	70926.22
05	1329.61	10212.11	1339.11	517.80	29700.00	4587.00	-811.81	19487.89	2747.89	21423.88
06	1231.41	8705.21	1723.81	2177.08	51000.00	14540.00	945.67	42294.79	12816.19	56056.65
07	1939.35	13554.05	4176.05	1695.13	46800.00	24990.00	-244.22	33245.95	20813.95	53815.68
08	1888.61	9200.01	2769.41	3321.35	38394.00	13328.00	1432.74	29193.99	10558.59	41185.32
09	3382.30	7626.60	1482.30	3803.38	42000.00	62400.00	421.08	34373.40	60917.70	95712.17
10	1391.86	10348.26	631.86	1035.58	21450.00	34892.00	-356.28	11101.74	34260.14	45005.60
11	913.56	2055.16	1806.06	1097.08	13562.50	25000.00	178.52	11507.34	23193.94	34879.80
12	1568.25	5313.35	3398.05	3448.90	24000.00	24000.00	1880.65	18686.65	20601.95	41169.25
13	1289.76	6077.26	990.26	2039.76	41520.00	75000.00	750.00	35442.74	74009.74	110202.48
14	1028.61	5482.36	948.61	14356.75	32000.00	17046.25	13328.14	26517.64	16097.64	55943.42
15	803.61	5265.61	1189.61	981.60	24000.00	8330.00	172.95	18734.39	7140.39	26047.73
16	1931.75	11744.55	1891.65	5314.16	54400.00	6997.20	3382.41	42655.45	5105.55	51143.41
17	2369.50	8915.50	1915.30	8194.16	55800.00	10710.00	5824.66	47284.50	8794.70	61903.86
18	1613.55	5259.85	1786.35	2194.16	22500.00	75000.00	580.61	17240.15	73213.65	91034.41
19	1256.66	6944.46	1457.56	1746.35	39200.00	25000.00	489.69	32255.54	25542.44	56287.67
20	1341.01	76689.71	1284.41	5436.88	28000.00	36000.00	4095.87	30331.29	34715.55	59142.71
21	3097.31	6216.86	1674.31	2442.70	39165.00	30000.00	-654.61	32948.14	28325.19	60618.73
22	2470.85	6966.35	2626.75	2981.35	27504.00	67860.00	510.50	20537.65	65233.25	86281.40
23	1642.81	5764.51	1319.86	5131.75	41115.00	9016.00	3488.94	35380.49	7696.14	46565.57
24	1708.61	4568.01	1316.91	10606.75	53344.00	25167.00	8898.14	48775.99	23850.13	81524.26
25	2327.81	7659.81	1331.56	4735.40	29872.00	12500.00	2407.59	22212.19	10668.44	35288.22
26	1341.91	7203.61	-	3942.70	33267.50	-	2600.79	26063.89	-	28664.68
27	1905.41	6732.16	2122.11	3556.75	30805.50	24000.00	1651.34	24073.34	21877.89	47602.57
28	1929.61	6138.16	2017.11	6213.50	33280.00	12506.00	4283.89	26941.84	10488.89	41714.62
29	2530.11	10831.06	1539.11	2442.70	54175.00	25000.00	-137.41	43343.94	23410.89	66617.42
30	2233.66	6237.16	1366.61	3053.38	38775.40	7780.00	5819.72	32538.24	6413.39	44771.35
Totals	50674.52	216987.83	53308.02	112764.04	1067381.90	720590.49	62089.52	850394.07	667282.43	1579766.44
Averages	1689.15	7232.93	1776.93	3758.80	35579.40	24019.68	2069.65	23346.47	22242.75	52658.88

4.3. Data analysis using the linear programming (LP) method

The figures below which are shown on a table form are weighted averages of the values obtained from the per hectare basis, taking each farm as a unit of production. These were found to differ from the arithmetic average figures shown on table 4.2.6. The weighted averages were used for analysis since they give a better picture of the actual farm situation.

As was explained earlier in the text, the following symbols have been used:

Products: Maize = Z
Tobacco = T
Fuelwood = E

Inputs: Labour in mandays = M
Land in hectares = L
Capital in Kshs. = C

Outputs: Revenue in Kenyan shillings = II

Crop	L	M	C	II
Maize (Z)	1.00	106.20	1 689.15	2 999.00
Tobacco (T)	1.00	324.00	7 140.07	31 181.00
Fuelwood (E)	1.00	13.74	237.49	2 900.63
Totals	3.00	443.94	9 336.71	37 080.63
Averages	1.00	147.98	3 112.24	12 360.21

Inputs available for the average farm in the study area are:

Land (L) = 15.36 hectares
Labour (M) = 600.00 mandays
Capital (C) = 10 699.01 Kenyan shillings.

4.3.1. Optimal allocation of land, basic equations, 15.4 hectares of land

Since this thesis proposes that production of maize (food crop) must be given a priority to the minimum requirement over the products, it was earlier pointed out that an average family in the study areas comprising of seven members of the household requires an average of 731.00 kilogrammes of maize per year (shelled maize); 0.40 hectares of land, which is the minimum amount of land, basing on the climatic and soil conditions of the area, enough to produce the needed maize, must always be allocated for maize production.

It is a policy of the tobacco buying company, which also makes available materials, in the form of a loan, to the farmers, that no single farmer in the area should engage more than 1.00 hectares of land in the production of tobacco. According to earlier findings discussed in chapter 2.3, this requires at least one hectare of fuelwood for curing of the tobacco. The following linear equations can thus be constructed:

$$\text{Max } \pi \text{ (Net revenue)} = 2999Z + 31181T + 2901E \quad (1)$$

$$1.0Z + 1.0T + 1.0E \leq 15.4-- \quad (2)$$

$$106.2Z + 324.0T + 13.7E \leq 600.0-- \quad (3)$$

$$1689Z + 7410T + 237.5E \leq 10699.0-- \quad (4)$$

$$Z \geq 0.4--- \quad (5)$$

$$T \leq 1.0--- \quad (6)$$

$$E \geq 1.0--- \quad (7)$$

Where (1) = Revenue maximizing equation
(2) = Land restriction equation

(3) = Labour restriction equation
(4) = Capital restriction equation
(5) = Minimum maize production requirement
(6) = Maximum tobacco production requirement
(7) = Minimum fuelwood production requirement.

The above equations were rearranged for the computer utilization as follows:

	Production alternatives			Restrictions	
	Maize (Z)	Tobacco (T)	Fuelwood (E)		RHS
Net revenue (TI)	2999.00	31181.00	2901.00	*	
Land (L)	1.00	1.00	1.00	$\leq$	15.40
Labour (M)	106.20	324.00	13.70	$\leq$	600.00
Capital (C)	1689.00	7410.00	237.50	$\leq$	10699.00
Minimaize	1.00			$\geq$	0.40
Maxtobacco		1.00		$\leq$	1.00
Minifuelwood			1.00	$\geq$	1.00

These linear equations were used as the basic equations for the analysis of the data.

Apart from the above basic equations, to find out how the changes in

a) Land area i.e. average farm size and
b) production function, i.e. the average revenue obtained, affected both the optimal land allocation and the maximal net revenue, the following linear equations were further developed and used.

4.3.2. 5 smallest farms, land area 4.9 hectares

Average net revenue, labour and capital requirements were calculated for the five smallest farms in the area. The average farm size for these five farms was found to be 4.9

hectares. Linear equations were constructed for these as follows:

$$\text{Max } \Pi = 476.3Z + 24220.8T + 5604.4E \quad \text{---------- (1)}$$
$$1.0Z + 1.0T + 1.0E \leqq 4.9 \quad \text{------- (2)}$$
$$95.0Z + 391.4T + 15.3E \leqq 600.00 \quad \text{------ (3)}$$
$$796.8Z + 5090.3T + 225.9E \leqq 10699 \quad \text{------- (4)}$$
$$Z \geqq 0.4 \quad \text{------- (5)}$$
$$T \leqq 1.0 \quad \text{------- (6)}$$
$$E \geqq 1.0 \quad \text{------- (7)}$$

--(1) to ---(7) are as above (4.3.1).

These equations were also prepared for computation as in the earlier equations.

4.3.3. 5 Largest farms, average farm size 27.6 hectares

Average net revenue, labour and capital requirements were calculated for the five largest farms in the area. The average farm size of these farms was found to be 27.6 hectares.

Linear equations were constructed for these as follows:

$$\text{Max } \Pi = 2049.8Z + 27351.5T + 1969.3E \quad \text{---------- (1)}$$
$$1.0Z + 1.0T + 1.0E \leqq 27.6 \quad \text{--- (2)}$$
$$102.2Z + 202.6T + 12.2E \leqq 600.0 \quad \text{--- (3)}$$
$$606.1Z + 4099.0T + 83.7E \leqq 10699.0 \quad \text{--- (4)}$$
$$Z \geqq 0.4 \quad \text{--- (5)}$$
$$T \leqq 1.0 \quad \text{--- (6)}$$
$$E \geqq 1.0 \quad \text{--- (7)}$$

--(1) to ---(7) are as above (4.3.1).

These were also prepared for analysis as follows:

		Production alternative (Z)	(T)	(E)	Restrictions	RHS
Net revenue	(Π)	2049.8	27351.5	1969.3		
Land	(L)	1.0	1.0	1.0	$\leq$	27.6
Labour	(M)	102.2	202.6	12.2	$\leq$	600.0
Capital	(C)	706.1	4099.0	83.7	$\leq$	10699.0
Minimaize	(Z)	Z			$\geq$	0.4
Maxtobacco	(T)		T		$\leq$	1.0
Minifuelwood	(E)			E	$\geq$	1.0

4.3.4. Change in Net Revenue Function

Using the figures from (4.3.2) and (4.3.3), an average net revenue function, input function and the labour and capital available in the area, from (4.3.1) equations were used to compare how different land areas could affect the optimal allocation and the maximal net revenue.

The following equations were used.

4.3.4.1. Land available = 2.5 ha.

$$\text{Max } \Pi = 2070Z + 28346T + 2780E \text{ ---------- (1)}$$

$$= 1.0Z + 1.0T + 1.0E \leq 2.5 \text{ ----- (2)}$$

$$106.2Z + 324.0T + 13.7E \leq 600.00 \text{ ---- (3)}$$

$$1689Z + 7410T + 237.5E \leq 10699.0 \text{ ----- (4)}$$

$$Z + \geq 0.4 \text{ ----- (5)}$$

$$T \leq 1.0 \text{ ----- (6)}$$

$$E \geq 1.0 \text{ ----- (7)}$$

--(1) to ---(7) as in 4.3.1. above.

4.3.4.2. Land available = 3.2 ha

$$\begin{aligned}
\text{Max } \Pi = \quad & 2070Z + 28346T + 2780E && \text{---------- (1)}\\
& 1.0Z + 1.0T + 1.0E \leq 3.2 && \text{----- (2)}\\
& 106.2Z + 324.0T + 13.7E \leq 600.00 && \text{---- (3)}\\
& 1689Z + 7410T + 237.5E \leq 10699.0 && \text{----- (4)}\\
& Z \geq 0.4 && \text{----- (5)}\\
& T \leq 1.0 && \text{----- (6)}\\
& E \geq 1.0 && \text{----- (7)}
\end{aligned}$$

-- (1) to ---(7) as in (4.3.1) above.

