SOCIO-ECONOMIC FACTORS AFFECTING SMALLHOLDER TEA PRODUCTION: A CASE STUDY OF THE KOROGWE TEA SUB-SCHEME, TANGA REGION

By

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ABSTRACT

This thesis presents a case study of the Korogwe tea sub-scheme in Tanga Region. It examines socio-economic factors affecting small-holder tea production under the 1979 farming system.

Fifty tea-growers were picked from a sampling frame covering 1,500 smallholders using a stratified random sampling approach based on plot size of tea. The farmers were interviewed in August-October, 1979. Questionnaires used and method of data analysis are described.

An average farm family had 9 people eating at home and cultivated on average 2.3 ha, of which 42 percent was for cash and the balance was for food crops. Computed food production by a typical farm family was on average below family annual minimum requirements by 6 percent of calories and 37 percent of protein in 1979. If families are to be self-sufficient, food production must be increased. On average, a farm family received Shs. 7,300 from crop sales in 1979, of which 42 percent was from tea and 32 percent from cardamom.

Effects of the following factors on tea production were studied:

(1) Distance from tea farms to green-leaf buying centres. Daily pluckings were limited by the number of possible round-trips per day during buying hours.

(2) Producer prices. Increased prices motivated farmers to pluck more in the short-run but transport to markets for the increase frequently was not available.

(3) Fertilizer distribution, which frequently was not satisfactory.

(4) As many tea bushes are immature, age in years had a statistically significant effect on yield of tea per ha.

(5) Use of desirable husbandry practices and a proper plucking rate tended to increase yield per ha but an increase in tea area, after allowing for other factors in the regression analysis, tended to reduce tea yield per ha. In an analysis of use of desirable husbandry practices, number of extension contacts was the most important single affecting variable. A third analysis indicated that area in cardamom was the most important single variable affecting total income per farm. Tea yield per ha, age of tea bushes in years and coffee area were also influencial.

Two basic analyses run by linear programming indicate that: In plan 1, where each farmer was required to maintain the government 0.60 ha tea quota, the optimum plan was 17 percent more profitable than the 1979 farming system. Crops included were 1.1 ha of cardamom, the required 0.6 ha of tea, and two crops for subsistence, namely 0.4 ha of bananas and 0.6 ha of beans. Plan 2 allowed farmers to respond to direct economic influences. This was 13 percent more profitable than plan 1, with the same food crops and only cardamom (1.7 ha) included as a cash crop. A sensitivity analysis for both plans 1 and 2 based on combinations of low and high producer prices for tea, cardamom and coffee, respectively, is also described. Under all of the plans considered, available family labour is underutilized in most months. Thus, development of other sectors of the economy to use this surplus labour would be highly desirable.

The future development of cardamom depends largely on a limited external market dominated by India, the largest producer. The requirement that farmers maintain 0.60 ha of tea looks rational as tea provides regular employment and income to farmers.

Based on this analysis, either tea prices should be increased or cardamom prices reduced (or both) if tea is to be an economically-viable crop. Coffee was not profitable under the conditions specified.

Other features of the analysis indicate that the 24 million kg target of made tea by 1981 in Tanzania looks unrealistic. Under the existing situations, this target may be reached by 1985 when tea-bushes planted by 1976 become mature.

DECLARATION

I, Musa Alli Lupatu, do hereby declare to the Senate of the University of Dar es Salaam that this thesis has not been submitted for a degree award to any other University and that it is my own original work.

MUSA ALLI LUPATU

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I underestimated the time and effort involved in this work when I launched out on the research leading to this thesis. As such, I alone did not pay the price for my misjudgement but my family too had to bear the burden. Specifically, my wife, Mamsanga, missed most of her week-ends, and our little Mfumbwa often cried when she learnt father was away.

Lastly I wish to thank Miss S.F. Hassanali for typing the long handwritten draft into its present form.

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LIST OF ACRONYMS

AFO	Assistant Field Officer
CAT	Coffee Authority of Tanzania
cif	Cost, insurance and freight
df	Degrees of freedom
FA	Field Assistant
FAO	Food and Agriculture Organization, United Nations
FO	Field Officer
GM	Gross margin
ITA	International Tea Agreement
KILIMO	Ministry of Agriculture
LP	Linear programming
MDB	Marketing Development Bureau, Ministry of Agriculture
NPK	20:10:10 nitrogen, phosphorus, potassium fertilizer
SA	Ammonium sulphate fertilizer
TIRDEP	Tanga Integrated Rural Development Programme
TRDB	Tanzania Rural Development Bank
TTA	Tanzania Tea Authority
UK	United Kingdom
UNCTAD	United Nations Committee for Trade and Development

CHAPTER I

INTRODUCTION

Export of primary products are of vital importance to the economies of the less-developed countries because agricultural products account for the largest share in export proceeds and form an important source of domestic cash income (Etherington, 1973). Over three quarters of Tanzania's exports come from agricultural goods (Marketing Development Bureau - MDB, 1978). As a result, the analysis of economic variables that affect agricultural production poses important socio-economic and political ramifications to the progress of a developing country like Tanzania.

Tea is one of the important export crops in Tanzania, netting Shs. 260 million and 195 million in foreign currency in 1977 and 1978 respectively (Daily News, 3rd May 1979). The drop in value in 1978 was due to lower world prices for tea. This thesis presents a case study of the Korogwe tea sub-scheme in Tanga Region. The scheme, which became self-reliant from the West Usambara tea project in 1973, produces 8 percent of the tea produced by smallholders in Tanzania. Tea production has on average been increasing since 1973/74 in the scheme although production targets are not defined. However, 1979 yields of 456 kg per ha of made tea in the scheme are well below the regional smallholder average of 750 kg per ha so that research appears desirable. This study, therefore, addresses itself to socio-economic factors affecting smallholder tea production. It explores the complexity of farming systems for smallholder tea farmers and uncertainties associated with the decision-making process and suggests possible future changes in government policy.

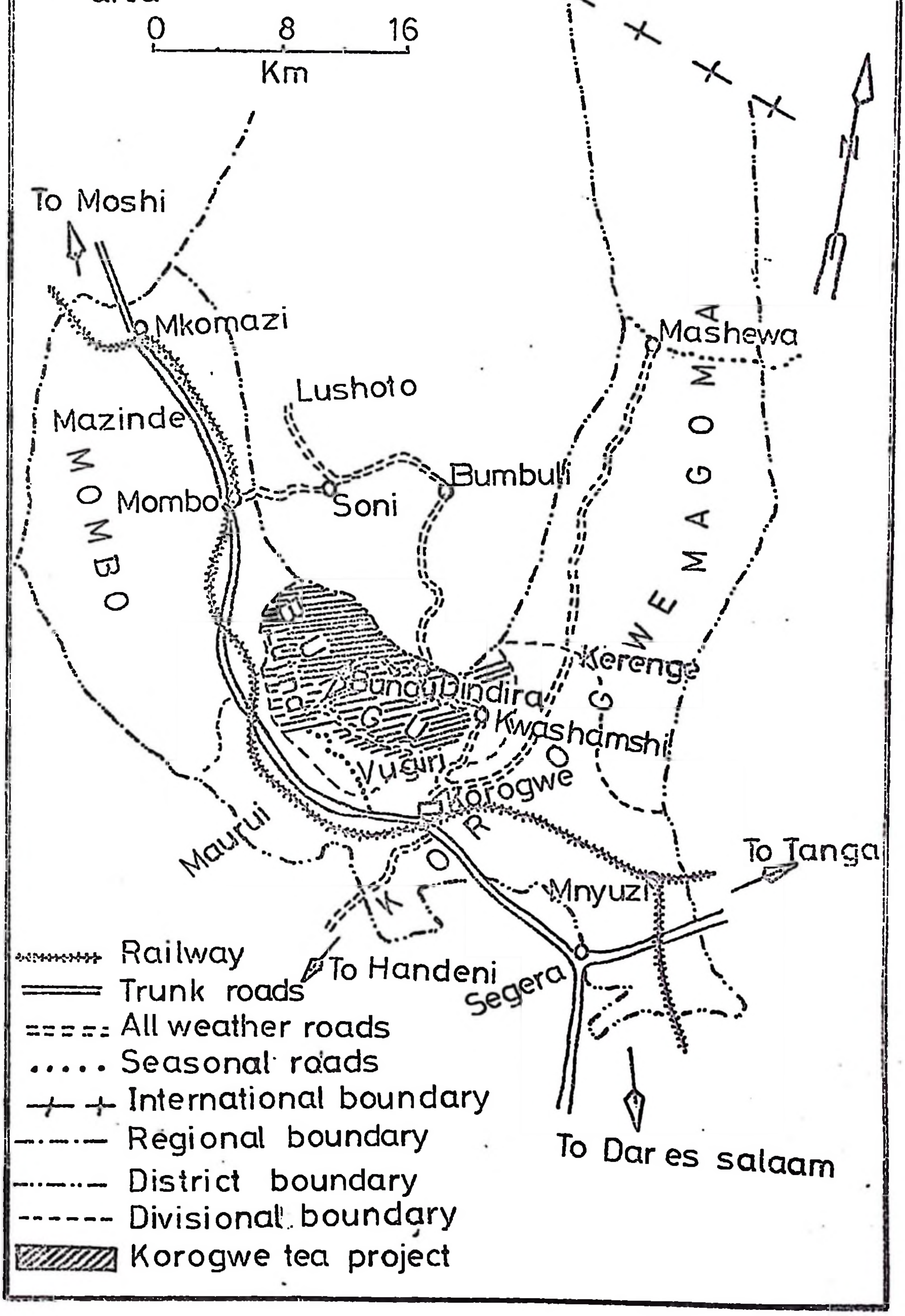
1.1 General Description of the Area of Study

1.1.1 Location

Korogwe tea sub-scheme is contained in Bungu, one of the four Divisions of Korogwe District, which goes around the mountains near Lushoto and hence has an unusual shape for an administrative body of land. The other three Divisions include Korogwe, Mombo and Magoma (Map 1-1). Bungu Division covers the Korogwe Highlands, lying between altitude 900-1,500 m above sea level. The Korogwe District in Tanga Region shares boundaries with other Districts as shown in Map 1-2. Tanga Region is situated on the northeastern part of Tanzania, 4^{o}-6^{o} latitude south and 37^{o}-39^{o} 10' longitude east. To the north, Tanga Region forms the international frontier with Kenya. It is bordered by the Indian Ocean in the east, Morogoro and Coast Regions to the south, and Kilimanjaro and Arusha Regions on the west.