4.3.4.3. Land available = 5.4 ha

$$\begin{aligned}
\text{Max } \Pi = \quad & 2070Z + 28346T + 2780E && \text{---------- (1)}\\
& 1.0Z + 1.0T + 1.0E \leq 5.4 && \text{----- (2)}\\
& 106.2Z + 324.0T + 13.7E \leq 600.00 && \text{---- (3)}\\
& 1689Z + 7410T + 237.5E \leq 10699.0 && \text{----- (4)}\\
& Z \geq 0.4 && \text{----- (5)}\\
& T \leq 1.0 && \text{----- (6)}\\
& E \geq 1.0 && \text{----- (7)}
\end{aligned}$$

--(1) to ---(7) as in (4.3.1) above.

4.3.4.4. Land available = 15.4 ha

$$\begin{aligned}
\text{Max } \Pi = \quad & 2070Z + 28346T + 2780E && \text{---------- (1)}\\
& 1.0Z + 1.0T + 1.0E \leq 15.4 && \text{----- (2)}\\
& 106.2Z + 324.0T + 13.7E \leq 600.00 && \text{---- (3)}\\
& 1689Z + 7410T + 237.5E \leq 10699.00 && \text{---- (4)}\\
& Z \geq 0.4 && \text{----- (5)}\\
& T \leq 1.0 && \text{----- (6)}\\
& E \geq 1.0 && \text{----- (7)}
\end{aligned}$$

--(1) to ---(7) as in (4.3.1) above.

4.3.4.5. Further analysis

Further tests were carried out on the equations on 4.3.1. above, land available being fixed at 15.4 hectares.

4.3.4.5.1. Total utilization of capital

Here all the capital available was to be utilized in the production

$$\begin{aligned}
\text{Max } \Pi = {} & 2070Z + 28346T + 2780E && \text{---------- (1)}\\
& 1.0Z + 1.0T + 1.0E \leq 15.4 && \text{----- (2)}\\
& 106.2Z + 324.0T + 13.7E \leq 600.00 && \text{---- (3)}\\
& 1689Z + 7410T + 237.5E = 10699.00 && \text{---- (4)}\\
& Z \geq 0.4 && \text{----- (5)}\\
& T \leq 1.0 && \text{----- (6)}\\
& E \geq 1.0 && \text{----- (7)}
\end{aligned}$$

---(1) ---(3), are the same as in (4.3.1) above,
---(4) requires that all the capital available be used up in the production process, and
---(5) to ---(7) are as in (4.3.1) above.

4.3.4.5.2. Total utilization of labour

Here all the labour available was to be utilized in the production

$$\begin{aligned}
\text{Max } \Pi = {} & 2070Z + 28346T + 2780E && \text{---------- (1)}\\
& 1.0Z + 1.0T + 1.0E \leq 15.4 && \text{----- (2)}\\
& 106.2Z + 324.0T + 13.7E = 600.0 && \text{----- (3)}\\
& 1689Z + 7410T + 237.5E \leq 10699.0 && \text{----- (4)}\\
& Z \geq 0.4 && \text{----- (5)}\\
& T \leq 1.0 && \text{----- (6)}\\
& E \geq 1.0 && \text{----- (7)}
\end{aligned}$$

---(1) and ---(2) are as in (4.3.1) above, and

---(3) requires that all the labour available be utilized in the production process, and

---(4) to ---(7) are as in (4.3.1) above.

5. RESULTS OF THE DATA ANALYSIS

5.1. Optimal allocation of land, basic equations; 15.4 hectares of land

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
70161.10	0.4	0.9	14.1	600.0	527.2	+72.8	10699.0	10699.0	0.0

Where

Z, T and E are as used earlier

A = Total amount of resource e.g. land in hectares, labour in mandays or capital in Kenya shillings available.

U = The amount of resource used, and

R = Remarks on the use, e.g. whether there is excess +, less -, or nothing, 0.

5.2. Optimal allocation of land, 4.9 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
44025.40	0.4	1.0	3.5	600.0	483.0	+117.0	10699	6199.80	+4499.20

Where

Z, T, E are as earlier indicated

A, U and R are as in 5.1 above.

5.3. Optimal allocation of land, 27.6 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
79793.00	0.8	1.0	25.8	600.0	600.0	0.0	10699.0	6837.10	+3861.90

Z, T, E, A, U and R are as in 5.1 above.

5.3.1. Land available = 2.5 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
32232.00	0.4	1.0	1.1	600.0	381.6	+218.4	10699.0	8346.9	+2352.1

Z, T, E, A, U and R are as in 5.1 above.

5.3.2. Land available 3.2 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
34178.00	0.4	1.0	1.8	600.0	391.1	+208.9	10699.0	8513.1	+2185.9

Z, T, E, A, U and R, are as in 5.1. above.

5.3.3. Land available = 5.4 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
46223.10	0.4	1.2	3.9	600.0	493.2	106.8	10699.0	10699.0	0.0

Z, T, E, A, U and R are as in 5.1 above.

5.3.4. Land available = 15.4 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
65557.5	0.4	0.9	14.1	600.0	527.5	+72.5	10699.0	10699.0	0.0

Z, T, E, A, U and R are as in 5.1 above.

5.3.4.1. Total utilization of capital

All the capital available is to be utilized in the production process, land area = 15.4 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
65557.7	0.4	0.9	14.1	600.0	527.5	+72.5	10699.0	10699.0	0.0

Z, T, E, A, U and R are as in 5.1 above.

5.3.4.2. Total utilization of labour

All the labour available to be utilized in the production process, land available = 15.4 hectares

Net revenue Kshs	Land allocation (ha)			Labour (MD)			Capital (Kshs)		
	Z	T	E	A	U	R	A	U	R
51195.8	2.8	0.4	12.2	600.0	600.0	0.0	10699.0	10699.0	0.0

Z, T, E, A, U and R are as in 5.1 above.

6. DISCUSSION OF THE RESULTS

6.1. Optimal allocation of land

Assuming that the production equations are a true representation of the situation in the surveyed farms, the optimal land allocation of the 15.4 hectares, available, which maximizes the net revenue was found to be as follows:

net revenue - 70 161.10 Kenyan shillings
maize production - 0.4 hectares
tobacco production - 0.9 hectares and
fuelwood production - 14.1 hectares.

Apart from the land resource, the maximal net revenue was achieved by the utilization of 527.2 mandays of the 600.0 available mandays, and 10 699.0 Kenyan shillings, the whole of the available capital resource.

This result shows that of all the available resources, capital was the most limiting. Land was also limiting resource since all of the available land resource was used.

The results show that 72.8 mandays of the available labour resource were not utilized. This shows that either the labour ought to be channelled into the production of other items, which requires less capital than, for example, tobacco, or more capital and/or land made available, before the excess labour could be utilized.

Alternatively, if no more capital and/or land is available to the farmer, the farmer could sell the excess available labour at the prevailing market price so as to earn an additional income, about Kenyan shillings 637.00.

Changing of the net revenue function and the production function, cases 4.3.2, and 4.3.3, with land resource availability also being varied, had, as indicated on

5.2 and 5.3, the following effects:
When the land resource was 4.9 hectares, more labour, 117.0 mandays remained unutilized, and some capital, Kenyan shillings 4 499.20 remained unutilized in the production process; when the land resource was increased, from 4.9 hectares to 27.6 hectares, all the land was utilized, all the labour was utilized, but some capital resource, 2 352.1 Kenyan shillings remained unused. In both these cases, land resource was indicated as the limiting resource, while capital was in abundance. Increasing the land resource, case 4.3.3, indicated that the labour which remained in case 4.3.2 was switched to the production of maize and fuelwood, after tobacco production had already reached its limit.

The most interesting results are shown by 4.3.4.1 to 4.3.4.4.
Here the net revenue function and all the other production functions were fixed, but the land resource availability was varied; it varied from 2.5 hectares, the least economic farm size possible in this area (Anonymous), to 15.4 hectares, the average farm size in the study area. Results, obtained for the utilization of labour and capital, show the following:

a) The use of both labour and capital increases with the increase in the land hectarage.

b) Capital resource is used up earlier than the labour resources, this occurs when the land resource is at 5.4 hectares.

c) Land resource allocated to maize production is constantly at its minimal requirement, 0.4 hectares.

d) More land is allocated for fuelwood production and for tobacco production, the former increasing faster than the latter.

e) After the capital resource has been totally used up, the remaining land and labour resources are allocated to fuelwood production.

These results again show that the most limiting resource in the study area is capital, followed by land, and then labour. Production of tobacco is more capital and labour intensive than that of maize and fuelwood, but maize production is more capital and labour intensive than fuelwood production.

This argument can further be discussed in the light of cases 5.3.4.1 and 5.3.4.2, in which cases the capital and labour resources, respectively available, had to be utilized in the production process, land resource being fixed at 15.4 hectares. These are compared with case 5.3.4.

When all the capital resource available was utilized, 72.5 mandays remained unused, while the land allocated to the three crops and the net revenue were as follows:

Crop	from	to	% change
Maize	0.4 ha	0.4 ha	0
Tobacco	0.9 ha	0.9 ha	0
Fuelwood	14.1 ha	14.1 ha	0
Net revenue	65 557.7 Kshs	65 557.7 Kshs	0

This result is included in the first test, as here, too, all the capital was utilized.

When all the available labour resource was utilized; while all the capital resource was used up, the land allocated to the three crops changed as follows:

Crop	from	to	% change
Maize	0.4 ha	2.8 ha	600.0
Tobacco	0.9 ha	0.4 ha	- 55.6
Fuelwood	14.1 ha	12.2 ha	- 13.5
Net revenue	65 557.5 Kshs	51 195.8 Kshs	- 21.9

This shows that the increase in the labour use from 527.5 mandays to 600 mandays, a change of 13.7 % resulted in a decrease of 21.9 % in the net revenue, 600 % increase in maize production and a decrease of 55.6 % and 13.5 % in the tobacco and fuelwood productions.

These results show the following:

1) With the average available resources and the average inputs of land, labour and capital resources in the study area, maize production should be kept at its minimum requirement, tobacco production at its maximum requirement, while the remaining resources should be devoted to fuelwood production, assuming the prevailing production functions developed from the average farm conditions can be taken as truly representative of the farming conditions in the area.

2) Any additional capital resource should be allocated to the tobacco production, followed by the maize production, while

3) Any additional labour resource should be allocated to the fuelwood production first, then maize production. No additional labour resource should be allocated to the tobacco production as

4) replacement of capital with labour in maize and fuelwood production would result into a more efficient use in the labour resource than vice versa, while replacing labour with capital in the tobacco production would give better

results than when the opposite was done.

6.2. Sensitivity analysis

To test how changes in the capital and labour resources available would effect both the maximal net revenue and the optimal land allocation, a sensitivity analysis was carried out.

This was done on the basic equations, case 4.3.1 whose results are shown on 5.1 as:

Net revenue Kshs	Land allocation, ha			Labour usage, MD			Capital usage, Kshs		
	Z	T	E	A	U	R	A	U	R
70 161.10	0.4	0.9	14.1	600.0	527.2	72.8	10699.0	10699.0	0.0

Total land area 15.4 ha.

The tests were done using the PARROW subprogramme of the TEMPO programme. This subprogramme determines a series of solutions by increasing the value of e.g. capital resource, or labour resource from the least specified amount to the maximum specified amount, by each time adding or subtracting, as the case may be, the specified amount.

6.2.1. Effect of changing the capital resource allocations

The amounts of capital resource, in Kenyan shillings, allocated to the production of each of the three crops were varied. Three cases were tested.

a) In case one, the programme was set to add the following amounts of capital resource to the initial capital allocations, and thereafter, to automatically keep on adding the value till the tenth addition was reached:

Crop	from (Kshs)	to (Kshs)
Maize	1689.00	1789.00
Tobacco	7410.00	4210.00
Fuelwood	237.50	237.50

When these were run, the following results were obtained:

Net revenue Kshs	Land allocation, ha			Labour usage, MD			Capital usage, Kshs		
	Z	T	E	A	U	R	A	U	R
Initial case 70 161.10	0.40	0.89	14.11	600.0	527.2	+72.8	10699.0	10699.0	0.0
Resultant case (a) 70 742.90	0.40	0.92	14.08	600.0	533.6	+66.4	10699.0	10699.0	0.0

b) In case two, the programme was set to add the following amounts of capital resource to the initial capital allocation and thereafter to keep on adding the value till the tenth addition was reached:

Maize, add	-3.00 Kenyan shillings
Tobacco, add	5.00 Kenyan shillings
Fuelwood, add	0.00 Kenyan shillings

The capital allocations, therefore, varied as follows:

Crop	from (Kshs)	to (Kshs)
Maize	1689.00	1659.00
Tobacco	7410.00	7360.00
Fuelwood	237.50	237.50

When these were run, the following results were

Net revenue Kshs	Land allocation, ha			Labour usage, MD			Capital usage, Kshs		
	Z	T	E	A	U	R	A	U	R
Initial case 70161.10	0.40	0.89	14.11	600.0	527.2	+72.8	10699.0	10699.0	0.0
Resultant case (c) 73038.80	0.85	1.00	13.55	600.0	600.0	0.0	10699.0	8604.80	+2094.20

6.2.2. Effects of varying the labour resource allocations

The amounts of labour resource, in mandays, required for the production of each of the three crops were varied. Three cases were tested:

a) In case one, the programme was set to add the following amounts of labour resource to the initial labour allocations till the tenth addition was reached:

Maize, add 5.0 mandays
Tobacco, add 10.0 mandays
Fuelwood, add 0.5 mandays

The labour allocations therefore varied as follows:

Crop	from (MD)	to (MD)
Maize	106.20	156.2
Tobacco	324.00	424.0C
Fuelwood	13.70	18.7C

When these were run, the following results were obtained:

Net revenue Kshs	Land allocation, ha			Labour usage, MD			Capital usage, Kshs		
	Z	T	E	A	U	R	A	U	R
Initial case 70161.10	0.40	0.89	14.11	600.0	527.2	+72.8	10699.0	10699.0	0.0
Resultant case (a) 62648.30	0.40	0.63	14.37	600.0	600.0	0.0	10699.0	8786.50	+1912.40

b) In case two, the programme was set to add the following amounts of the labour resource to the initial labour resource allocations till the tenth addition was reached:

Maize, add	3.0 mandays
Tobacco, add	-5.0 mandays
Fuelwood	0.0 mandays.

The labour allocations, therefore, varied as follows:

Crop	from (MD)	to (MD)
Maize	106.20	136.20
Tobacco	324.00	274.00
Fuelwood	13.70	13.70

When these were run, the following results were obtained:

Net revenue Kshs	Land allocation, ha			Labour usage, MD			Capital usage, Kshs		
	Z	T	E	A	U	R	A	U	R
Initial case 70161.0	0.40	0.89	14.11	600.0	527.2	+72.8	10699.0	10699.0	0.0
Resultant case (b) 70188.90	0.40	0.90	14.10	600.0	461.4	+138.6	10699.0	10699.0	0.0

c) In case three, the programme was set to add the following amounts of the labour resource to the initial labour resource allocations till the tenth addition was reached:

maize, add 0.0 mandays,
tobacco, add 10.0 mandays and
fuelwood, add -0.5 mandays.

The labour allocations, therefore varied as follows:

Crop	from (MD)	to (MD)
Maize	106.20	106.20
Tobacco	324.00	424.00
Fuelwood	13.70	-16.30

When these were run, the following results were obtained:

Net revenue Kshs	Land allocation, ha			Labour usage, MD			Capital usage, Kshs		
	Z	T	E	A	U	R	A	U	R
Initial case 70161.10	0.40	0.89	14.11	600.0	527.2	+72.8	10699.0	10699.0	0.0
Resultant case (c) 70188.90	0.40	0.90	14.10	600.0	566.7	+13.3	10699.0	10699.0	0.0

6.2.3. Results of the sensitivity analysis

6.2.3.1. Varying the capital resource requirements

When more capital was needed per hectare for the production of maize and less for the production of tobacco, keeping the per hectare capital requirements for fuelwood production unaltered, there was only an insignificant increase in the net revenue, no change occurred in the land allocated for maize production, and there

was a slight increase in the land allocated for tobacco production. There was also a slight decrease in the land allocated for fuelwood.

Increasing the unit need of capital for tobacco production and, at the same time, lowering the unit needs for the maize and fuelwood production, increased the net revenue significantly, case 6.2.1 (c), from Kshs 70161.10 to Kshs 73038.80. The land allocated for tobacco production remained constant, while that allocated for maize production increased significantly, from 0.40 ha to 0.89 ha, an increase of more than 100 %, case 6.2.1 (c). At the same time, the amount of land resource made available for fuelwood production decreased by about 3.4 %.

6.2.3.2. Varying the labour resourcerequirements

When the amount of labour resource needed per hectare in the production of the three crops were increased, case 6.2.2. (a), there was a significant decrease in the net revenue of about 10 %. The land resource allocated to maize production remained at its minimum requirement of 0.4 ha, while there was a significant decrease in the tobacco hectarage of about 29 %. The land allocated for fuelwood production increased slightly, by about 2 %.

Increasing the labour resource requirements for maize production, while decreasing those for tobacco, and keeping the unit requirements for fuelwood constant, had no significant effect on the maximal net revenue, case 6.2.2 (b). There was also no significant change in the land resource allocations, but the amount of unused labour increased significantly, by about 90 %.

6.3. Some concluding remarks

Assuming the production functions and their restrictions used in this study to be true presentation for the study area, it can be observed that of all the productive resources available in the study area, which may be channelled in the production of the three studied crops, maize, tobacco and fuelwood, capital is the most limiting.

Production of both fuelwood and maize should be more labour extensive and less capital intensive. This is more so in the production of fuelwood. Tobacco production, on the contrary, gives better results when made less labour extensive and more capital intensive.

Best net revenue is obtained when more labour is utilized in the production of fuelwood, followed by maize and then tobacco, while the same is true when more capital and hence more land is allocated to the tobacco production. With more available capital, tobacco production takes an upper hand on the production of all the other two crops, while maize production has an advantage over fuelwood production in land allocation.

No significant competition for the use of land exists amongst these crops in the study area.

These concluding remarks must be read with a lot of care. As it is always with this kind of research, setting biases in answers given by the respondents may be detected, but single testing for such biases in order to either exclude them or adjust for them is still not possible. Caution must be taken so that subjectiveness is avoided.

Bias may come about from the respondents part as a result of them not being able to remember exact figures for the inputs and outputs, as such answers are based on memory. Due to expectations and doubt, answers given by the respondents may

not reflect the reality of the farming business situation.

Bias may also come from the part of the recorder as a result of not recording the exact answers given by the respondents.

Finally, to add to the above concluding remarks, the following words by Schumacher would act as food for thought in tacking the problems of improving the welfare of the rural communities. "To restore a proper balance between city life and rural life is perhaps the greatest task in front of modern man. It is not simply a matter of raising agricultural yields so as to avoid world hunger. There is no answer to the evils of mass emigration into cities unless the whole level of rural life can be raised, and this requires the development of an agroindustrial culture, so that each district, each community, can offer a colourful variety of occupations to its member" (Schumacher 1974).

7. REFERENCES

AGATSIVA, J.L. and MWENDWA, H. 1982. Land Use Mapping of Kenya Using Remote Sensing Techniques. Ministry of Environment and Natural Resources. KREMU. Technical Report Series No. 72. June 1982.

ARNOLD, E.E.M. 1978 a. Economic and political environment for investment in natural tropical forest development. In proceedings of the conference on improved utilization of tropical forests. USA.

---------- 1978 b. Wood energy and rural communities. A paper presented at the 8th World Forestry Congress. Jakarta. Indonesia.

BAJRACHARYA, D. 1980. Fuelwood and food needs versus deforestation. An nergy study of a Hill village, Panchayat, in Eastern Nepal. Energy for Rural Development Programme Report. RR-80-2.

BARNES, C., ENSMINGER, J. and O'KEEFE, P. 1984. Wood, Energy and Households. Perspectives on Rural Kenya. The Beijer Institute. Stockholm - Sweden.

BEETS, W.C. 1984. Agroforestry in African Farming Systems. USAID. Washington D.C. USA.

BEN SALEM, B. and TRAN VAN NAO 1981. Fuelwood production in traditional farming systems. Unasylva (FAO). No. 131 Volume 33. FAO. Rome.

BEST, M. 1979. The scarcity of Domestic Energy. A study in three villages. South African Labour Development. Research Unit Working Paper No. 27. Cape Town. S. Africa.

BIALY, J. 1979. Firewood use in a Sri Lankan village. A preliminary survey. University of Edinburg, School of

Engineering Sciences. Edinburg.

BODHAL, GIBBS and SIMMONS 1970. Campaign against Malnutrition in Kenya 1964-1968. Government Printer. Nairobi.

BON VOISIN, S. 1982. The implications of community forestry projects in Unjarat - India (John Mill Essay). The Commonwealth Forestry Review No. 187 Volume 61(2).

BRISCOE, J. 1979. The Political Economy and Energy Use in Rural Bangladesh. Harvard University of Environmental Systems Programme. Harvard U/niversity. Cambridge.

CLAWSON, M. et al. 1977. Research in Forest Economics and Forest Policy. Resources for the future. Washington D.C. USA.

DIGERNES, T.H. 1977. Wood for Fuel. Energy Crisis Implying Desertification. The case of Bara of the Sudan. Ph.D. Dissertation. University of Bergen. Norway.

---------- 1979. Fuelwood crisis causing unfortunate land use - and the other way around. Norsk Geografisk Tidskrift No. 33, 23 - 32.

DORMAN, SAMUELSSON and SOLOW 1958. Linear Programming and Economic Analysis. The Rand Series.

DYKSTRA, D.P. 1984. Mathematical programming for Natural Resource Management. McGraw-Hill Book Company. USA.

FAO 1978. Economic Analysis of Forestry Projects. FAO - Rome. Italy.

FOUND, W.C. 1971. A theoretical approach to rural land use patterns. Edward Arnold - Bristol - United Kingdom.

FRENCH, D. 1980. The Economics of Renewable Energy Systems for Developing Countries. Natural Resources Forum No. 4(1). UND New York.

Government of Kenya 1982. Development Plan 1983/88. Government Printer. Nairobi - Kenya.

---------- 1980. The rural/Urban Household Energy Consumption survey. October/November, 1978. Central Bureau of Statistics. Nairobi - Kenya.

---------- 1983. Statistical Abstract. Central Bureau of Statistics. Nairobi - Kenya.