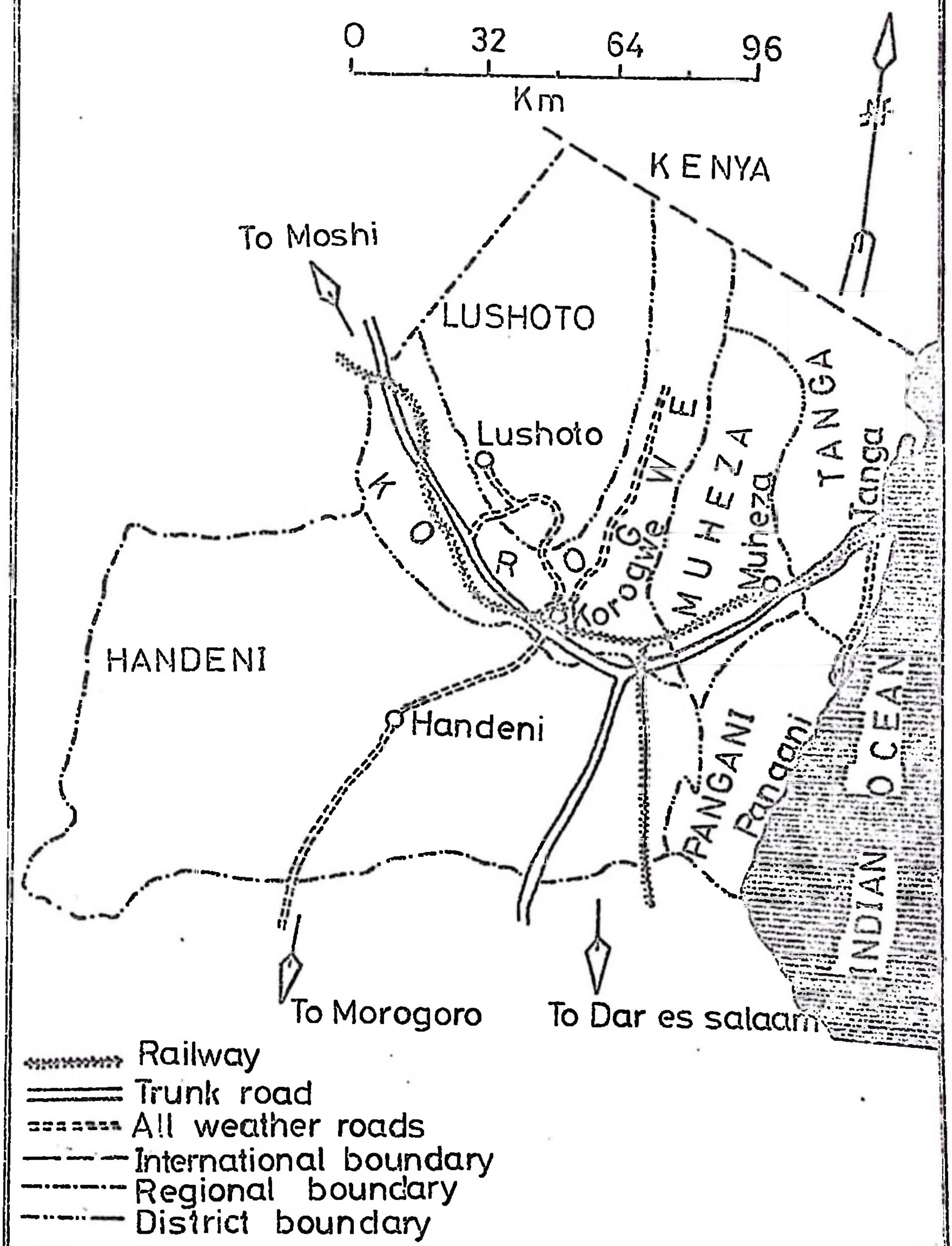
1.1.2 Human population, land area and use

Bungu Division occupies a land area of 285 km^2, or 7.6 percent of the District area of 3,756 km^2. Based on the population census of 1978 (Daily News, 17th January 1979), Korogwe District has 191 thousand inhabitants with a male:female sex ratio of 116:100 compared to the regional ratio of 105:100. For Tanzania the male:female sex ratio is 95:100. About a quarter of the District's population live in Bungu Division, which has the highest population density of 166 individuals per km^2 in Korogwe District. The District average is 51 people per km^2.



Map 1-1. Korogwe District: Divisions and tea project area.

Map 1-2. Tanga Region: Communications and administrative Districts



About three-quarters of Tanga Region, containing approximately 2 million ha of land, is estimated to be suitable for agriculture and livestock production. This land is used by three types of producers, namely estate, smallholders and ujamaa villages. Ninety percent of the smallholders cultivate less than 2 ha farms, while in Lushoto and Muheza Districts more than 70 percent of the farms are less than 1 ha (Tanga Integrated Rural Development Program - TIRDEP, 1975). While there is already an acute land shortage in the highlands due to high population density and limited area for additional cultivation, the fertile parts in the lowlands in the plantation areas are occupied by estates. The highland areas, including Korogwe Highlands in Bungu Division, are the most intensively-farmed parts of the Region.

Smallholder farming predominates in these highland areas but there are also tea estates and great forest reserves which are not available for smallholder farming. As a result, land shortage in these highlands becomes spectacular. Trees are cut down and remaining forests are taken into cultivation at an increasing rate. Consequently, the areas suffer from soil erosion and destruction of the natural ecology. These facts in connection with the prevalent production pattern, whereby large areas are planted to food crops including maize but not much is done for soil conservation, has resulted in an alarming deterioration of soil fertility. Thus TIRDEP (1975) concluded in summary that these highly-populated highlands, which are less provided with infrastructure as well, show signs of stagnation on a medium level of development.

1.1.3 Climate and topography

Tanga Region is characterised by greatly varying environmental conditions. In terms of topography, the flat or slightly rolling terrain ranges from the coastal strip to the inland plains, with the Nguu Mountains as the only major elevation, rising to a height of 1,500 m above sea level, and the Masai steppe. The Usambara Mountains, on the other hand, reach a height of 2,400 m.

Climate in the Region is affected by altitude and distance from the Indian Ocean. The coastal strip is warm and wet, with an average annual rainfall of 1,200 to 1,400 mm. Rainfall decreases towards the inland and falls to 850 mm in Handeni town, and only 500 mm per annum in the Masai steppe. The situation is different for the highlands. Precipitation increases with altitude, reaching 1,500 to 2,400 mm depending also on slope direction in the Usambara Mountains, which have a temperate climate. As an example, table 1-1 shows an average annual rainfall of 1,780 mm based on a 7-year average for Bungu Division in Korogwe.

TIRDEP (1975) argued that rainfall is probably the most important climatic factor for farming in Tanga Region, with agricultural seasons being influenced by mean annual and monthly rainfall as well as rainfall probability, concluding that unrealibility of rainfall and a relatively high probability of too low precipitation in many months are major problems.

Two rainy seasons can be distinguished in Tanga Region. The short rains called "Vuli" fall during October to January and the long

Table 1-1. Korogwe tea sub-scheme: Rainfall distribution by months, 1972/73 - 1978/79 by years and 7-year average

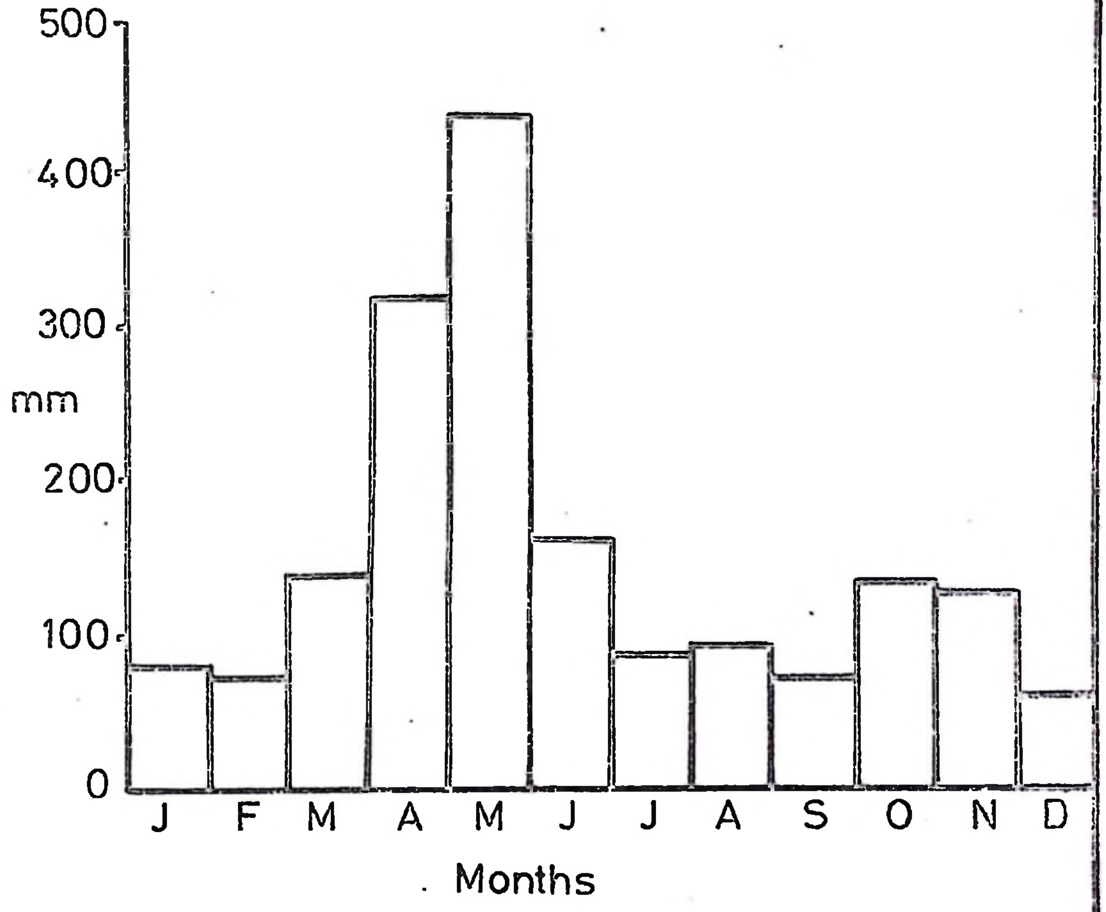
Month	July-June year							Average 1972/73-1978/79
	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	
	Mm							
July	131	42	184	72	109	42	37	88
August	52	52	21	27	138	299	57	92
September	103	17	29	158	93	107	14	74
October	233	33	47	39	114	466	9	134
November	326	45	37	21	74	83	297	126
December	76	68	31	53	49	52	104	62
January	66	57	96	23	83	129	99	79
February	98	12	36	47	98	90	128	73
March	55	59	134	59	214	297	158	139
April	255	185	388	280	345	353	426	319
May	252	213	428	515	477	380	788	436
June	83	120	169	187	154	148	267	161
Total	1,730	903	1,600	1,481	1,948	2,446	2,384	1,784

Source: Korogwe tea sub-scheme, monthly rainfall records.

rains namely "Masika" normally start in the middle of March and continue to May. The long rains produce about half of the annual precipitation in the Region. Sometimes a period of intermittant heavy showers called "Mchoo" occurs either in June or July. The two main rainy seasons, "Vuli" and "Masika", are however not very distinct as can be seen in figure 1-1.

Discussion of rainfall is of limited value if not related to temperatures and evaporation rates. Temperature variations between seasons and between day and night are relatively small in the lower areas, varying from 20° to 30°C. The coastal climate is characterised by high atmospheric humidity which often reaches the 100 percent maximum and drops to a minimum of 65 to 70 percent, but on average the daily minimum is not less than 90 percent. Evaporation is low in

Figure 1-1. Korogwe tea sub-scheme : Mean monthly rainfall 1972/73-1978/79 average



Source: Table 1-1.

the coastal area but soil water is lost quickly because of high infiltration rates of the coastal sands. The Usambara Mountains, on the other hand, have a temperate climate with relatively large temperature differences between seasons and between day and night with moderate atmospheric humidity. Evaporation rates are however not very high on the Highlands despite moderate humidity because of cloud cover. As a result, the Highlands tend to be high in agricultural potential relative to the coastal areas.