---------- 1984 a. Economic Survey. Central Bureau of Statistics. Nairobi - Kenya.

---------- 1984 b. District Focus for Rural Development. Government Printer. Nairobi - Kenya.

---------- 1984 c. South Nyanza District Development Plan. Government Printer. Nairobi - Kenya.

HEADY, E.O. and DILLON, J.C. 1972. Agricultural Production Functions. Iowa State University Press. Iowa . USA.

HOEKSTRA, D.A. and KUGURU, F.M. Ed. 1982. Agroforestry Systems for Small Scale Farmers. Proceedings of the ICRAF/ BAT workshop held in Nairobi. September 1982.

---------- 1983. The Use of Economics in Agroforestry. ICRAF - Nairobi. Kenya.

HOFSTAD, O. 1978. Preliminary Evaluation of the Taungya System for combined Wood and Food Production in North Eastern Tanzania. University of Dar-es-Salaam. Forestry Division. Record No. 2.

HOSIER, R. 1981 a. Surveys of domestic Energy Consumption in Kenya. Beijer Institute Fuelwood Project working paper. Nairobi - Kenya.

---------- 1981 b. Something to Buy Paraffin with. An analysis of domestic Energy Consumption Patterns in Rural Kenya. Ph.D. thesis. Clark University.

KEIPI, K. 1977. Transfer Pricing for Log Allocation in a Decentralized Forest Products Firm. Communicationes Instituti Forestalis Fenniae 89.2. Helsinki.

---------- 1978. Approaches for Functionally Decentralized Wood Procurement Planning in a Forest Products Firm. Communicationes Instituti Forestalis Fenniae 93.4. Helsinki.

KELTIKANGAS, M. 1971. Time Factor and Investment Calculations in Timber Growing. Theoretical Fundamentals. Acta Forestalia Fennica Vol. 120.

KILKKI, P. 1985. Timber Management Planning. Silva Carelica 5. University of Joensuu. Joensuu. Finland.

KING, K.F.S. 1979. Population and Social Pressures on Land Base. The Forestry Chronicle. No. 6 Volume 55.

LEYS, C. 1976. Continuity and Change in Agriculture - a chapter from the book "Underdevelopment in Kenya". Heinemann Educational Books. London.

LIPTON, M. 1977. Why poor people stay poor. A Study of Urban Bias in World Development. London.

MacGREGOR, J.T. 1962. Forestry as a competitor for land. Some problems in land use decisions. 8th British Forestry Conference - 1962. East Africa.

MANIBOG, F. 1979. Patterns of Energy Utilization in a Philippine Village: Sources, Wnduse and Correlation Anlysis. International Energy Agency. Paris.

MANZAVA, F.N. 1984. Land Reform for Rural Development. A paper delivered to the Kenyan-Finnish Seminar on Rural Development and Land Questions. June 1984.

MISHAN, E.J. 1971. Cost-benefit analysis. Unwin University Books. London.

MUNGALA, P.M. 1979. Estimation of Present and Likely Future Demand for Fuelwood and Charccal in Machakos District - Kenya. Master's Thesis. University of Dar-es-Salaam. Tanzania.

MUTHOO, M.K. 1970. Renewable Natural Resources Planning for Regional Development with Reference to Kashmir. Unpublished Doctor of Philosophy Thesis. Commonwealth Forestry Institute. Oxford.

MWANIPOPO, P.B. 1977. A Woodfuel Consumption Survey in Morogoro Urban Area. Special Project in Forest Economics. division of Forestry. University of Dar-es-Salaam. Tanzania.

NAYLOR, T.H. and VERNON, J.M. 1969. Microeconomics and Decision Models of the Firm. Harcourt, Brace and World. USA.

O'KEEFE, P., RASKIN, P. and BERNOW, S. 1984. Energy and Development in Kenya, Opportunities and Constraints. Beijer Institute. Stockholm - Sweden.

OMWAMI, R.K. 1983. Economic Analysis of Plantation Forests in Kenya. LMST Method Apllied. Unpublished M.Sc.

Thesis. University of Helsinki - Finland.

OPENSHAW, K. 1982. Survey of biomass. A conditionally renewable energy resource. Beijer Institute - Nairobi.

REDDY, A.K.N. et al. 1980. Rural Energy Consumption Patterns in Bangalore. A field study. Indian Institute of Science. New Delhi - India.

REDMAN, B.J. and REDMAN, J.C. 1981. MIcroeconomics. Resource Allocation and Price Theory. Connecticut - USA.

RIIHINEN, P. 1981. Forestry and the Timber Economy in Economic Development. Silva Fennica Vol. 15 No. 2: 199-207. Helsinki Finland.

SCHAETZL, L. and AY, P. 1979. The Rural Energy System of Nigeria. Report prepared for the United Nations University. Tokyo - Japan.

SCHUMACHER, E. 1974. Economic Growth and Rural Development. Blond and Briggs. United Kingdom.

TAHA, H.A. 1982. Operations Research. An introduction. Collier/Macmillan Publishers. London/New York.

WOOD, D-H. et al. 1979. The Socio-economic and Environmental Context of Fuelwood Programmes. USAID - Washington D.C. USA.

World Bank 1978. Forestry sector policy guidelines. The World Bank, Washington D.C. USA.

APPENDIX (i)

Farm size (in hectares), crops growing in the farm (all crops), area for each crop grown (in hectares), animals (cattle), kept by the farmer; only mature cattle were considered, and land values.

Farm No.	Area of farm, ha	Crops grown	Crop areas, ha	Animals kept, No.	Land value, Kshs/ha
01	14.20	Maize	6.00	4	3 000.00
		Sorghum	3.00		
		Coffee	1.00		
		Tobacco	1.10		
		Trees	4.30		
		Total	15.90		
02	30.00	Maize	6.00	8	1 500.00
		Sugar cane	2.60		
		Tobacco	2.00		
		Trees	2.40		
		Total	13.00		
03	23.00	Maize	2.00	4	3 000.00
		Sorghum	1.20		
		Tobacco	1.00		
		Cassava	1.00		
		Beans	1.00		
		Trees	1.00		
		Total	7.20		
04	9.60	Maize	2.00	4	3 000.00
		Tobacco	1.00		
		Cassava	2.40		
		Trees	0.01		
		Total	5.41		
05	8.30	Maize	2.40	6	2 000.00
		Sorghum	2.40		
		Cassava	0.50		
		Tobacco	0.50		
		Trees	1.30		
		Total	7.60		
06	13.30	Maize	2.50	8	1 500.00
		Cassava	0.40		
		Vegetables	0.20		
		Bananas	0.25		
		Sugar cane	4.60		
		Tobacco	1.00		
		Trees	1.20		
		Total	10.15		
07	4.10	Tobacco	0.50	2	6 000.00
		Maize	1.50		
		Trees	1.20		
		Total	3.20		

08	8.30	Tobacco	0.75	4	3 000.00
		Maize	2.00		
		Trees	1.20		
		Sorghum	0.40		
		Beans	0.40		
		Sweet potatoes	0.10		
		Total	4.35		
09	19.30	Sugar cane	1.60		
		Maize	0.80		
		Sorghum	0.40		
		Tobacco	0.75		
		Trees	0.12		
		Total	3.67		
10	3.20	Sweet potatoes	0.25		
		Cassava	0.25		
		Maize	1.20		
		Trees	0.50		
		Tobacco	0.50		
		Total	2.70		
11	50.00 (estimated)	Maize	2.50	5	2 400.00
		Cassava	1.00		
		Tobacco	0.30		
		Sweet potatoes	0.20		
		Beans	0.40		
		Ground nuts	0.40		
		Trees	0.30		
		Total	6.00		
12	12.50	Cassava	1.25		
		Maize	2.10		
		Sweet potatoes	0.20		
		Tobacco	1.00		
		Trees	0.80		
		Total	5.35		
13	5.42	Maize	2.08		
		Tobacco	0.75		
		Beans	0.40		
		Ground nuts	0.40		
		Trees	0.30		
		Total	4.43		
14	25.00	Tobacco	1.00	4	3 000.00
		Maize	0.40		
		Trees	2.20		
		Total	3.60		
15	10.40	Maize	4.20	10	1 200.00
		Trees	0.30		
		Cassava	1.50		
		Tobacco	1.25		
		Total	7.75		
16	6.70	Trees	1.20		

		Maize	1.25		
		Sorghum	0.62		
		Tobacco	0.50		
		Total	3.57		
17	13.60	Cassava/			
		Sweet potatoes	0.50		
		Maize	1.25		
		Tobacco	1.00		
		Sorghum	0.10		
		Bananas	1.00		
		Trees	1.40		
		Total	5.25		
18	5.60	Maize	1.25	6	2 000.00
		Sorghum	0.25		
		Cassava	0.25		
		Tobacco	1.00		
		Trees	0.40		
		Total	3.15		
19	7.90	Maize	2.00	4	3 000.00
		Tobacco	0.50		
		Trees	0.80		
		Total	3.30		
20	20.70	Maize	1.70		
		Beans	1.00		
		Ground nuts	1.50		
		Tobacco	1.00		
		Trees	2.00		
		Total	7.20		
21	20.00	Maize	1.00		
		Finger millet	0.50		
		Cassava	0.50		
		Tobacco	0.75		
		Trees	1.40		
		Total	4.15		
22	11.00	Maize	2.00	10	1 200.00
		Cassava	0.50		
		Finger millet	0.10		
		Sweet potatoes	0.10		
		Sorghum	0.10		
		Tobacco	0.75		
		Sisal	-		
	Trees		0.90		
		Total	4.45		
23	11.00	Tobacco	0.75	10	1 200.00
		Maize	0.40		
		Sorghum	0,20		
		Cassava	0.40		
		S. potatoes	0.20		
		E. potatoes	0.10		
		Trees	3.20		
		Total	5.25		

24	30.00	Tobacco	0.30	6	1 333.00
		Maize	0.40		
		Beans	-		
		Finger millet	0.10		
		Cassava	0.20		
		Trees	1.50		
		Total	3.00		
25	25.80	Finger millet	0.50	10	2 400.00
		Cassava	0.50		
		Sweet potatoes	-		
		Maize	0.50		
		Beans	-		
		Vegetables	-		
		Tobacco	0.75		
		Trees	0.80		
		Total	3.05		
26	3.00	Tobacco	0.80		
		Maize	1.00		
		Beans	1.00		
		Total	2.80		
27	6.00	Maize	0.40		
		Sorghum	0.20		
		Cassava	0.40		
		Tobacco	1.10		
		Trees	0.50		
		Total	2.60		
28	12.00	Maize	0.20		
		Cassava	0.60		
		Finger millet	0.40		
		Sweet potatoes	0.10		
		Beans	0.10		
		Ground nuts	0.20		
		Tobacco	0.75		
		Trees	1.04		
		Total	3.39		
29	25.00	Tobacco	0.50	7	1 714.00
		Maize	1.00		
		Finger millet	0.50		
		Trees	0.40		
		Sweet potatoes	0.20		
		Bananas	1.50		
		Total	4.10		
30	11.00	Maize	0.80	16	750.00
		Cassava	0.75		
		Bananas	1.50		
		Tobacco	0.80		
		Trees	1.08		
		Total	4.93		

APPENDIX (ii)