1.1.4 Soils and vegetation

Information on soils in Tanga Region, as in many parts of Tanzania, is deficient. Most soils which have developed in the southern part of Tanzania along the coast and over the Usambara Mountains are sandy loams. In the north and south of these Mountains, deep red loams have formed, while black clays are found in topographic depressions. The sandy loams of the Usambara are ferrallitic in nature or ferrisols in the upper elevations. Lower down, where rainfall is less, the soils are ferruginous. These soils, which are reddish-brown in appearance, have medium to high fertility with moderate agricultural potential. However, soil erosion in some areas has led to non-productive soils of low agricultural potential.

The vegetation varies from place to place but in general the Region is characterised by tropical savannah grass and bush on the lowlands. The highlands on the contrary have upland moist forests and the highest areas are covered by tropical forests.

1.1.5 Farming systems and agricultural enterprises

Natural, economic and socio-institutional conditions of agricultural production vary from place to place and over periods of time. In the process of adopting cropping patterns and farming practices to the conditions of each location and the aims of the farmers, more or less distinct types of farm organizations have developed so that no farm is organized exactly like another. According to Ruthenberg (1971), however, it is necessary to classify farms according to their farm management characteristics if we are to devise meaningful measures in agricultural policy and development. Based on this type of classification, the typical farming system identified in the Korogwe Highlands is a subsistence crop and perennial cash-crop system.

Major perennial crops cultivated for cash include tea, coffee and cardamom. Tea is planted on pure stand, while both coffee and cardamom are intercropped with bananas, at the ratios of banana: coffee = 1:4, and banana:cardamom = 1:3.

Subsistence food crops grown are bananas, beans, maize and cassava. These can either be intercropped or grown in pure stand. Most farmers grow maize and beans on pure stand but some intercrop maize with cassava, which is left as pure stand after the maize harvest. When maize is intercropped with cassava, the ratios are $\frac{1}{3}$ cassava and $\frac{2}{3}$ maize.

Land preparation for coffe, cardamom, tea and bananas coincide with that for maize and cassava. For beans, land preparation normally starts after the planting of the main food crops. The normal planting season for all crops except beans (which are planted after the long rains) is during the long rains in March and April. After establishment, tea continues bearing for over 50 years, coffee for over 30 years, bananas for about 15 years and cardamom for 10 to 14 years to give economic yields.

1.2 The Tea Industry

The tea plant, Camellia sinensis, has been cultivated for so long that its home as a wild plant is a matter of speculation (Eden, 1976). However, its long history in the Asian continent suggests that its place of origin is somewhere in the southeastern part of Asia. Today, tea is grown and manufactured in a variety of regions that differ in topography and climate. Its development in the modern form known today started in India many years ago and later spread to the relatively new growing regions. In East Africa, commercial tea production started between 1920 and 1934.

Among the common beverages, tea production traverses the whole gamut from peasant smallholder to the sophiscated commercial industry in size of unit and refinement of technique. Made tea, commonly known as black tea, is produced from the young leaves and unopened buds of the tea plant Camellia sinensis (L.) O. Ktze. Although this species includes widely different varieties, of the three main ones, China, Assam and Cambodia, Assam "jot", which grows to heights up to 20 m, is the most suited to Tanzanian conditions. When it is grown in tea gardens, however, tea is maintained by pruning to a height of less than one m. A first look at a well-kept tea garden gives an impression of a luxuriant raised lawn.

1.2.1 World tea production

World production of manufactured tea in 1976 was 1,628 thousand tons, of which 1,433 thousand tons (88 percent) was from developing countries (MDB, 1979b). Production of the largest traditional Far East producers, India and Sri Lanka, declined from 52 percent of the total in 1964-66 to 43 percent in 1974-76. On the other hand, production in Africa increased from 6.5 percent to 9.4 percent during the same period. Data and projections for manufactured tea production, consumption and exports by countries are shown in table 1-2.

World tea production increased relatively sharply in 1977 by 9 percent above the 1976 level. The recorded increase was a result of good weather coupled with higher producer prices. For the Far East, increases in India and Indonesia were offset in part by decreases for Sri Lanka and Bangladesh so that the total for the region increased by only 0.5 percent. The decline in Bangladesh was reportedly due to fine plucking, whereas in Sri Lanka it was a continuation of the long-term declining trend since the middle of the 1960's (MDB, 1979b).

Production in Africa was estimated to be higher by 2.4 percent in 1978 than in 1977, reaching a total of 198 thousand tons. On average, world tea production shows an upward trend, with a projected increase of 3.4 percent annually between 1980 and 1985, reaching a 2.25 million ton total by that year (table 1-2). Most of the rise in production during this period is expected from increased yields of tea already planted, i.e. from new plantings, replantings and

Table 1-2. World: Tea production, consumption and trade, actual, 1961-63 and 1972-74 averages, and projections, 1980 and 1985

Country	Average		Projections		Annual growth rate		
	1961-63	1972-74	1980	1985	1961-63 to 1972-74	1972-74 to 1980	1980 to 1985
	1,000 tons				Percent		
Production:							
Developing countries:							
India	394	472	582	683	2.8	3.0	3.3
Sri Lanka	213	210	216	225	-.1	.5	.8
Kenya	16	54	84	105	12.0	6.4	4.6
Indonesia	78	64	76	88	-1.8	2.6	3.0
Tanzania	5	13	17	23	9.7	4.2	6.2
Other	91	178	231	277	8.7	4.3	4.0
Total	752	991	1,206	1,401	4.5	2.3	2.1
Centrally-planned countries:							
China	178	306	428	548	5.1	5.0	5.1
Other	51	84	105	117	5.9	3.6	2.3
Total	229	390	533	665	4.9	4.6	4.5
Developed countries	88	143	168	183	4.5	2.3	2.1
World total	1,069	1,524	1,907	2,250	3.3	3.3	3.4
Consumption:							
Developing countries	387	585	784	976	3.9	4.4	4.5
Centrally-planned countries	198	378	525	642	6.1	4.7	4.2
Developed countries	466	544	594	630	1.4	1.3	1.3
World total	1,050	1,507	1,903	2,248	3.3	3.4	3.4
Exports:							
Producing countries:							
India	214	199	238	268	-.6	2.6	2.4
Sri Lanka	202	194	196	199	-.3	.1	.3
Kenya	14	50	72	92	12.2	5.5	5.6
Indonesia	30	42	44	46	3.2	.7	.9
Tanzania	4	10	12	15	8.7	3.5	4.5
Other	120	209	249	289	6.7	2.7	3.2
Total	584	704	811	909	1.7	2.1	2.3
Non-producers	28	81	110	115	17.2	3.2	.9
World total	612	785	921	1,024	2.3	2.3	2.2

Source: MDB, 1978, table 2.8, p. 22.

infilling completed by the 1980/81 season.

1.2.2 World tea trade

Efforts on increased world tea production may be frustrated by low world tea demand. During the period 1964-66 to 1974-76, world production of manufactured tea in developing countries grew at an annual rate of 3.4 percent but net exports grew at only 1.9 percent. The annual rate of increase in exports for the traditional tea producing and exporting countries, India and Sri Lanka, has been lower in the same period than the world average of 2.3 percent. On the other hand, the rate of export expansion in Africa and Latin America has been relatively higher, resulting in an increased export share.

World exports of manufactured tea in 1978 were 737 thousand tons, a figure lower by 4.4 percent compared to 1977 exports. Major declines in tea exports occurred in the Far East, particularly in India, because of imposition of an export duty on tea due to low world import demand in 1978. As a result, India's exports fell by 28 percent from 230 thousand tons in 1977 to 166 thousand tons in 1978. On the contrary, African exports were a record high in 1978, rising from 154 thousand tons in the previous year to 166 thousand tons. Record increases were from Malawi and Tanzania, while Uganda and Zaire experienced declining exports.

World imports increased at an annual growth rate of 2 percent between 1964-66 and 1974-76. Of this, total developed countries accounted for the largest share, although their imports had been increasing at a slower rate of 1.1 percent. Reasons advanced for the low rate of increase are the decline of per capita consumption in the traditional tea-consuming countries like the United Kingdom (UK) and Australia. In total, imports in the developed countries fell from 514 thousand tons in 1977 to 415 thousand tons in 1978, a decline of 19 percent. On the other hand, the import rate of increase of 3.7 percent for developing countries, surpassing the world average, indicates a moderate rise in per caput tea consumption in these countries.

1.2.3 World tea prices

Money price is one of the measuring rods used often in the market to combine diverse commodities like coffee, sugar, and tea to a single total figure. A problem economists face when they choose money price as the measuring rod is to determine which prices to use. This difficulty arises in part because prices can be raised or lowered by inflation or deflation. In other words, the value of money changes between years. Economists can, however, adjust for the changeability of this measuring rod by using an index number of prices called a "deflator". What is needed is some kind of average of the price changes, each being weighted according to its approximate economic importance and based on specified price series. The deflator can be used to compute or deflate current prices into "real" prices in terms of say Shs. of unchanged purchasing power of a selected base year.

In table 1-3, 1976 was selected as a base year so that the deflator in that year equals 100. The year 1976 is hence regarded as "normal" in terms of prices after adjusting for other factors. Current prices in other years were converted into real money prices in terms of Shs of unchanged 1976 purchasing power. To illustrate the process of deflation in table 1-3, take the tea price in 1970 and compare it with the 1976 price, i.e. the base year. The 1970 deflator was estimated by MDB (1978) as 52; hence the deflated tea price in 1976 equals the current 1970 price divided by the deflator and multiplied by 100. That is (110/52) x 100 = US ¢ 212. Thus, in general, deflated tea prices in the table are obtained by dividing the current price by the assumed deflator and multipling by 100.

The deflator values for 1951 through 1976 and projections from 1980 to 1990 came from MDB (1978, 1979b) while the 1977 and 1978 values were interpolated by the author to provide continuity and are therefore shown in parentheses. Actual tea prices in 1977 were the highest on record and in 1978 were the second highest. Based on the assumed deflator levels, deflated prices in 1977 were the highest since 1967 and in 1978 were the highest since 1971.

Projections by MDB in 1977 based on 1976 constant prices and a projected continued close balance between world production and consumption indicated that prices were expected to change little from their average level of US ¢ 154 per kg in 1976. The effect of this would have been to halt the long-run decline in real tea prices. The MDB forecasts, however, went wrong because of unforseeable circumstances, namely the worst frost in the history of Brazil in mid-1975 that killed 550 million of her coffee trees and damaged another 1,400 million, floods that destroyed several million coffee trees in Columbia and severe drought in El Salvador, all of which led to reduced coffee production and raised coffee prices to record-high

Table 1-3. World: Market price per kg for tea in current and constant terms, actual 1951 to 1978, projected 1980, 1985 and 1990[a]

Year	Tea price		Deflator[b] (1976 = 100)	Year	Tea price		Deflator[b] (1976 = 100)
	Current	In 1976 terms			Current	In 1976 terms	
	US cents				US cents		
Actual:				Actual:			
1951	113	263	43	1967	127	270	47
52	94	214	44	68	104	221	47
53	113	269	42	69	97	198	49
54	161	392	41	70	110	212	52
55	154	367	42	71	105	191	55
56	149	347	43	72	105	175	60
57	137	311	44	73	106	149	71
58	142	323	44	74	140	159	88
59	141	328	43	75	138	141	98
60	142	323	44	76	154	154	100
61	136	302	45	77	271	(251)	(108)
62	138	313	44	78	218	(188)	(116)
63	130	289	45	Projected:			
64	132	293	45	1980	216	163	132
65	129	280	46	85	293	159	184
66	126	268	47	90	390	157	249

Source: 1951 to 1976 and the projections, MDB, 1978, table 2.9, p. 24; 1977 to 1978, MDB, 1979b, p. 15. Numbers in parentheses for the latter years are interpolations by the author for the deflator which were then used to calculate the deflated prices.
a/ Average of all teas in the London Auctions weighted by volume sold.
b/ Cost, insurance, and freight (cif) prices of manufactured exports of developed market economies.

levels, pulling tea (and cocoa to a lesser extent) with it to reach record high prices in 1977. These high prices likely account for the "inactivated" tea trade in 1978. More recent projected prices call for a gradual decline from 1978 forward to a deflated level by 1990 only slightly above that in 1976 (table 1-3).