Variable input factors

Farm No.	Crop	Crop area, ha	Crop production costs Item	Man-days (MD)	Cost (Kshs)	Comments
01	Maize	6.00	Seed	-	540.00	
			Ploughing	42	420.00	Labour costed
			Harrowing	42	420.00	at Kshs 10.00
			Planting	42	420.00	per day
	(ox plough)		Weeding 1st	42	420.00	
	(labour)		Weeding 2nd	42	420.00	Total labour
			Harvesting	21	210.00	cost = Kshs.
			Transporting	21	210.00	2 520.00
			Fertilizers	-	-	
				252	3060.00	
	Tobacco	1.10 (ox)	Clearing	16	154.00	
			Ploughing	22	220.00	
			Planting	38	374.00	
			Weeding 1st	31	308.00	
			Weeding 2nd	16	154.00	
			Fertilizing	9	88.00	
			Spraying	3	22.00	
			Ridging	9	88.00	
			Topping	31	308.00	
			Suckering	31	308.00	Total labour
			Harvesting	38	374.00	cost = Kshs
			Transporting	9	88.00	2 530.00
			Materials loan		2316.00	
				263	5302.00	
	Trees	4.30	Clearing	-	2300.00	
			Pitting	-		Records were
			Seedlings	-	1560.00	available in
			Planting	-		money terms
			Weeding	-		on fuelwood
			Pruning	-		production.
			Thinning	-	7916.30	
			Harvesting	-		Labour cost
			Transporting	-		value = Kshs
				1052	12076.80	10516.80
02	Maize	6 .00	Seed	-	540.00	
			Clearing	42	540.00	
			Ploughing	42	420.00	
			Harrowing	42	420.00	
			Planting	42	420.00	Labour costed
			Weeding 1st	42	420.00	at Kshs 10.00
			Weeding 2nd	21	210.00	per day
			Harvesting	21	210.00	
			Fertilizers	-	-	
				252	3060.00	Labour cost value = Kshs 2 520.00
	Tobacco	2.00	Clearing	-	2000.00	

					Ploughing	14	350.00
					Harrowing	7	175.00
					Ridging	7	175.00
					Planting	14	350.00
					Weeding 1st	7	175.00
					Weeding 2nd	14	350.00
					Fertilizing	7	175.00
					Spraying	1	25.00
					Topping	14	350.00
					Suckering	14	350.00
					Harvesting	30	750.00
		Transporting	30	750.00			
		Loan (materials)		9000.00			
			159	14975.00			
ees	2.4	Clearing	-	1125.00	Hired		
		Pitting	-	1125.00	contractor		
		Seedlings	-	650.00			
		Planting	12,5	175.00			
					Weeding	-	
					Pruning	-	
					Thinning	-	
250.00					Harvesting	25	
250.00					Transporting	25	
3525.00							
200.00	- cost of		03		Maize	2.0	
93.00	hired labour						
93.00							
93.00							
46.70							
200.00							
180.00							
46.70							
799.10							
					Tobacco	1.0	
	3 people employed at						
14400.00	200/- per month for 9 months						
3113.55							
17513.55							
200.00					Trees	1.0	
400.00					(2 500 trees)		
325.00							
140.00							
140.00							

Clearing	30
Ploughing	14
Harrowing	14
Planting	14
Weeding 1st	7
Weeding 2nd	30
Seed	
Fertilizers	-
Transporting	7

Clearing	
Ploughing	
Harrowing	
Ridging	
Planting	2160
Weeding 1st	
Weeding 2nd	
Fertilizing	
Spraying	
Topping	
Suckering	
Harvesting	
Transporting	
Materials loan	-

Clearing	30
Pitting	60
Seedlings	-
Planting	14
Weeding	14

			Pruning	-	-	
			Thinning	-	-	
			Harvesting	14	140.00	
			Transporting	14	140.00	
					1485.00	
04	Maize	2.0	Seed	-	-	
			Clearing	-	-	
			Ploughing	14	140.00	
			Harrowing	14	140.00	
			Planting	14	140.00	Labour costed
			Weeding 1st	14	140.00	at Kshs 10 pe
			Weeding 2nd	14	140.00	manday
			Harvesting	7	70.00	
			Transporting	7	70.00	
			Fertilizers	-	-	
			Threshing	1	10.00	
					350.00	
	Tobacco	1.0	Clearing (Ploughing x 3)	13	130.00	
			Harrowing	8	80.00	
			Ridging	4	40.00	
			Planting	30	250.00	
			Weeding 1st	7	70.00	
			Weeding 2nd	30	250.00	
			Fertilizing	-	-	
			Spraying	4	40.00	
			Topping	30	250.00	
			Suckering	30	250.00	
			Harvesting	30	250.00	
			Transporting	30	250.00	
			Materials loan	-	3160.00	
					5070.00	
	Trees	0.01	Seedlings	-	52.00	
			Clearing	2	20.00	
			Pitting			
			Planting	3	30.00	
			Weeding	2	20.00	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	3	30.00	
			Transporting	3	30.00	
					182.00	
05	Maize	2.4	Seed	-	42.00	Seed from hom
			Clearing	-	-	supply (no
			Ploughing	14	230.00	seed bought)
			Harrowing	14	280.00	
			Planting	7	140.00	
			Weeding 1st	14	280.00	
			Weeding 2nd	30	600.00	labour costed
			Harvesting	7	140.00	at 600/- per
			Transporting	2	40.00	month
			Threshing	2	40.00	
			Fertilizing	-	-	
					1842.00	

	Tobacco	0.5	Clearing	7	140.00
			Ploughing	7	140.00
			Harrowing	4	80.00
			Ridging	4	80.00
			Planting	10	200.00
			Weeding 1st	4	80.00
			Weeding 2nd	14	280.00
			Fertilizing	4	80.00
			Spraying	4	80.00
			Topping	14	280.00
			Suckering	14	280.00
			Harvesting	30	600.00
			Transporting	10	200.00
			Material loans	-	2068.55
					4588.55
	Trees	1.8	Clearing	12	240.00
			Ploughing	12	240.00
			Pitting	15	300.00
			Planting	15	300.00
			Seedlings	-	585.00
			Weeding	15	300.00
			Pruning	-	-
			Thinning	-	-
			Harvesting	15	300.00
			Transporting	2	40.00
					2005.00
06	Maize	2.5	Clearing	-	-
			Ploughing	39	325.00
			Harrowing	39	325.00
			Planting	30	250.00
			Weeding 1st	39	325.00
			Weeding 2nd	12	100.00
			Harvesting	54	450.00
			Transporting	6	50.00
			Seeds	-	40.00
					1865.00
	Tobacco	1.0	Clearing	-	-
			Ploughing	-	-
			Harrowing (4 times)	36	300.00
			Ridging	9	75.00
			Planting	42	350.00
			Weeding 1st	308	2566.70
			Weeding 2nd	6	50.00
			Fertilizing	3	25.00
			Spraying	3	25.00
			toppping	22	183.30
			Suckering	88	733.30
			Harvesting	66	550.00
			Transporting	10	83.30
			Materials loan	-	2802.20
					7743.80
	Trees	1.2	Clearing	6	50.00

Labour costed at 250/- per month

			Ploughing	6	50.00
			Pitting	6	50.00
			Planting	6	50.00
			Seedlings	-	300.00
			Weeding	8	66.70
			Pruning	4	33.35
			Thinning	1	8.30
			Harvesting	2	16.60
			Transporting	2	16.60
					641.55
07	Maize	1.5	Clearing	-	-
			Ploughing	30	300.00
			Harrowing	21	210.00
			Planting	21	210.00
			Weeding 1st	14	140.00
			Weeding 2nd	30	300.00
			Harvesting	10	100.00
			Transportin	2	20.00
			Threshing	1	10.00
			Seeds	-	50.00
					1340.00
	Tobacco	0.5	Clearing	5	50.00
			Ploughing	56	560.00
			Harrowing (3 times)	30	300.00
			Ridging	30	300.00
			Planting	56	560.00
			Weeding 1st	30	300.00
			Weeding 2nd	50	300.00
			fertilizing	5	50.00
			Spraying	1	10.00
			Topping	50	500.00
			Suckering	50	500.00
			Harvesting	30	300.00
			Transporting	14	140.00
			Materials loan	-	1300.00
					4670.00
	Trees	1.2	Clearing	30	300.00
			Ploughing	-	-
			Pitting	120	1200.00
			Planting	120	1200.00
			Seedlings	-	231.25
			Weeding	60	600.00
			Pruning	-	-
			Thinning	-	-
			Harvesting	14	140.00
			Transporting	1	10.00
					3731.25
08	Maize	2.0	Clearing	40	266.70
			Ploughing	63	420.00
			Harrowing	30	200.00
			Seeds	-	360.00
			Planting	30	200.00 Labour costed
			Weeding 1st	30	200.00 at 200/- per

			Weeding 2nd	140	933.30	month
			Harvesting	10	66.70	
			Transporting	5	33.30	
			Threshing	5	33.30	
					2680.00	
	Tobacco	0.75	Clearing	20	133.30	
			Ploughing	30	200.00	
			Harrowing	21	140.00	
			Ridging	21	140.00	
			Planting	60	400.00	
			Weeding 1st	21	140.00	
			Weeding 2nd	63	420.00	
			Fertilizing	60	400.00	
			Spraying	2	13.30	
			Topping	60	400.00	
			Suckering	60	400.00	
			Harvesting	63	420.00	
			Transporting	10	66.70	
			Material loan	-	2624.80	
					5898.10	
	Trees	1.2	Clearing	10	66.70	
			Ploughing	60	400.00	
			Pitting	120	800.00	
			Seedlings	-	225.00	
			Planting	60	400.00	
			Weeding	100	666.70	
			Pruning	-	-	
			Thinning	5	33.30	
			Harvesting	10	66.70	
			Transporting	5	33.30	
					2691.70	
09	Maize	0.8	Clearing	-	-	
			Ploughing	54	540.00	
			Harrowing	21	210.00	
			Seeds	-	50.00	
			Planting	21	210.00	Labour costed
			Weeding 1st	21	210.00	at Kshs 300/-
			Weeding 2nd	24	240.00	per month
			Harvesting	24	240.00	
			Transporting	8	80.00	
			Threshing	1	10.00	
					1790.00	
	Tobacco	0.5	Clearing	109	100.00	
			Ploughing	20	200.00	
			Harrowing	10	100.00	
			Ridging	10	100.00	
			Planting	10	100.00	
			Weeding 1st	70	700.00	
			Weeding 2nd	70	700.00	
			Fertilizing	10	100.00	
			Spraying	2	20.00	
			Topping	40	400.00	
			Suckering	40	400.00	
			Harvesting	60	600.00	