Tea has been experiencing cyclical changes in prices largely because of changes in coffee prices and to some degree due to adverse weather conditions in the major tea-producing countries - India and

Sri Lanka. Tea, like her sister beverage crop coffee, has an inelastic demand. Small shortages result in large price increases. Hopp and Foote (1955), in their study of factors that affect coffee prices, noted that when coffee supplies are declining, efforts are made by importing countries to maintain or increase inventories and prices tend to be higher than would be expected from the level of supply in relation to consumption. When supplies are increasing, inventories may be reduced, hence prices tend to be lower than otherwise expected. Similar effects and record high coffee prices may have caused record high prices for tea in 1954, 1967, 1977 and 1978; and extremely low prices in 1952, 1969 and 1971 through 1973 (table 1-3). The period between price increases and increased production of tea largely depends on farmers' efforts and ability to catch up with the price changes through new plantings, rehabilitation of tea bushes or intensified plucking. It is important, however, to note that declining prices do not affect production as consistently as rising prices because, once tea is established, farmers will continue to pluck unless prices fall beyond tolerable limits.

1.2.4 <u>International Tea Agreement (ITA)</u>

By definition, an international commodity agreement is a politically acceptable medium through which producing countries rally their interests on agreeable pre-set objectives. The primary aim of any international commodity agreement is to control or remove fluctuations in world prices by adjusting production towards an equilibrium point in the long run. This can be achieved in a variety of ways. The common practice is to set up quota systems tied to maximum and minimum trading prices or storage programs to even-out supply.

An international tea agreement by producing countries is long overdue. General instability in export quantities and prices, caused by changes in demand and supply fluctuations for major beverages as a result of bad weather and cyclical production imposed by changes in market prices, indicate that an international agreement for tea is necessary. Indeed, world tea prices have recently been record high, reflecting record high prices for coffee. However, tea prices are now declining and a more recent international tea agreement, including a quota system, was discussed by the United Nations Committee for Trade and Development (UNCTAD) (1978a, b). The UNCTAD team concluded that a stocking arrangement for tea is technically feasible.

The basic objectives for an international tea agreement as discussed by the FAO Intergovernmental Group on tea and its sub-group of exporters (1977) include, <u>inter allia</u>; to sustain and improve, in real terms, export earnings from tea and returns to growers; to provide for special needs of smallholder growers, to create stable conditions in international trade in tea and ensure that its prices are rewarding to producers and equitable to consumers, to remove obstacles to the expansion of tea consumption and provide for improvements in its marketing and distribution, and finally to increase participation by developing countries in activities such as tea blending and packaging.

Another step made to cement the international tea agreement has been the formation of an International Tea Promotion Association by governments of tea exporting countries. The Governing Board of the association first met in April 1979 and listed the following objectives: To coordinate, develop, and promote tea consumption and enhance global tea programmes.

Based on the assumption that quota shares of ITA depend to some degree on the volume of past exports, East African countries including Tanzania likely will win regular quota increases, allowing them to sell their total export surpluses. Given this situation, and if the agreement comes into effect, it would be a rational decision for Tanzania to continue the expansion of its tea industry for in so doing it will have increased exports. A point in mind for this endeavour is that, while deciding to increase production, Tanzania must also know the position of other producing countries and more specifically their likely quota shares.

1.2.5 Tea in the economy of Tanzania

The economic importance of tea to the economy of Tanzania increased rapidily following the recent expansion in production and recent high world prices. Its contribution to Tanzania's foreign exchange increased from 1.3 percent in the middle 1950's to 8.1 percent in 1977 when tea was Tanzania's seventh largest earner (table 1-4). Tea is already a major source of cash income to most smallholder farmers in the areas where it is grown.

Apart from providing a rapidily growing source of foreign exchange, the tea industry in Tanzania caters for a promising growing domestic market. Domestic tea consumption increased from 1,000 tons to over 2,000 tons in the decade ending in 1978.

Table 1-4. Tanzania: Value of exports by major commodities, 1970-1977

Commodity	Calender year							
	1970	1971	1972	1973	1974	1975	1976	1977
	Million shs							
Coffee	312	227	383	495	375	483	1,282	1,870
Cotton	247	245	336	333	473	297	613	542
Cloves	109	179	240	233	88	321	261	244
Sisal	179	134	145	222	463	302	240	228
Tobacco	45	43	49	56	88	92	188	206
Cashewnuts	115	120	150	141	196	177	131	188
Tea	42	49	54	45	69	81	134	180
Diamonds	161	209	123	165	122	178	159	151
Petroleum products	111	143	216	87	130	139	173	134

Source: Tanzania, United Republic of, 1979, table 10, p. 20.

1.2.6 Tea production and processing in Tanzania

Tea is grown in four widely-separated areas of Tanzania. The oldest plantings date from 1934 and are in the Rungwe and Lupembe-Mufindi areas of the southern highlands and in the Usambara Mountains in Tanga Region. Recently tea has been planted in West Lake Region and trials have been carried out successfully in Kigoma and Mara Regions where commercial tea production has not started yet. Prior to smallholder tea production in 1961/62, all of Tanzania's tea was produced on privately-owned estates. At present tea is produced by three types of producers namely private estates, Tanzania Tea Authority (TTA) estates and smallholder growers.

By 1978, 8,675 ha were planted by 28,684 smallholders with an average plot size of 0.31 ha per farmer. Out of this total, 3,272 ha were planted between 1961 and 1971 and 5,403 ha were planted during an International Development Association financed Phase I project ending in 1974/75. At the end of this project, TTA had planted a total of 268 ha in Bukoba and Lupembe. In 1977 the TTA acquired a 717 ha Dulwa estate in Amani, Tanga. There have not been any major plantings by either smallholders or TTA after the 1975/76 crop year (table 1-5). Private estates in total covered a planted area of 8,400 ha in 1978. Area expansion has remained stagnant for the estates since the 1966/67 season.

Private estates produce the largest share of Tanzania's tea despite approximately equal hectarage to that of smallholders. This is due to two main reasons: Smallholder tea is mostly immature and secondly the use of recommended husbandry practices is not well adhered to. Thus, while in 1977/78 for instance, private estates produced 12,000 tons of made tea at an average yield of 1,300 kg per ha, smallholder farmers produced 4,000 tons at an average yield of 500 kg per ha (table 1-5). The low smallholder average yield reflects a substantial proportion of immature hectarage. But, even then, TTA estimates that smallholder yield from mature plots averages only 800 kg of made tea per ha, considerably below smallholder yield of 1,600 kg per ha for Kenya.

Tea in Tanzania is processed by either private or TTA factories. Green leaf produced by private estates is mainly processed in private factories but some small private estates deliver their production to TTA factories. Smallholder green leaf is processed in TTA factories except that from the 590 ha Korogwe tea sub-scheme which is processed in two private factories owned by Ambangulu and Dindira estates.

Table 1-5. Tanzania: Total planted tea area, made tea production and tea yield per ha, 1961/62 to 1977/78

July-June crop year	Area				Production[b]			Yield per ha[c]	
	Estates		Small-holders	Total	Private estates	Small-holders	Total	Private estates	Small-holders
	Pri-vate	TTA[a]							
	- - - - 1,000 ha - - -				- - 1,000 tons - -			- 1,000 kg - -	
1961/62	7.8	0	0.1	7.9	4.3	0	4.3	0.6	0
62/63	8.0	0	.1	8.1	5.0	0	5.0	.6	0
63/64	8.3	0	.4	8.7	4.8	0	4.8	.6	0
64/65	8.5	0	.7	9.2	5.6	0	5.6	.7	0
65/66	8.8	0	1.0	9.8	6.7	0.1	6.8	.8	0.1
66/67	9.0	0	1.4	10.4	6.8	.2	7.0	.8	.1
67/68	9.1	0	1.7	10.8	7.6	.4	8.0	.8	.2
68/69	9.1	0	2.0	11.1	8.2	.6	8.8	.9	.3
69/70	9.3	0	2.7	12.0	7.8	.7	8.5	.8	.3
70/71	9.3	0	3.3	12.6	8.4	.8	9.2	.9	.2
71/72	9.2	0	4.8	14.0	10.4	1.2	11.6	1.1	.2
72/73	9.2	0	5.9	15.1	11.6	1.7	13.3	1.3	.3
73/74	9.1	0	7.4	16.5	10.5	1.7	12.2	1.2	.2
74/75	9.1	0	8.4	17.5	11.8	2.0	13.8	1.3	.2
75/76	9.1	0.3	8.7	18.1	10.9	2.2	13.1	1.2	.2
76/77	9.1	.3	8.7	18.1	12.1	3.1	15.2	1.3	.4
77/78	8.4	1.0	8.7	18.2	12.0	4.0	16.0	1.3	.5

Source: MDB, 1979b, table 1.2, p. 2.

a/ In 1977, TTA acquired Bulwa, a private estate in Tanga Region with a total of 717 ha of mature tea. Thus, TTA owned 985 ha of tea in 1977/78.

b/ Up to 1977/78, TTA's tea was immature so that no production was recorded. Production of tea from Bulwa estate, acquired in 1977, is included under private-estate production.

c/ Smallholder tea was immature from 1961/62 through 1964/65.

Table 1-6 shows a break down of made tea production by TTA and private factories for two recent years. In 1977/78, TTA factories accounted for 30 percent, while private factories processed the balance. The proportion for TTA in the preceding year was 26 percent. In terms of tonnage, TTA factory output in 1977/78 was 38 percent larger than the preceding year, while private factories increased by only 15 percent. The general increase was due to more tea bush entering maturity for smallholders and increased yields for estates due to improved husbandry practices, particularly the use of fertilizers coupled with good weather.