				Transporting	10	100.00
				Materials loan	-	996.00
						4616.00
		Trees	0.12	Clearing	-	-
				Ploughing	-	-
				Pitting	1	10.00
				Seedlings	-	25.50
				Planting	1	10.00
				Weeding	1	10.00
				Pruning	-	-
				Thinning	-	-
				Harvesting	-	10.00
				Tansporting	-	-
						65.50
10	Maize	1.2		Clearing	-	-
				Ploughing	16	160.00
				Harrowing	16	160.00
				Seeds	-	18.00
				Planting	8	80.00
				Weeding 1st	32	320.00
				Weeding 2nd	32	320.00
				Harvesting	-	-
				Transporting	-	-
				Threshing	-	-
						1053.00
		Tobacco	0.5	Clearing	10	100.00
				Ploughing	20	200.00
				Harrowing	10	100.00
				Ridging	10	100.00
				Planting	10	100.00
				Weeding 1st	70	700.00
				Weeding 2nd	70	700.00
				Fertilizing	10	100.00
				Spraying	2	20.00
				Topping	40	400.00
				Suckering	40	400.00
				Harvesting	60	600.00
				Transporting	10	100.00
				Materials loan	-	996.00
						4616.00
		Trees	0.12	Clearing	-	-
				Ploughing	-	-
				Pitting	1	10.00
				Seedlings	-	25.50
				Planting	1	10.00
				Weeding	1	10.00
				Pruning	-	-
				Thinning	-	-
				Harvesting	1	10.00
				Transporting	-	-
						65.50
11		Maize	2.5	Clearing	5	33.00
				Ploughing	20	133.00

No harvests were made due to drought effect

Labour costed at Kshs 300/- per manday per month

			Harrowing	10	67.00	
			Seeds	-	100.00	Non commerci
			Planting	10	67.00	seeds
			Weeding 1st	10	67.00	Ox plough us
			Weeding 2nd	[illegible]	[illegible]	[illegible]
			Harvesting	10	67.00	
			Transporting	3	20.00	
			Threshing	3	20.00	
					774.00	
		Tobacco	0.8	Clearing	2	13.00	
				Ploughing	7	47.00	
				Harrowing	7	47.00	
				Ridging	7	47.00	
				Planting	10	67.00	
ur coste				Weeding 1st	7	47.00	Labou
00/- per				Weeding 2nd	20	133.00	at 20
ay per				Fertilizing	2	13.00	manda
				Spraying	2	[illegible]	month
				Topping	10	67.00	
				Suckering	10	67.00	
				Harvesting	30	200.00	
				Transporting	5	33.00	
				Materials loan	-	-	No available
						794.00	rewards
	Trees	0.3	Clearing		2	13.00	
			Ploughing		7	47.00	
			Pitting		10	67.00	
			Seedlings		-	150.00	
			Planting		10	67.00	
			Weeding		12	30.00	
			Pruning		-	-	
			Thinning		-	-	
			Harvesting		5	33.00	
			Transporting		1	6.50	
						463.50	
	Maize	2.08	Clearing		-	-	Used ground
			Ploughing		20	200.00	Family labour
			Harrowing		10	100.00	costed at 30(
			Seeds		-	74.00	per month
			Planting		10	100.00	
			Weeding 1st		30	300.00	Hand
			Weeding 2nd		10	100.00	Oxen
			Harvesting		10	100.00	
			Transporting		2	20.00	
			Threshing		5	50.00	
						1044.00	
	Tobacco	1.00	Clearing		5	50.00	
			Ploughing		10	100.00	
			Harrowing		5	50.00	
			Ridging		5	50.00	
			Planting		14	140.00	
			Weeding 1st		5	50.00	
			Weeding 2nd		5	50.00	
			Fertilizing		2	20.00	

12

			Spraying	2	20.00	
			Topping	20	200.00	
			Suckering	20	200.00	
			Harvesting	30	300.00	
			Transporting	5	50.00	
			Materials loan	-	2352.15	
					3532.15	
	Trees	0.012	Clearing	-	-	
			Ploughing	-	-	
			Pitting	0.5	5.00	
			Seedlings	-	7.50	
			Planting	0.5	5.00	
			Weeding	-	-	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	1	1.00	
			Transporting	-	-	
					13.50	
13	Maize	2.08	Clearing	-	-	Old field
			Ploughing	42	420.00	
			Harrowing	21	210.00	
			Seeds	-	92.50	
			Planting	21	210.00	
			Weeding 1st	30	300.00	Labour coste
			Weeding 2nd	21	210.00	at Kshs 300/-
			Harvesting	10	100.00	per manday p.
			Transporting	2	20.00	month
			Threshing	5	50.00	
					1612.50	
	Tobacco	0.75	Clearing	-	-	
			Ploughing	12	120.00	
			Harrowing	6	60.00	
			Ridging	6	60.00	
			Planting	13	130.00	
			Weeding 1st	13	130.00	
			Weeding 2nd	13	130.00	
			Fertilizing	16	160.00	
			Spraying	16	160.00	
			Topping	-	-	
			Suckering	-	180.00	
			Harvesting	-	130.00	
			Transporting	10	100.00	
			Materials loan	-	2400.00	
					3810.00	
	Trees	0.80	Clearing	5	50.00	
			Ploughing	-	-	
			Pitting	10	100.00	
			Seedlings	-	20.00	Self prepared
			Planting	10	100.00	
			Weeding	-	-	
			Pruning	5	50.00	
			Thinning	-	-	
			Harvesting	5	50.00	
			Transporting	1	10.00	

					380.00	
14	Maize	0.40	Clearing	5	25.00	
			Ploughing	5	25.00	
			Harrowing	3	12.50	
			Seeds	-	37.00	
			Planting	3	15.00	Labour costed
			Weeding 1st	3	15.00	at 150/- per
			Weeding 2nd	3	15.00	manday per
			Harvesting	2	5.00	month
			Transporting	1	5.00	
			Threshing	1	5.00	
					159.50	
	Tobacco	1.0	Clearing	6	30.00	
			Ploughing	16	80.00	
			Harrowing	8	40.00	
			Ridging	8	40.00	
			Planting	20	100.00	
			Weeding 1st	8	40.00	
			Weeding 2nd	10	50.00	
			Fertilizing	5	25.00	
			Topping	20	100.00	
			Spraying	5	25.00	
			Suckering	20	100.00	Paid hired
			Harvesting	15	75.00	labour
			Transporting	5	25.00	150/- per
			Curing	20	100.00	month (rate
			Materials loans	-	3088.00	used)
					3913.40	
	Trees	2.2	Clearing	-	-	
			Ploughing	-	-	
			Pitting	20	100.00	
			Seedlings	-	412.50	
			Planting	20	100.00	
			Weeding	10	50.00	
			Pruning	-	-	
			Weeding	10	50.00	Slashing
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	10	50.00	
			Transporting	5	25.00	
					737.00	
15	Maize	4.2	Clearing	20	100.00	
			Ploughing	60	300.00	
			Harrowing	30	150.00	
			Seeds	-	185.00	Paid hired
			Planting	30	150.00	labour
			Weeding 1st	30	150.00	150/- per
			Weeding 2nd	30	150.00	month. Rate
			Harvesting	10	50.00	used.
			Transporting	5	25.00	
			Threshing	5	25.00	
					1285.00	
	Tobacco	1.25	Clearing	-	-	

			Ploughing	18	90.00	
			Harrowing	10	50.00	
			Ridging	10	50.00	
			Planting	20	100.00	
			Weeding 1st	10	50.00	
			Weeding 2nd	10	50.00	
			Fertilizing	5	25.00	
			Spraying	5	25.00	
			Topping	-	250.00	
			Suckering	-	250.00	
			Harvesting	10	50.00	
			Transporting	10	50.00	
			Curing	-	1400.00	
			Materials loan	-	4000.00	
					6440.00	
	Trees	0.80	Clearing	8	40.00	
			Ploughing	7	35.00	
			Pitting	10	50.00	
			Seedlings	-	150.00	
			Weeding	5	25.00	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	2	10.00	
			Transporting	2	10.00	
					320.00	
16	Maize	1.25	Clearing	-	-	
			Ploughing	14	93.00	Labour valued
			Harrowing	14	93.00	at Kshs 200/-
			Seeds	-	225.00	per month
			Planting	5	33.00	(cost of hire
			Weeding 1st	70	467.00	labour)
			Weeding 2nd	6	40.00	Oxen
			Harvesting	6	40.00	
			Transporting	2	13.00	
			Threshing	5	33.00	
					737.00	
	Tobacco	0.50	Clearing	-	-	
			Ploughing	8	53.00	
			Harrowing	6	40.00	
			Ridging	6	40.00	
			Planting	56	373.00	
			Weeding 1st	30	200.00	
			Weeding 2nd	10	67.00	
			Fertilizing	5	33.00	
			Spraying	5	33.00	
			Topping	50	333.00	
			Suckering	50	333.00	
			Harvesting	20	133.00	
			Transporting	10	67.00	
			Curing	56	373.00	
			Materials loan	-	2800.00	
					4878.00	
	Trees	1.20	Clearing	-	-	

			Ploughing	-	-	
			Pitting	15	100.00	
			Seedlings	-	160.00	
			Weeding	10	67.00	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	5	33.00	
			Transporting	2	13.00	
					373.00	
17		Maize	1.25	Clearing	10	83.00	
				Ploughing	15	125.00	Used labour
				Harrowing	10	83.00	cost of 250,-
				Seeds	-	375.00	per month -
				Planting	10	83.00	cost of hired
				Weeding 1st	70	583.00	labour
				Weeding 2nd	70	583.00	
				Harvesting	7	58.00	
				Transporting	5	42.00	
				Threshing	5	42.00	
						1557.00	
		Tobacco	1.00	Clearing	7	58.00	
				Ploughing	14	117.00	
				Harrowing	7	58.00	
				Ridging	7	58.00	
				Planting	60	500.00	
				Weeding 1st	28	233.00	
				Weeding 2nd	7	58.00	
				Fertilizing	5	42.00	
				Spraying	5	42.00	
				Topping	30	250.00	
				Suckering	30	250.00	
				Harvesting	30	250.00	
				Transporting	5	42.00	
				Loan	-	4680.00	
						6813.00	
		Trees	1.4	Clearing	20	167.00	
				Ploughing	18	150.00	
				Pitting	30	250.00	
				Seedlings	-	262.50	
				Weeding	30	-	
				Pruning	-	-	
				Thinning	-	-	
				Harvesting	10	83.00	
				Transporting	5	42.00	
						1204.50	
18		Maize	1.25	Clearing	-	-	
				Ploughing	10	67.00	
				Harrowing	8	53.00	
				Seeds	-	50.00	Home seed
				Planting	8	53.00	
				Weeding 1st	42	280.00	Labour costed
				Weeding 2nd	21	140.00	at Kshs 190/-
				Harvesting	9	60.00	per MD per
				Transporting	6	40.00	month

			Threshing	1	7.00	
					750.00	
	Tobacco	1.00	Clearing	6	40.00	
			Ploughing	16	107.00	
			Harrowing		8	53.00
			Ridging	8	53.00	
			Planting			
			Weeding 1st		2000.00	
			Weeding 2nd			
			Fertilizing	5	33.00	
			Spraying	5	33.00	
			Topping	20	133.00	
			Suckering	20	133.00	
			Harvesting	15	100.00	
			Transporting	5	33.00	
			Curing	-	-	
			Materials loan	-	2400.00	
					4865.00	
	Trees	0.40	Clearing	4	27.00	
			Ploughing	4	27.00	
			Pitting	5	33.00	
			Seedlings	-	75.00	
			Planting	5	33.00	
			Weeding	10	67.00	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	5	33.00	
			Transporting	2	13.00	
					248.00	
19	Maize	2.0	Clearing	-	-	
			Ploughing	21	133.00	
			Harrowing	17	108.00	Cost of labou
			Seeds	-	100.00	190/- per
			Planting	17	108.00	month (hired
			Weeding 1st	135	855.00	labour)
			Weeding 2nd	17	108.00	(oxen)
			Harvesting	15	95.00	
			Transporting	5	32.00	
			Threshing	2	13.00	
					1552.00	
	Tobacco	0.5	Clearing	-	-	
			Ploughing	8	51.00	
			Harrowing	6	38.00	
			Ridging	6	38.00	
			Planting	56	355.00	
			Weeding 1st	30	190.00	
			Weeding 2nd	10	63.00	
			Fertilizing	5	32.00	
			Spraying	5	32.00	
			Topping	50	317.00	
			Suckering	50	317.00	
			Harvesting	20	127.00	
			Transporting	10	63.00	
			Loan	-	1277.00	