Table 1-6. Tanzania: Production of made tea by type of factory and place, 1976/77 and 1977/78

Type of factory and place[a/]	1976/77		1977/78	
	Quantity	Proportion of total	Quantity	Proportion of total
	Tons	Percent	Tons	Percent
TTA factories:				
Rungwe (Katumba)	1,317	8.7	1,881	10.2
Njombe (Lupembe)	903	5.9	1,208	6.5
Usambara (Mponde)	602	4.0	1,032	5.6
Amani (Bulwa)	720	4.7	822	4.5
Bukoba (Bukoba)	471	3.1	612	3.3
Total	4,013	26.4	5,555	30.1
Private factories:				
Rungwe:				
(Chivanjee)	1,100	7.2	1,650	8.9
(Musekera)	1,055	6.9	822	4.5
Total	2,155	14.1	2,472	13.4
Njombe:				
(Luponde)	518	3.4	534	2.9
Total	518	3.4	534	2.9
Mufindi:				
(Lugoda)	1,995	13.1	2,695	14.6
(Kilima)	1,700	11.2	1,732	9.4
(Stone Valley)	821	5.4	1,109	6.0
Total	4,516	29.7	5,536	30.0
Usambara:				
(Karimi)	1,100	7.3	1,150	6.2
(Kwamkoro)	1,020	6.7	935	5.1
(Ambangulu)	674	4.4	808	4.4
(Dindira)	412	2.7	405	2.2
(Marvera)	280	1.9	396	2.1
(Herkulu)	234	1.5	340	1.9
(Balangai)	280	1.9	331	1.8
Total	4,000	26.4	4,355	23.6
Total private factories	11,208	73.6	12,907	69.9
Grand total	15,208	100.0	18,452	100.0

Source: MDB, 1979b, table 1.1, p. 1.
a/ Brackets indicate particular area where factory is situated.

By 1978/79, 80 percent of the green leaf processed by TTA factories was collected from smallholder farmers, while the balance came from small estates and TTA collections.

Production of made tea by private and TTA factories form the total for Tanzania. Table 1-7 shows national made tea production by Regions. Iringa Region tops the national list by its contribution of 38 percent, followed by Tanga Region with 33 percent and Mbeya Region with 26 percent in 1978/79. Total national made tea production fell by 5 percent from 1977/78 to 1978/79 (table 1-7). Under normal circumstances, production would be expected to rise because more smallholder tea plantings mature each year. However, the reverse was true for 1978/79, possibly because of poor transport as a result of the tight fuel supply.

Table 1-7. Tanzania: National made tea production by Regions and areas, 1976/77 to 1978/79

Tea-growing area	July-June crop year			Proportion of total		
	1976/77	1977/78	1978/79	1976/77	1977/78	1978/79
	- - - 1,000 kg - - -			- - - - Percent - - -		
Iringa Region:						
Mufindi	4,517	5,536	5,080	30	30	29
Njombe	1,421	1,743	1,554	9	9	9
Total	5,938	7,279	6,634	39	39	38
Tanga Region:						
Usambara	5,331	6,218	5,790	35	34	33
Mbeya Region:						
Rungwe	3,468	4,343	4,511	23	24	26
West Lake Region:						
Bukoba	471	612	612	3	3	3
Grand total	15,208	18,452	17,547	100	100	100

Source: TTA, 1978, p. 2 and 1979, 1st, 2nd, 3rd and 4th quarter reports.

1.2.7 Marketing of Tanzanian tea

Smallholder tea-growers sell green leaf to processing factories and are paid monthly according to the quantity of green leaf sold. There is usually a lapse of about 2 weeks between payment and last sales in a particular month. Farmers receive Shs. 1.10 net of credit deductions for fertilizer and stumps per kg of green leaf sold. The net price paid to farmers increased from between 48 and 60 cents in 1971/72, depending on factory, to 70 cts per kg nationwide in 1976/77 (table 1-8), an increase of 17 to 46 percent over a period of 6 years. Following the price increase on the international market for tea early in 1977, the government announced an increase in producer price to Shs. 1.50 per kg. At the same time the deduction for credit repayment was raised from 20 cents to 40 cents per kg of green leaf sold. Thus the smallholder net realisations stood at Shs. 1.10 from 1977/78 to date (table 1-8). Previous regional differences in green leaf prices to growers were said to be due to quality variations in the conversion rate of green leaf into made tea. The announced equal tea price by government in 1977 was a matter of policy. Conversion rates presumably were about the same as in prior years.

TTA handles the procurement and marketing of all smallholder tea processed in its factories at Lupembe, Bukoba, Katumba and Mponde. About 14 percent of the tea produced is consumed locally and the rest is exported (table 1-9). The local consumption figure for tea indicates a relatively small domestic demand. Thus, viability of the Tanzanian tea industry is determined largely by the export market.

Table 1-8. Tanzania: Smallholder net producer price per kg for green leaf tea, 1971/72 to 1979/80[a/]

July-June crop year	Usambara (Tanga)	Lupembe (Iringa)	Mufindi (Iringa)	Bukoba (West Lake)	Rungwe (Mbeya)
			Cents		
1971/72	55	55	-	60	48
72/73	50	51	55	60	49
73/74	52	51	52	60	55
74/75	52	52	60	60	55
75/76	55	55	60	60	65
76/77	70	70	70	70	70
77/78	110	110	110	110	110
78/79	110	110	110	110	110
79/80	110	110	110	110	110

Source: Through 1977/78 - MDB, 1978, table 2.5, p. 19.
1978/79 forward - MDB, 1979b, pp. i and ii.

a/ Regions are shown in brackets in the box heads.

Table 1-9. Tanzania: Tea production, exports and domestic consumption, 1961/62 to 1977/78[a/]

July-June crop year	Production	Exports	Domestic consumption	Domestic consumption as a proportion of production
	- - - - -	-1,000 tons-	- - - - -	Percent
1961/62	4.3	3.0	0.9	21
62/63	5.0	3.6	.8	16
63/64	4.8	3.8	1.1	23
64/65	5.7	3.4	1.3	23
65/66	6.8	3.5	1.2	17
66/67	7.2	4.0	1.3	18
67/68	7.9	5.7	1.4	17
68/69	8.8	5.8	1.8	20
69/70	8.5	6.6	1.6	19
70/71	9.2	6.9	1.9	21
71/72	11.6	7.2	2.1	18
72/73	13.3	8.8	2.4	18
73/74	12.3	10.4	2.5	20
74/75	13.9	8.2	2.6	19
75/76	13.0	9.8	2.2	17
76/77	15.2	12.5	2.2	14
77/78	18.5	15.0	3.5	19

Source: MDB, 1978, table 2.2, p. 13.

a/ Figures do not balance exactly because production figures relate to crop years while export and domestic consumption data relate to fiscal years and no allowance is made for changes in stock levels.

While local tea sales in the country are handled by Tanzania Tea Blenders, export made tea is sold through the London auction and by private treaty. Prior to 1977, large quantities of tea were sold through the Mombasa auction in Kenya. However, the imposition of a sales tax on tea in transit in 1976 by Kenya and border closure with Tanzania led to higher sales by private treaty and through the London auction.

Table 1-10 shows average prices per kg of Tanzanian tea sold at the London auctions by months from 1971/72 to 1978/79. Record high prices in 1976/77 were a result of a strong demand from importing countries caused by the extreme shortage and high price of coffee. UK is by far the most important consumer of Tanzanian tea, accounting for 73 percent of the total export value in 1977. Many other countries take lesser amounts (table 1-11).

Table 1-10. Tanzania: Average price per kg of Tanzanian tea sold at London auctions, cif Europe, by months, 1971/72 to 1978/79

Month	1971/ 72	1972/ 73	1973/ 74	1974/ 75	1975/ 76	1976/ 77	1977/ 78	1978/ 79
					Shs.			
July	7.98	7.39	7.08	10.47	10.37	16.30	26.65	16.50
Aug.	7.68	7.55	7.04	9.99	10.29	14.59	18.89	15.00
Sept.	8.30	7.02	7.10	9.27	9.81	15.01	14.81	15.63
Oct.	7.96	6.86	6.96	9.74	9.84	16.19	18.56	15.75
Nov.	7.34	7.02	7.48	10.64	11.04	16.23	17.88	16.38
Dec.	7.74	7.25	7.90	10.78	10.94	15.87	17.58	16.61
Jan.	7.60	7.14	8.34	10.98	10.87	16.68	19.05	20.35
Feb.	7.72	7.47	8.73	11.14	11.22	18.34	19.05	17.14
Mar.	7.90	7.56	11.28	10.01	10.90	28.92	18.60	17.99
Apr.	7.76	7.69	11.14	10.44	11.32	34.22	17.11	17.10
May	7.87	7.48	10.53	9.92	12.27	29.78	16.37	18.19
June	7.80	7.75	10.62	10.53	14.23	28.48	17.02	17.92
Average	7.80	7.33	8.68	10.33	11.09	20.88	18.49	17.05

Source: MDB, 1978, table 2.6, p. 20, for years 1971/72 through 1976/77. MDB, 1979 b, table 4.2, p. 16, for years 1977/78 and 1978/79.

Table 1-11. Tanzania: Exports of made tea, value and derived price by country of destination, 1977

Country	Value f.o.b.[a/] Dar es Salaam	Quantity	Derived price per kg (Value/Quantity)[b/]
	Shs million	1,000 kg	Shs
United Kingdom	130.5	9,458	13.8
Netherlands	12.2	697	17.4
Canada	10.8	401	26.9
United States	5.8	376	15.5
Egypt	5.7	282	20.1
Pakistan	4.9	357	13.7
Zambia	2.6	74	34.5
Eire	2.2	92	23.4
West Germany	1.6	113	14.1
Others	1.6	125	16.2
Total or average	177.9	11,975	14.8

Source: TTA, 1978, p. 11.
a/ Free on board vessel or vehicle.
b/ Computed from unrounded data.

1.2.8 Tea in Tanga Region, including the Korogwe sub-scheme

Tea is an important cash crop, second only to sisal in the economy of Tanga Region. In 1973 tea earned the Region Shs. 13.5 million, accounting for 9 percent of the total value of cash crops (table 1-12). In that year, sisal accounted for 78 percent.

In Tanga Region, tea is grown in the Usambara Mountains largely by private estates which produced 77 percent of the total regional output in 1978/79 (table 1-13). Smallholders grow the balance and have been increasing in relative importance. Smallholder tea producers are concentrated in Mponde area in Lushoto District and Bungu in Korogwe District. Private estates likewise are found in these areas, with additional estates in Amani of Muheza District. Tanga Region produces a third of the total national made tea.

Table 1-12. Tanga Region: Important cash crops, 1973

Crop	Quantity	Value	Proportion of total value
	1,000 tons	Shs million	Percent
Sisal	103.0	117.4	78.2
Tea	3.6	13.5	9.0
Cardamom	.5	9.7	6.5
Copra	2.1	4.2	2.8
Coffee	1.1	2.9	1.9
Cashewnut	2.2	2.1	1.4
Cotton	.3	.3	.2
Total	-	150.1	100.0

Source: TIRDEP, 1975, V.I, p.7.

Table 1-13. Tanga Region: Regional made tea production by type of producer, 1976/77 to 1978/79

Type of producer	July-June crop year			Proportion of total		
	1976/77	1977/78	1978/79	1976/77	1977/78	1978/79
	--- 1,000 kg ---			---- Percent ----		
Private estates[a]	4,534	4,884	4,456	85	78	77
Smallholders:						
Lushoto	602	1,032	1,065	11	17	18
Korogwe	195	302	269	4	5	5
Total	797	1,334	1,334	15	22	23
Regional total	5,331	6,218	5,790	100	100	100

Source: TTA, 1979.
a/ Includes Bulwa estate acquired by TTA in 1977.

The importance of tea as a cash crop for smallholders is on the increase. A total of 873 ha were planted by 1972 by 2,514 farmers before the World Bank project, but the increase during Phase I of the World Bank project was spectacular. During that period, area planted increased to 2,149 ha and the number of farmers increased to 5,388 by 1976. On average, a smallholder cultivates 0.40 ha of tea in the Region.

Korogwe tea sub-scheme, which is the particular concern of this study, comprises 1,500 smallholder tea growers and produced 5 percent of the regional made tea production in 1978/79 (table 1-13). Production by the scheme is shown in table 1-14 on a monthly basis, with annual totals, from 1973/74 through 1978/79. Production increased from 88 tons in 1973/74 to 268 tons in 1978/79, an increase of 38 percent per year. This sharp increase began when the scheme was divorced from the then West Usambara tea project in Lushoto District.

Table 1-14. Korogwe tea sub-scheme: Made tea production by months, 1973/74 - 1978/79

Month	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79
			1,000 kg			
July	3.7	8.8	7.3	7.8	9.5	11.1
Aug	6.2	7.6	10.1	11.5	16.9	13.6
Sept	8.4	13.5	12.3	18.2	20.7	28.6
Oct	8.9	7.5	23.6	25.6	31.2	19.0
Nov	7.4	11.9	12.5	22.7	34.0	12.5
Dec	8.6	7.2	12.9	12.0	35.7	33.3
Jan	7.8	12.5	10.9	10.1	39.6	32.8
Feb	3.7	9.6	4.2	19.9	28.4	29.3
Mar	3.1	5.7	5.5	15.8	31.2	47.9
Apr	10.6	20.0	8.9	21.1	21.5	26.3
May	11.1	9.2	8.8	14.5	22.0	14.1
June	7.6	10.1	9.3	14.2	11.2	8.2
Total	87.7	123.7	126.3	194.5	302.0	268.5

Source: Korogwe tea sub-scheme, 1979.

A sharp increase in production took place in 1977/78, likely because farmers plucked to a maximum extent to try to take advantage of high prices that already were turning down. The relatively declining production in 1978/79 could be due to lowered plucking as prices were already below their recent highs. Transport problems were also serious because of frequent break-down of vehicles and bad roads that had not been maintained for a long time.

1.2.9 The Tanzania Tea Authority (TTA)

TTA was established by the Tea Ordinance (Amendment) Act of 1968 and started its operations on 1st April 1969. Its headquarters and registered office is in Dar es Salaam. Since its inception, TTA has involved itself in various development activities as follows: (1) Recruitment of smallholder tea growers, (2) distribution of planting materials and provision of extension services to these growers, (3) establishment of tea estates and supervision of private estates, (4) planning and building of new factories and expansion or renovation of old factories to accommodate increased smallholder green leaf production, and (5) purchases of green leaf from village collecting centres and transporting it to processing factories. Payments for collected leaf are made to smallholder growers monthly according to the amount sold.

TTA owns five factories with a total processing capacity of 6,250 tons per year. In 1977/78, the factories processed a total of 5,576 tons of made tea, accounting for 89 percent of capacity. The Authority hopes that these factories will in future operate at full capacity as more smallholder tea plantings mature. Two more factories have been planned, one under construction at Mwakaleli and another to be constructed at Igoga. These two factories will have operating capacities of 2,000 and 1,000 tons per annum respectively when completed.

1.2.10 The World Bank Tea Project

In 1972, the World Bank approved a US $10.7 million loan for smallholder tea production in Tanzania. The project provided for expansion in smallholder tea planting programmes in four areas including Rungwe, Usambara, Lupembe and Bukoba. The project involved production of planting materials, provision of fertilizer to growers, construction of 300 km of roads in green-leaf collecting areas, construction of tea factories supervised by TTA, purchase of leaf collecting vehicles and provision of extension services to tea growers.

The project target was to produce 9.5 million kg of tea per year at full maturity from 8,300 ha to be planted by 1974. The project was carried out by TTA. Fertilizer was procured by the Tanzania Rural Development Bank (TRDB) and distributed to growers through the defunct co-operative societies and unions, an activity taken up by villages at present. Smallholders obtained loans in the form of planting materials and fertilizers which are being repayed by deducting a cess which from 1977 forward has been 40 cents per kg of green leaf sold.

Table 1-15 shows area under tea and number of smallholders by Region and period of planting. Before the World Bank Phase I project, smallholder tea growers in Rungwe had planted an area covering 35 percent of the total area suitable for tea. Under the Phase I project, out of the projected 8,300 ha, a total of 5,671 ha were planted by 16,047 farmers and TTA. To complete the programme, mainly by increasing the size of plots to become economically more viable, a further loan was necessary. Thus, following a request by TTA in 1977, MDB prepared a proposal for a Phase II project for smallholder tea expansion (appearing as projected in table 1-15). The proposal was submitted to the World Bank by the Government of Tanzania. Under the proposed extension of the loan, it is envisaged that a total of 2,629 ha will be planted within the areas covered by the original project to achieve the targeted 8,300 ha.

Participants in the Phase I project, numbering 16,047, have larger plots averaging 0.34 ha than tea growers of the pre-project period with 0.26 ha plots. Regional variation, however, in the size of holdings are large. In Rungwe and Lupembe, holdings are close to that planned by TTA of 0.6 ha per household, while in Bukoba, plots are as small as 0.09 ha. The low figure for Bukoba is attributed to the high proportion of tea growers relative to available land suitable for tea growing.

1.3 Coffee in the Economy of Tanzania

Coffee has often been Tanzania's largest foreign exchange earner in the 1970's and maintains this position in 1979. In 1977 coffee exports were valued at Shs. 1,870 million, representing 32 percent of the value of major exports in Tanzania (table 1-4). Coffee is a major source of cash income to about 10 percent of the country's 17.5 million people and is an important crop to the economic and social development of Tanzania.

Coffee is cultivated largely by smallholders who produce over 80 percent of the total coffee production and the rest is produced by estates concentrated mainly in Kilimanjaro Region. The major coffee producing Regions are West Lake, Kilimanjaro and Arusha.

Table 1-15. Tanzania: Area under tea and number of smallholders by period of planting by Region

Planting period and project[a]	Planted area: Smallholders	Planted area: Estates: TTA	Planted area: Estates: Others	Planted area: Total	Smallholders: Proportion of total area	Smallholders: Recruited[b]	Smallholders: Average tea area per farm
	Ha	Ha	Ha	Ha	Percent	No.	Ha
Actual							
Planted before World Bank Project:							
Rungwe (Mbeya)	1,152	0	34	1,186	35	5,439	0.21
Lupembe (Iringa)	798	0	332	1,130	24	2,921	.27
Usambara (Tanga)	873	0	78	951	27	2,514	.35
Bukoba (West Lake)	449	0	284	733	14	1,763	.25
Total	3,272	0	728	4,000	100	12,637	.26
Planted during World Bank Project:							
Rungwe (Mbeya)	2,849	0	0	2,849	53	4,492	.63
Usambara (Tanga)	1,276	0	0	1,276	23	2,874	.44
Lupembe (Iringa)	514	154	0	878	10	912	.56
Bukoba (West Lake)	764	114	0	668	14	7,769	.09
Total	5,403	268	0	5,671	100	16,047	.34
Sub-total	8,675	268	728	9,671	-	28,684	.31
Projected							
World Bank Expansion:							
Lupembe (Iringa)	541	496	0	1,038	34	0	-
Rungwe (Mbeya)	851	0	0	851	53	0	-
Bukoba (West Lake)	200	0	0	740	13	0	-
Expected total	1,593	496	0	2,629	100	0	-
Grand total	10,268	764	728	12,300	-	28,684	-

Source: MDB, 1978, table 2.4, p. 17.
a/ Regions are shown in brackets.
b/ Number of growers is not expected to increase. Instead average size of plots per farm will increase.

Production of coffee in Tanzania has since the middle 1960's fluctuated between 45 thousand and 55 thousand tons. This period was preceded by a rapid increase in production in the early 1950's because of large-scale planting of coffee trees in response to the price boom of the 1950's. However, the increased production was not sustained as the planting of new trees lessened and earlier plantings aged and became less productive. The spread of coffee berry disease in Arusha and Kilimanjaro Regions badly affected production and poor standards of husbandry reduced yields also.

In general production has been stagnant in the traditional coffee-growing areas of Tanzania, namely Kilimanjaro and parts of West Lake and Mbeya Regions, reflecting lack of space for expansion and absence of improvement in average yields. The current average yields of coffee for smallholder growers is less than 300 kg per ha. In Kilimanjaro, however, yields average 500 kg per ha and estates record 600 to 800 kg per ha. On the other hand, production is increasing in new areas such as the southern Highlands, including Ruvuma and some parts of Mbeya Region.

The Coffee Authority of Tanzania (CAT) has therefore launched a program to improve coffee yields and six Regions--Kilimanjaro, Arusha, West Lake, Mbeya, Ruvuma and Tanga--have simultenously started to implement the programme. CAT has also proposed to open new areas in less-developed Regions--Kigoma, Mara, Rukwa and Ruvuma--and less-developed areas of Iringa, Mbeya, Morogoro, Tanga and West Lake Regions. Upon implementation of the proposed program, coffee production in Tanzania is expected to rise by 35 percent, reaching 84 thousand tons per year in the 1980's.

World coffee prices have fluctuated widely. As noted earlier, record-high prices in early 1977 were a result of environmental and political factors, including the worst frost in a century in July

1975 in Brazil which killed ⅓ of her coffee trees. Brazil is the major coffee-producing country in the world. The volume of coffee to be available in future will therefore depend in part on the recovery of production in Brazil, good weather conditions, ability to control coffee diseases, political stability in the producing countries and farmers' willingness and motivation to increase area and yield in response to the recent high prices. According to MDB (1977a), World Bank projections indicate that coffee prices will ultimately rise again from the middle 1980's after falling sharply from the 1977 high (table 1-16). MDB (1977a) indicates that coffee prices are unlikely to fall to a level at which the crop becomes unprofitable either to individual growers or to the nation as a whole. It may therefore be desirable for Tanzania to expand her production as the 1976 International Coffee Agreement does not limit coffee expansion. As noted later, however, coffee at 1979 prices was not an economically-viable crop within the area covered by this thesis.

Table 1-16. Coffee: World price per kg, actual and projected, specified averages and years

Actual		Projected in 1977	
Period	Price[a]	Year	Price[a]
	U.S. ¢		U.S. ¢
Average:		1977	616
1960-69	89	1978	451
1970-72	108	1979	381
Annual:		1980	341
1974	145		
1975	144	1985	315
1976	315	1990	440

Source: MDB, 1977a, table 4.2, p. 22.
a/ Spot price in current United States (U.S.) cents of prime washed Guatemalans on the New York market.

1.4 Cardamom in the Economy of Tanzania

Cardamom is a spice produced within Tanzania mainly in Tanga Region where it is the most important cash crop for smallholders, its value to this group of producers surpassing that of tea and coffee taken together (TIRDEP, 1975). The main producing areas in the Region are the Highland areas in Muheza, Korogwe and Lushoto Districts and to a lesser extent in the Nguu Mountains of Handeni District. The total area planted with cardamom was estimated at 4 thousand ha in 1978 (MDB, 1979a). Other Regions which grow some cardamom are Morogoro, Kilimanjaro and Mbeya. Cardamom production has declined since 1973/74 despite attractive returns to farmers, indicating that the farmers are not keenly looking after their crop (MDB, 1977b).