					2595.00	
20	Maize	1.70	Clearing	33	220.00	
			Ploughing	33	220.00	
			Harrowing	21	140.00	Labour coste
			Seeds	-	279.00	at 200/. per
			Planting	21	140.00	month
			Weeding 1st	21	140.00	
			Weeding 2nd	12	80.00	
			Harvesting			
			Transporting	36	240.00	
			Threshing			
					1469.00	
	Tobacco	1.00	Clearing	10	67.00	
			Ploughing	25	167.00	
			Harrowing	20	133.00	
			Ridging	20	133.00	
			Planting	112	747.00	
			Weeding 1st	80	533.00	
			Weeding 2nd	21	140.00	
			Fertilizing	10	67.00	
			Spraying	10	67.00	
			Topping	100	667.00	
			Suckering	100	667.00	
			Harvesting	60	400.00	
			Transporting	10	67.00	
			Curing	-	-	
			Loan	-	2480.00	
					6335.00	
	Trees	2.00	Clearing	10	67.00	
			Ploughing	10	67.00	
			Pitting	12	80.00	
			Seedlings	-	375.00	
			Planting	30	200.00	
			Weeding	15	100.00	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	5	33.00	
			Transporting	2	13.00	
					935.00	
21	Maize	1.00	Clearing	-	-	
			Ploughing	25	330.00	
			Harrowing	25	330.00	
			Seeds	-	50.00	Home seed
			Planting	25	330.00	
			Weeding 1st	100	400.00	Labour
			Weeding 2nd			
			Harvesting	4	53.00	costed at Ksh
			Transporting	4	53.00	396/- = 400/-
			Threshing	5	67.00	per month
					1413.00	
	Tobacco	0.75	Clearing	6	80.00	
			Ploughing	15	200.00	

			Harrowing	7	93.00	
			Ridging	7	93.00	
			Planting	8	107.00	
			Weeding 1st Weeding 2nd	24	320.00	
			Fertilizing	2	27.00	
			Spraying	2	27.00	
			Topping	21	280.00	
			Suckering	21	280.00	
			Harvesting	10	133.00	
			Transporting	10	133.00	
			Curing	-	800.00	
			Materials loan	-	2046.50	
					4619.50	
	Trees	1.40	Clearing	30	400.00	
			Ploughing	15	200.00	
			Pitting	30	400.00	
			Seedlings	-	262.50	
			Planting	15	200.00	
			Weeding	-	-	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	20	267.00	
			Transporting	5	67.00	
					1796.50	
22	Maize	2.00	Clearing	7	58.30	
			Ploughing	54	450.00	
			Harrowing	27	225.00	
			Seeds	-	100.00	(Self employe
			Planting	18	150.00	farmer)
			Weeding 1st	18	150.00	Family labour
			Weeding 2nd	50	416.70	costed at
			Harvesting	13	108.30	Kshs 250 per
			Transporting	5	41.70	manday
			Threshing	2	16.70	
					1716.70	
	Tobacco	0.75	Clearing	7	58.30	
			Ploughing	54	450.00	
			Harrowing	27	225.00	
			Ridging	27	225.00	
			Planting	-	300.00	
			Weeding 1st	14	116.70	
			Weeding 2nd	14	116.70	
			Fertilizing	5	41.70	
			Spraying	5	41.70	
			Topping Suckering	-	400.00	
			Harvesting	30	250.00	
			Transporting	10	83.30	
			Curing	-	-	
			Materials loan	-	2045.65	
					4383.05	
	Trees	0.90	Clearing	14	116.70	
			Ploughing	27	225.00	

			Pitting	30	250.00	
			Seedlings	-	158.35	
			Planting	30	250.00	
			Weeding 1st	-	-	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	20	166.70	
			Transporting	5	41.70	
					1208.45	
23	Maize	0.40	Clearing	-	-	
			Ploughing	7	58.30	
			Harrowing	7	58.30	
			Seeds	-	25.00	
			Planting	4	33.30	
			Weeding 1st	7	58.30	
			Weeding 2nd	14	116.70	
			Harvesting	5	41.70	
			Transporting	1	8.30	
			Threshing	2	16.60	
					416.50	
	Tobacco	0.75	Clearing			
			Ploughing			
			Harrowing			
			Ridging			
			Planting			
			Weeding 1st			
			Weeding 2nd		1500.00	
			Fertilizing			
			Spraying			
			Topping			
			Suckering			
			Harvesting			
			Harvesting			
			Transporting			
			Curing			
			Materials loan		2332.75	
					3832.75	
	Trees	3.20	Clearing			
			Ploughing			
			Pitting		500.00	Seedlings raised from local seeds (wildings)
			Seedlings			
			Planting			
			Weeding			
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	10	83.30	
			Transporting	5	41.70	
					625.00	
24	Maize	0.40	Clearing	3	15.00	
			Ploughing	14	70.00	
			Harrowing	7	35.00	
			Seeds	-	50.00	
			Planting	14	70.00	
			Weeding 1st	30	150.00	
			Weeding 2nd	10	50.00	

			Harvesting	3	15.00	
			Transporting	1	5.00	
			Threshing	2	10.00	
					470.00	
	Tobacco	0.80	Clearing	7	35.00	
			Ploughing	30	150.00	Labour costed
			Harrowing	15	75.00	at Kshs 150/-
			Ridging	15	75.00	per month
			Planting	14	70.00	
			Weeding 1st	36	180.00	
			Weeding 2nd	15	75.00	
			Fertilizing	5	25.00	
			Spraying	5	25.00	
			Topping	25	125.00	
			Suckering	25	125.00	
			Harvesting	30	150.00	
			Curing	-	-	
			Materials loan	-	1982.50	
					3092.50	
	Trees	1.50	Clearing			
			Ploughing			
			Pitting		500.00	
			Seedlings			
			Planting			
			Weeding			
			Pruning	-	-	
			Thinning	-	-	
			Harvesting		100.00	
			Transporting		10.00	
					610.00	
25	Maize	0.50	Clearing	-	-	
			Ploughing	12	120.00	
			Harrowing	12	120.00	
			Seeds	-	100.00	
			Planting	4	40.00	
			Weeding 1st	20	200.00	
			Weeding 2nd	20	200.00	
			Harvesting	10	100.00	
			Transporting	2	20.00	
			Threshing	2	20.00	
					880.00	
	Tobacco	0.75	Clearing	-	-	
			Ploughing	16	160.00	Labour costed
			Harrowing 3x	48	480.00	at Kshs 300/-
			Ridging	16	160.00	per month
			Planting	14	140.00	
			Weeding 1st	42	420.00	
			Weeding 2nd	42	420.00	
			Fertilizing	2	20.00	
			Spraying	2	20.00	
			Topping	4	40.00	
			Harvesting	-	600.00	Contractors
			Transporting	-	-	
			Curing	-	-	

			Materials loan	-	2300.00	
					5860.00	
	Trees	0.80	Clearing			
			Ploughing			
			Pitting			
			Seedlings			
			Planting		1000.00	
			Weeding			
			Pruning			
			Thinning			
			Harvesting			
			Transporting			
26	Maize	1.00	Clearing	-	-	Old farm
			Ploughing	14	116.70	
			Harrowing	14	116.70	
			Seeds	-	50.00	Home seed
			Planting	7	58.30	
			Weeding 1st Weeding 2nd	36	300.00	
			Harvesting	10	83.30	
			Transporting	5	41.70	
			Threshing	2	16.70	
					733.40	
	Tobacco	0.80	Clearing	28	233.30	Labours coste
			Ploughing	14	116.70	at Kshs 250/-
			Harrowing	28	233.30	per month
			Ridging	8	66.70	
			Planting	14	116.70	
			Weeding 1st	14	116.70	
			Weeding 2nd	14	116.70	
			Fertilizing	8	66.70	
			Spraying	14	116.70	
			Topping			
			Suckering	60	500.00	
			Harvesting			
			Transporting	7	58.30	
			Curing	-	-	
			Loans	-	2760.00	
					4501.80	
26	Trees		Clearing			
			Ploughing			
			Pitting			
			Seedlings			
			Planting	No trees of the		
			Weeding	right age		
			Pruning			
			Thinning			
			Harvesting			
			Transporting			
27	Maize	0.40	Clearing	7	58.30	
			Ploughing	7	58.30	
			Harrowing	4	33.30	
			Seeds	-	50.00	Labour costed

			Planting	5	41.70	at Kshs 250/
			Weeding 1st	14	116.70	per month
			Weeding 2nd	14	116.70	
			Harvesting	5	41.70	
			Transporting	1	8.30	
			Threshing	1	8.30	
					533.30	
	Tobacco	1.10	Clearing	14	116.70	
			Ploughing	30	250.00	Labour coste
			Harrowing	60	500.00	at 250/-
			Ridging	30	250.00	per month
			Planting	36	300.00	
			Weeding 1st Weeding 2nd	52	433.30	
			Fertilizing	5	41.70	
			Spraying	5	41.70	
			Topping	30	250.00	
			Suckering	30	250.00	
			Harvesting	30	250.00	
			Harvesting	30	250.00	
			Transporting	7	58.30	
			Curing	-	-	
			Materials loan	-	3100.00	
					5841.70	
	Trees	0.50	Clearing Ploughing Pitting Seedlings Planting Weeding Pruning Thinning Harvesting Transporting	Cost of contract work	700.00	
28	Maize	0.20	Clearing	-	-	Old farm
			Ploughing	4	33.30	
			Harrowing	2	16.70	
			Seeds	-	20.00	Labour 250/-
			Planting	5	41.70	
			Weeding 1st	10	83.30	
			Weeding 2nd	5	41.70	
			Harvesting	2	16.70	
			Transporting	1	8.30	
			Threshing	1	8.30	
					270.00	
	Tobacco	0.75	Clearing	10	83.30	
			Ploughing	21	175.00	
			Harrowing	14	116.70	
			Ridging	7	58.30	
			Planting	21	175.00	
			Weeding 1st	21	175.00	
			Weeding 2nd	18	150.00	
			Fertilizing	5	41.70	
			Spraying	5	41.70	