Cardamom produced in Tanzania is mainly exported; some is sold by local spice merchants for household use. The major export markets for Tanzanian cardamoms are Pakistan, West Germany, Jordan and Sweden. Tanzania is the world's second cardamom exporter, with India being the largest since 1973. Tanzania competes with India, Sri Lanka and Guatemala for the export market. However, 30 percent of India's cardamom is consumed locally and both India and Sri Lanka produce cardamom oil which limits the availability of the seeds for export. Cardamom production was low in 1975 following an outbreak of Kate disease in Kerala, India, and lack of rain. Low production resulted in rising international prices for cardamom starting in 1976 to early 1977. Tanzanian cardamoms fetched Shs. 100 per kg in 1977 compared to Shs. 46 in 1976 and Shs. 29 in 1975, cost and freight in international markets.

The international market price for cardamoms looks bright, and MDB (1977b) suggested an improvement programme for cardamom consisting of input distribution packages, credit facilities, extension, research and storage construction.

1.5 Problem Studied and Objectives of the Study

1.5.1 Background to the problem

Past studies on smallholder tea production in Tanzania were descriptive in nature and none attempted to analyse farming systems. The complexity of farming systems for tea farmers and the uncertainties associated with the decision-making process are features which indicate that a systems approach to research in the area of study could be useful as a guide to possible future changes in government policy.

1.5.2 The problem

Many smallholders have been attracted to tea growing since its introduction to these farmers in 1961. Despite this effort by government, however, smallholder tea yield per ha has been low. For example estate production in 1974/75 was 1,250 kg per ha while that of smallholders was 750 kg per ha of made tea (Ministry of Agriculture, 1977). Reasons advanced for low yields include: Improper husbandry practices by smallholders, in particular pruning, fertilizer application, and a low plucking rate; leaf collection is poorly planned; insufficient and poorly planned transport, and labour competition with subsistence food crops and other cash crops such as coffee and cardamom.

On the other hand, Tanzania hopes to increase tea production from the 1976 national level of 15 million kg to 24 million kg by 1981 and envisages that smallholder output will increase as new plantings mature. This was noted in the Third Five-Year Development Plan, 1976-81 (Tanzania, United Republic of, 1978). The Economic Survey 1977/78 (Tanzania, United Republic of, 1979) indicated that increased tea production by smallholders has been largely due to expansion of hectarage and good weather. But a report by TIRDEP (1975) showed that land availability is a limiting factor for productivity in the higher areas of Tanga Region.

So questions arise as to how best to obtain the desired increased output. TIRDEP (1975) also pointed out that cardamom has developed into the Region's third most important cash crop after sisal and tea, and the largest cash crop enterprise for smallholder growers. This could threaten smallholder tea production into which the government has injected large amounts of money from a World Bank loan since 1972. In spite of its present attraction to farmers, however, the economy of cardamom depends largely on the development of a relatively limited and uncertain world market dominated by India (TIRDEP, 1975).

1.5.3 Objectives of the study

In view of these problems, objectives of this study are as follows:

(1) To examine farm-level constraints particularly:

   (a) Labour and land and the extent to which tea-growing conflicts with family needs for subsistence.

   (b) Supply of inputs, such as fertilizer, and transport of green leaf.

(2) To assess the effectiveness of the extension service and its impact on smallholder tea production.

(3) To assess the effect of changes in relative prices on production.

(4) To investigate possible effects of cardamom and coffee on tea output.

(5) On the basis of all of the above, to develop optimum production plans that make best use of resources available to typical farm families in meeting their expressed goals.

CHAPTER II

LITERATURE REVIEW

Studies on smallholder and estate tea production have been made in Tanzania and elsewhere in developing countries. This chapter is divided into three parts, presenting historical and economic studies of tea in Tanzania; economic studies of tea elsewhere in developing countries, and relevant studies on the International Tea Agreement.

2.1 Historical and Economic Studies of Tea in Tanzania

The focus on smallholder tea development in Tanzania reveals an interesting history. It was first thought tea was an estate crop and that it could not be grown successfully and economically by independent smallholder farmers. However, in 1961 a plan was worked out for organizing and encouraging smallholders to grow tea under the criterion that farmers were to be engaged only in activities relating to the growth of the crop in their own fields (Sabry, 1966).

Thus, schemes for establishing peasant-grown tea were begun in 1961 alongside the existing tea estates (Dijk, 1964). According to Dijk, three conditions need to be fulfilled for successful tea growing. These include adequate and well-distributed rainfall, high soil acidity and availability of processing facilities. Consequently, four separate Regions regarded as suitable for smallholder tea growing were identified in Tanzania. These regions were Tanga, Iringa, Mbeya and West Lake. In these Regions, already-established tea estates were prepared to provide stumps and also process peasants' green leaf. Input supplies were to be channelled through a recognised body so that farmers had to group themselves into cooperatives. Considerable progress was seen by the end of the 1963/64 season as over 400 ha out of 1,200 ha targeted by 1969 had been planted. Based on his findings, Dijk then recommended, among other things, expansion of the tea schemes, financial support to smallholder tea growers, provision of better planting materials, well-organized transport and communications for marketing outside the tea-growing areas.

With respect to smallholder tea production in Tanzania, Moody (1970) made an economic survey in Bukoba and concluded that the most important features of an input-output analysis are labour and land inputs. Moody argued that tea cultivation was very demanding upon labour but could still give a reasonable return to labour at the 1969 price of cents 60 per kg of green leaf paid to farmers. He also noted that family labour was available for extended tea cultivation.

Lukando (1973) made an economic survey of tea at Lupembe in Njombe District and showed that, although the recommended average tea holding per family was 0.60 ha, seventy-five percent of the farmers in the area cultivated between 0.25 and 0.45 ha of tea in 1972. Lukando concluded that tea was a labour-intensive crop and its introduction in Lupembe resulted in either a drop-out or neglecting the traditional cash crops--coffee and pyrethrum.

Kasiita (1974) studied the profitability and farming efficiency of smallholder tea growers in Rungwe, Mbeya Region. Based on 1973 prices, rural wages, yields and level of technology, Kasiita concluded that smallholder tea production did not give economic returns to farmers' resources.

A study by Kuandika (1973) on tea resource utilization in West Usambara, Tanga Region, concluded that high income was associated with large farms cropped with tea.

Ndamugoba (1974) investigated the economics of smallholder tea production at Maruku in Bukoba and found that farmers with larger tea hectarage operated larger farms of other crops and were the ones who showed high managerial ability on tea, and therefore had economically-viable tea farms. Ndamugoba argued that these farmers could manage their tea holdings better than other farmers because their disposable income was high enough to pay for casual hired labour.

Mwaikugile (1976) looked into the growth of the smallholder tea industry in Rungwe, Mbeya Region. Scarce land, especially in the areas where coffee and tea estates stand, employment opportunities on the Uhuru Railway and high investment costs were singled out as obstacles to increased tea hectarage and production.

2.2 Economic Studies on Tea Elsewhere in Developing Countries

Various economic studies on tea have been made elsewhere in developing countries.

In India, the falling price for tea in world markets in the 1960's caused much concern. Consequently, the Reserve Bank of India (India, Reserve Bank of, 1972) felt that the problem of expanding India's production must concentrate on quality, and greater investment should be made in new plants and equipment. New varities of tea plants needed to be introduced especially on smallholdings, it was observed.

Using linear regression to forecast India's tea production and consumption, Monaharan (1973) concluded that by 1980 70 percent of all tea production in India would be consumed domestically. Implicitly, other tea-producing countries would have more room for tea exports.

Savur (1973) examined the problem of surplus labour and productivity in the Indian tea industry. In particular he showed how female labour was made to create surplus value in the tea industry by unfair management techniques to raise labour productivity and by underpayment of wages. Conclusions drawn from this study were that the interest of the proprietors and management which served them ran counter to those of the working class. This indicated that a total structural change was the only way to enable workers to obtain a fair return for their labour.

A second paper by the Reserve Bank of India (India, Reserve Bank of, 1977) revealed that the tea industry in India occupies an important place in the national economy of the country and showed that productivity topped the list of all producing countries between 1970 and 1973, with an average yield of 1,239 kg of made tea per ha. The paper, however, commented that future prospects of the Indian tea plantations would depend on the industry's efforts to extend the area under cultivation and to replace old tea bushes (of which the average age was about 60 years) which had therefore become uneconomic.

The UK mission on the Bangladesh tea industry (UK, Ministry of Overseas Development, 1977), on the other hand, reported on the viability and future prospects for this industry. The UK mission concluded that by 1995 only 15 percent of the area would remain in production out of a total 43,833 ha under tea in 1977 in Bangladesh. The rest would be phased-out as yields declined to uneconomic levels due to old age. To bring production back to the 1977 level by 1995, the Bangladesh tea industry would need a complete reconstruction programme to revive its plantations. Failure of such a programme would entail low exports in the decade starting in 1990.

Etherington (1974) gave a brief account on the history, growth and possible subsequent decline of tea in Indonesia. He outlined alternative strategies for the reconstruction of the Indonesian tea industry at the end of the 1960's. Etherington concluded that the decline of the Indonesian tea industry was a result of three major factors: The system of production based largely on smallholders where yields were low, declining world tea prices in the 1960's and possibly Indonesia's method of selling tea by forward contract.

Comparative studies on mechanical and hand plucking of tea have also been made. Shih et al (1974) carried out a 3-year experiment on tea plucking in Taiwan by machine, shears and hand. The study concluded that the best quality tea was obtained by hand plucking, but more tea was plucked by machine and shears per ha respectively. However, the team concluded that with careful pruning, correct fertilizer treatment and other cultural changes, the quality of mechanically-plucked and shear-cut tea could be improved. Despite the low quality tea resulting from mechanical plucking, their economic returns surpassed the hand-plucking method. Thus these authors showed that net profit acruing from machine-harvested tea and tea cut by shears were greater than that from hand-plucked tea by 47 percent and 35 percent respectively.

Other profit-motive studies include those of Dayananda (1978) and Sarkar (1978). Dayananda attempted to construct an economic model of the world tea market with reference to Sri Lanka, while paying particular attention to the non-competitive market structure for tea. On the supply side, the estate tea market was regarded as monopsonistic. The study considered two alternative cartels, namely Sri Lanka acting alone and secondly Sri Lanka and India acting together to form a cartel. The model revealed potential gains only in the short run when Sri Lanka acts alone as a cartel but potential gains were found both in the short run and long run when the two countries acted together.

Sarkar (1978), on the other hand, highlighted some of the basic national and international policy imperatives for the world's tea industry and the major areas of ignorance which needed to be investigated closely with a view to establishing a national tea policy. He discussed the relative costs and profitability of tea production in the traditional (Asian) and the newly-emergent (African) tea-producing countries. The paper expressed concern over high taxes and costs of inputs and recommended subsidies to new producing countries in the developing world, particularly to smallholder schemes in East Africa.

2.3 Studies on the International Tea Agreement (ITA)

A striking feature of the world tea industry is the long-term negotiations for an effective international tea agreement.

Josling and Harris (1976) lamented that there had been no international agreement on tea since 1955, perhaps because of the restricted nature of international trade. They concluded that the prospects must be for continued weak prices as production capacity keeps pace with a sluggish demand.

Chanmugan (1976) pointed out that international efforts to standardize tea prices through collective action have not met with success as supply was outstripping demand and export earnings were stagnant. The main strategy had been to regulate exports by quotas. An effective floor price for tea needs the cooperation of Indonesia and Kenya. The Sri Lanka tea industry is declining due to high taxation and government interference.