			Topping	14	116.70	
			Suckering	14	116.70	
			Harvesting	30	250.00	
			Transporting	5	41.70	
			Curing	-	-	
			Baling	-	-	
			Materials loan	-	2400.00	
					4341.80	
	Trees	1.04	Clearing	30	250.00	
			Ploughing	36	300.00	
			Pitting	40	333.30	
			Seedlings	-	195.00	
			Planting	30	250.00	
			Weeding	-	-	
			Thinning	-	-	
			Pruning	-	-	
			Harvesting	15	125.00	
			Transporting	5	41.70	
					1495.00	
29	Maize	1.00	Clearing	30	400.00	
			Ploughing	14	186.70	
			Harrowing	10	133.30	
			Seeds	-	58.50	
			Planting	14	186.70	
			Weeding 1st	30	400.00	
			Weeding 2nd	30	400.00	
			Harvesting	10	133.30	
			Transporting	5	66.70	
			Threshing	4	53.30	
					2015.50	
	Tobacco	0.50	Clearing	7	93.30	
			Ploughing	20	266.70	
			Harrowing	20	266.70	Labour costed
			Ridging	10	133.30	at 400/- per
			Planting	34	453.30	month
			Weeding 1st	28	373.30	
			Weeding 2nd	14	186.70	
			Fertilizing	4	53.30	
			Spraying	2	26.70	
			Topping	20	266.70	
			Suckering	20	266.70	
			Harvesting	36	480.00	
			Curing	-	-	
			Materials loan	-	2800.00	
					5666.70	
	Trees	0.40	Clearing	5	66.70	
			Ploughing	7	93.30	
			Pitting	7	93.30	
			Seedlings	-	-	
			Weeding	-	-	
			Pruning	-	-	
			Thinning	-	-	
			Harvesting	4	50.00	Contract
			Transporting	2	20.00	
					393.30	

30	Maize	0.8	Clearing			
			Ploughing			
			Harrowing			
			Seeds			
			Planting			
			Weeding 1st			
			Weeding 2nd			
			Harvesting			
			Transporting			
			Threshing			
	Tobacco	0.80	Clearing	10	116.70	
			Ploughing	20	233.30	
			Harrowing	10	116.70	
			Ridging	10	116.70	
			Planting	30	350.00	
			Weeding 1st	30	350.00	Labour costed
			Weeding 2nd	30	350.00	at 350/- per
			Fertilizing	5	58.30	month
			Spraying	5	58.30	
			Topping	14	163.30	
			Suckering	14	163.30	
			Harvesting	21	245.00	
			Transporting	5	58.30	
			Curing	-	600.00	
			Materials loan	-	1 843.15	
				204	4 823.05	
	Trees	1.08	Clearing	-	-	
			Ploughing	-	-	
			Pitting	-	250.00	
			Seedlings	-	202.50	
			Planting	-	200.00	
			Weeding	-	50.00	
			Pruning	-	20.00	
			Thinning	-	-	
			Harvesting	-	50.00	
			Transporting	-	20.00	

APPENDIX (iii)

Fixed production factor items (inputs)

Farm	Oxen			Plough		Jokes + chains			Curing barns		
No.	No.	Cost Kshs	Age Yrs	No.	Cost Kshs	Age Yrs	No.	Cost Kshs	Age Yrs	No.	Cost Kshs	Age Yrs
01	4	4400.00	5	1	690.00	2	2	100.00	2	1	3212.00	6
02	4	5200.00	5	1	700.00	3	2	150.00	6	1	1000.00	5
03	4	3600.00	7	1	175.00	25	2	50.00	25	1	1476.00	4
04	4	4400.00	5	1	400.00	2	2	170.00	2	1	2100.00	2
05	4	5300.00	5	1	500.00	4	2	130.00	4	1	1000.00	8
06	4	4000.00	6	1	300.00	16	2	100.00	2	1	1700.00	0
07	2	2600.00	7	1	450.00	11	1	140.00	4	1	3200.00	7
08	2	2400.00	8	1	350.00	8	1	65.00	8	1	3500.00	5
09	2	3000.00	8	1	350.00	6	1	65.00	6	1	2286.00	4
10	2	4000.00	8	1	885.00	2	2	210.00	2	1	3000.00	3
11	2	4000.00	8	1	885.00	2	2	210.00	2	1	3000.00	3
12	4	4000.00	4	1	600.00	3	2	170.00	3	1	2800.00	2
13	4	5200.00	7	1	250.00	18	2	171.00	18	1	3840.00	5
14	2	5200.00	6	1	800.00	1	1	260.00	1	1	4375.00	5
15	4	6000.00	5	1	300.00	18	2	50.00	18	1	2500.00	3
16	4	3800.00	5	1	300.00	15	2	150.00	15	1	3410.00	5
17	4	4400.00	6	1	500.00	14	2	135.00	14	1	3000.00	0
18	2	2600.00	6	1	500.00	4	1	60.00	4	1	2060.00	4
19	2	2500.00	7	1	110.00	25	1	65.00	4	1	3100.00	4
20	2	3000.00	8	1	120.00	25	2	90.00	25	1	4800.00	1
21	4	7200.00	6	1	400.00	3	2	190.00	3	1	2465.00	5
22	4	6000.00	7	1	500.00	20	2	122.00	20	2	2660.00	5
23	4	4800.00	6	2	360.00	2	2	50.00	1	1	1500.00	2
24	4	7200.00	8	1	150.00	5	2	40.00	5	1	120.00	5
25	4	4000.00	6	1	150.00	25	2	68.00	25	1	4400.00	5
26	4	4280.00	7	1	560.00	1	2	150.00	1	1	4960.00	3
27	4	2400.00	5	1	600.00	1	2	200.00	1	1	4165.00	3
28	4	6000.00	9	1	600.00	1	2	250.00	1	1	295.00	2
29	4	4000.00	8	1	600.00	1	2	130.00	1	1	2365.00	1
30	4	4400.00	10	1	700.00	0	2	180.00	2	1	1265.00	2

APPENDIX (iv)

Physical outputs

Farm No.	Farm area, ha	Crop: Maize Area, ha	Maize kgs	Tobacco Area, ha	Tobacco kgs	Trees Area, ha	Trees No.of poles
01	14.20	6.00	900	1.10	2020	4.80	1000
02	30.00	6.00	2700	2.00	4200	2.40	1000
03	28.00	2.00	2070	1.00	1369	1.00	250
04	9.60	2.00	1170	1.00	2700	0.01	437
05	8.30	2.40	-	0.50	900	1.80	500
06	18.30	2.50	2520	1.00	3000	1.20	872
07	4.10	1.50	900	0.50	1300	1.20	872
08	8.30	2.00	2700	0.75	1600	1.20	1000
09	19.30	0.80	900	0.75	1800	0.12	1248
10	3.20	1.20	-	0.50	650	0.50	1342
11	50.00	2.50	600	0.80	700	0.80	2000
12	12.50	2.10	2400	1.00	2000	2.20	2308
13	5.42	2.08	2250	0.75	1800	0.80	4000
14	25.00	0.40	4500	1.00	2000	2.20	2308
15	10.40	4.20	1620	1.25	2000	1.20	1000
16	6.70	1.25	216	0.50	1600	1.20	1000
17	13.60	1.25	2700	1.00	3100	1.40	1000
18	5.60	1.25	900	1.00	1500	0.40	1500
19	7.90	2.00	1350	0.50	1400	0.80	2000
20	20.70	1.70	3600	1.00	2000	2.00	800
21	20.00	1.00	900	0.75	1958	1.40	3500
22	11.00	2.00	3600	0.75	1719	0.90	2262
23	11.00	0.40	810	0.75	2057	3.20	1029
24	30.00	0.40	1200	0.80	2667	1.50	2000
25	25.80	0.50	450	0.75	1400	0.80	200
26	8.00	1.00	1080	0.50	1521	-	-
27	6.00	0.40	540	1.10	2054	0.50	1200
28	12.00	0.20	-	0.75	1560	1.04	1000
29	25.00	1.00	900	0.50	1375	0.40	1000
30	11.00	0.80	2340	0.80	1733	1.08	420

APPENDIX (v)

Revenue data

Farm No.	Area, ha	Crops						Fuelwood		
		Maize			Tobacco					
		Area, ha	Production, kgs	Revenue, Kshs	Area, ha	Production, kgs	Revenue, Khsh	Area, ha	Production, No. of poles	Revenue, Keshs
01	14.20	6.00	900.00	1800.00	1.10	2020.00	35350.00	4.80	1000.00	15000.00
02	30.00	6.00	2700.00	4800.00	2.00	4200.00	58800.00	2.40	1000.00	13000.00
03	28.00	2.00	2070.00	3420.00	1.00	1369.00	20535.00	1.00	250.00	5800.00
04	9.60	2.00	1170.00	1560.00	1.00	2700.00	44550.00	0.01	437.00	3496.00
05	8.30	2.40	0.00	0.00	0.50	900.00	14850.00	1.80	500.00	8250.00
06	18.30	2.40	2520.00	4200.00	1.00	3000.00	51000.00	1.20	872.00	5000.00
07	4.10	1.50	900.00	1300.00	0.50	1300.00	23400.00	1.20	1000.00	30000.00
08	8.30	2.00	2700.00	5400.00	0.75	1600.00	28800.00	1.20	1000.00	16000.00
09	19.30	0.80	900.00	1800.00	0.75	1800.00	31500.00	0.12	1248.00	7488.00
10	3.20	1.20	0.00	0.00	0.50	650.00	10725.00	0.50	1342.00	17446.00
11	50.00	2.50	600.00	1500.00	0.80	700.00	10850.00	0.80	2000.00	20000.00
12	12.50	2.10	2400.00	6000.00	1.00	2000.00	24000.00	0.01	2308.00	2400.00
13	5.42	2.08	2250.00	3000.00	0.75	1800.00	31500.00	0.80	4000.00	60000.00
14	25.00	0.40	4500.00	4500.00	1.00	2000.00	32000.00	2.20	2308.00	37500.00
15	10.40	4.20	1620.00	2880.00	1.25	2000.00	30000.00	1.20	1000.00	10000.00
16	6.70	1.25	216.00	5400.00	0.50	1600.00	27200.00	1.20	1000.00	10000.00
17	13.60	1.25	2700.00	9000.00	1.00	3100.00	55800.00	1.40	1000.00	15000.00
18	5.60	1.25	900.00	1500.00	1.00	1500.00	22500.00	0.40	1500.00	30000.00
19	7.90	2.00	1350.00	2250.00	0.50	1400.00	19600.00	0.80	2000.00	20000.00
20	20.70	1.70	3600.00	8000.00	1.00	2000.00	28000.00	2.00	800.00	18000.00
21	20.00	1.70	900.00	1200.00	0.75	1958.00	29370.00	1.40	3500.00	42000.00
22	11.00	2.00	3600.00	4720.00	0.75	1719.00	20628.00	0.90	2262.00	33930.00
23	11.00	0.40	810.00	810.00	0.75	2057.00	30855.00	3.20	1029.00	20800.00
24	30.00	0.40	1200.00	3000.00	0.80	2667.00	42672.00	1.50	2000.00	37750.00
25	25.80	0.50	450.00	1125.00	0.75	1400.00	22400.00	0.80	200.00	10000.00
26	8.00	1.00	1080.00	2700.00	0.30	1521.00	26617.00	-	-	-
27	6.00	0.40	540.00	180.00	1.10	2054.00	33891.00	0.50	1200.00	24000.00
28	12.00	0.20	0.00	0.00	0.75	1560.00	24960.00	1.04	1000.00	10000.00
29	25.00	1.00	900.00	1200.00	0.50	1375.00	27087.50	0.40	1000.00	10000.00
30	11.00	0.80	2340.00	5200.00	0.80	1733.00	31020.70	1.08	420.00	19000.00
Totals	462.92	52.83	42216.40	88445.00	25.65	59641.00	890461.70	36.36	37208.00	5121040.00
Aver.	15.35	1.76	1407.20	2948.17	0.86	1988.03	29682.06	1.21	1240.27	17071.00