Etherington (1972) emphasized the efficiency of the East African tea industry. Due to the removal of technical and legal constraints, the industry entered a state of equilibrium in the 1960's so that, in spite of declining prices in the decade ending in 1970, East Africa's tea production increased at a rapid rate. Etherington pointed out that the export market was in a situation of oversupply likely to persist during the 1970's so that an international tea agreement would be the only effective tool and was long overdue. In this endeavour, acting against the general call to restrict exports is a rational market-sharing strategy in an oligopoly situation where there are a few (2) large producers and many small ones. Large percentage increases in output by small producers have little effect on world prices and, precisely because they are small, the stake of the small producer in an agreement is small. This gives the small countries a strong vantage point from which to bargain with countries like India and Sri Lanka which have a great deal to lose if there is no agreement. Given their bargaining position, it is likely that the East African countries will win regular quota increases, allowing them to sell their total export surpluses. The free market situation for tea looked gloomy for East Africa in the 1970's but market equilibrium at higher prices seems to be more likely in the 1980's. This conclusion is based primarily on a secular decline in India's tea exports as her domestic market grows faster than her production. It would therefore be a rational decision to continue the expansion of the tea industry in East Africa and Tanzania in particular because of the seemingly favourable future prospects.

Of interest on the international tea agreement have been discussions by UNCTAD and FAO. In 1977, the FAO Intergovernmental Group on Tea agreed upon the basic objectives of an international programme for tea which were '<u>inter alia</u>,' to sustain and improve in real terms the export earning from tea and returns to growers, to remove obstacles to expansion of tea consumption, to improve statistical and market intelligence on tea and provide a framework for improvement in marketing and distribution and increase the participation of developing countries in these activities.

UNCTAD (1978a) reviewed the historical developments of international action and negotiations on tea which began in 1933 with the first international tea agreement. Post-World War II developments included the FAO consultative committee on tea, the Mauritus agreement and the formation of the intergovernmental group and working party in tea exporting countries.

Developments since the mid-1970's on ITA as discussed by UNCTAD (1978b) include an international stocking arrangement with supplementary measures. UNCTAD concluded that the stocking arrangement for tea is technically feasible and would work most effectively if combined with a system of export quotas. A similar model suggested was a combined buffer stock-export quota arrangement. This system was expected to maintain tea prices at those of 1977 over a 5-year period beginning in 1978 within a 10 percent fluctuation.

CHAPTER III

METHODOLOGY

3.1 Source and General Nature of Data

3.1.1 Primary data

Statified sampling based on plot size of tea was carried out in 1979 to choose 50 farmers from a sampling frame covering 1,500 smallholder tea-growers in Bungu Division of Korogwe District, Tanga Region. Details are discussed in section 3.2. Two questionnaires, one for the sample farmers and another for extension workers, were formulated. The farmer questionnaire was used to collect primary data on characteristics of the sample farmers and their families and 1979 agricultural enterprises including labour requirements by months, cash inputs, area, yields and production, and husbandry practices with emphasis on tea, cardamom, coffee and subsistence food crops. The extension-worker questionnaire sought background information about individual field staff and their activities in general, educational background and general attitudes toward extension work and development.

Personal observations and informal communication with farmers and party and government officials helped in identifying innovations of major value to farming systems of the area. This latter technique was adopted after Bartlett (1978), one of the pioneers in studying small-scale farm improvement taking beans as a case study in lowlands of Morogoro Region.

3.1.2 Secondary data

Secondary data were collected from TTA offices in Bungu and at the headquarters, Ministry of Agriculture, and MDB in Dar es Salaam with respect to production, exports and local consumption of tea. Other information on various crops, including trends in yields and development strategies for the area, were obtained from the Korogwe District Agricultural Development Office and TIRDEP in Tanga. Library sources were used for data on world trends for tea production, consumption and demand, prices and progress towards international tea agreements.

3.2 Data Collection

A letter of introduction through the TTA headquarters in Dar es Salaam and the Regional Development Director in Tanga was sent to Bungu Division in June 1979. The letter indicated in summary who I was and the aim of the research. Government officials in Bungu then informed farmers through their Ward secretaries that the aim of the research was to investigate major problems that hinder increased tea production. Finally, cooperation of farmers following selection, particularly those who were picked at random, was sought and they were told that the results of the research were for the benefit of every farmer in the area.

3.2.1 Pre-survey and general sampling strategy

A first draft of the farmer questionnaire covering important questions thought to contain most of the required information was pre-tested by talking to five smallholder tea growers picked at random and an extension worker questionnaire was pre-tested by talking to one field staff also picked at random in Bungu Division in July 1979. Informal and formal talks to public officials were also made and secondly data available locally in the area of study were collected. This pre-survey helped to relate the extent to which local trends and events corresponded with those identified broadly in other tea-growing areas of Tanzania.

Based on the local data, observation of the area and experience drawn from elders and public officials, it was possible to formulate a sampling strategy. Thus, stratification of tea farmers according to their size of tea plots was used to draw a stratified random sample. The TTA office in Bungu kept a list of all smallholders, with complete records for each individual regarding his size of tea plot, production, fertilizer and planting materials supplied, and income from green leaf sales. Also Bungu Division was the only hilly area of Korogwe District that grows tea and has a homogeneous ecology with socially-related inhabitants. For this reason, the study was confined to this one area.

Basic farmer problems such as transport of green leaf from farms to buying posts and availability of fertilizer and planting materials were identified during the pre-survey. Having completed the pre-test survey, unnecessary questions were dropped and sensitive ones put at the end of each questionnaire. Fully revised questionnaires, one for farmers and another for extension workers, were ready in August 1979.

3.2.2 Details with respect to stratification

Data in the TTA office in Bungu indicated that there were 1,500 smallholder tea growers with tea plot size varying between 0.1 and 1.8 ha. TTA recommends an average farm size of 0.6 ha per household.

According to Saulle (1979), there was variation in husbandry practices between farmers owning plots of size 0.1 to 0.4 ha, 0.5 to 1.0 ha and above one ha. On this basis, it was felt rational to group farmers according to these strata because estimation of population means using a stratified random sample would be more precise than those given by a simple random sample. Among the smallholders, 62 percent owned plots of size 0.1 to 0.4 ha, 29 percent had 0.5 to 1.0 ha and 9 percent had above one ha. A sample size of 50 farmers was based on time and funds as constraints. Thus, by using a table of random numbers, 30 farmers were picked at random from the 62 percent group, 15 from the 29 percent group and 5 from the last group. These farmers formed the sample.

Population means were estimated by strata, and then weighted by population size within strata. That is, $\overline{X} = \frac{\sum n_j \overline{X}_j}{\sum n_j}$, where $\overline{X}$ = estimated population mean, n_j = stratum size and $\overline{X}_j$ = stratum mean for the sample.

3.2.3 Questionnaire design

The two questionnaires, one for farmers and the other for extension workers, were designed to make use of available data in the TTA office in Bungu first and then ask both farmers and extension workers to fill-in missing details from memory. Questions were built-up in a sequence to cover specific details to arrive at logically-acceptable answers. Areas under tea for each farmer were available and these were used to cross-check farmers' estimates on areas for other crops. Labour requirement per activity per crop was estimated on a per-farm basis and calculated per ha. To develop the labour required per farm for various operations, farmers were asked how long it took to perform a given activity such as land preparation, weeding, fertilizer application, pruning and harvesting and how many people of different age groups were involved. Where farmers did not remember these details, they were asked to indicate how long it would take if that operation was performed then. Monthly labour allocation was estimated by asking them to indicate the months in which specified farm operations were mostly carried out.

Yields for the 1978/79 crop season were regarded as normal by most farmers but slightly lower than normal by local Ministry of Agriculture (KILIMO) staff and were recorded as normal. During the survey period, maize and beans were being harvested and farmers easily indicated number of bags obtained. A bag was estimated to weigh 90 kg for maize and 100 kg for beans. Cassava harvesting continues throughout the year, as does tea and bananas. About $\frac{1}{3}$ of the cassava planted was harvested and replanted annually. Per ha estimates on harvest were based on bags of dried cassava (estimated to weigh 50 kg) from areas actually harvested divided by total area in cassava. Banana production per farm was estimated on the assumption by local KILIMO staff that a bunch weighs 15 kg on average and two out of five banana stands are harvested per year.

Data on tea production was obtained from the TTA office and that for cardamom and coffee from sales records in village offices by assuming that all coffee and cardamom was sold through village cooperatives.

Family labour and land were the major resource inputs identified for crop input-output relations. There was virtually no hired casual or permanent labour by households. Items of cost identified were fertilizers and planting materials for tea and coffee seedlings and cardamom plantings for farmers starting these crops. Farmers reserved own seeds of beans and maize from the preceding season and both cassava cuttings and banana suckers were obtained free of charge from neighbours.

Husbandry practices were investigated with respect to tea, cardamom, coffee and the major food crops, namely maize, cassava, bananas and beans. The main husbandry practices recorded on tea after establishment included weeding, fertilizer application, pruning and plucking of green leaf. For the rest of the crops, husbandry practices are summarised in chapter IV.

Other variables of influence to tea production that were recorded include age of tea bush, age of farmers, education level of farmer based on maximum class reached or adult education, and contacts with extension agent. Area of other crops, number of years a farmer worked in a tea estate, and details with regard to family structure including adults available to supply farming labour, number of school children and those under school age and old parents in the family were recorded.

Total farmer income was assumed to originate mainly from cash crops and part of the food crops. Based on the researcher's experience as a resident of the area of study, supplemented with estimates from local KILIMO staff and farmers, it was deduced that typical farmers consume half of the bananas they produce and sell the rest as ripe or green and sell $\frac{3}{4}$ of the beans harvested and retain $\frac{1}{4}$ for family consumption and seeds for the next season. Total farmer income was calculated based on 1979 prices for tea, cardamom, coffee, beans and bananas because maize and cassava were normally retained for family consumption only.

3.2.4 The full survey

The fully revised farmer and extension worker questionnaires were ready in mid-August 1979 and the full survey started henceforth and ended early in November. Two thirds of the survey time was spent collecting field data from farmers and extension workers. The balance was used in collecting secondary information from offices in TTA at Bungu and the headquarters, MDB, Ministry of Agriculture in Dar es Salaam, District Agricultural Development Office in Korogwe and TIRDEP in Tanga. Farmers were cooperative and anxious to learn what ideas a researcher resident in that area could provide to solve their problems. A timetable was provided to each village listing farmers to be interviewed and dates, with a break of two days between villages to make sure all farmers were interviewed. Tea staff accompanied the researcher to most of the villages, and in each village the chairman and secretary were present to introduce the researcher to the selected farmers. All farmers picked at random were available for interview.

3.3 Technique of Data Analysis

In drawing up a model for a typical smallholder farmer, the method employed in data analysis may influence the final plan.

Various tools are used to analyse farm data. The most common ones employed are gross margin (GM), budgeting, program planning and linear programming (LP). All these tools yield useful results at times but differ in their merits and demerits. Another technique often employed to analyse farm data is regression analysis which can either be simple or multiple. In all complex studies with several factors like this one, multiple regression is preferred.

In this study, data were analysed first by tabulations and multiple regression. Regression analyses were designed to measure the effect of various tabulated variables on tea production, total farmer income and tea husbandry practices on individual farms. To determine how tea fits in with the needs of farmers for subsistence food crops and other potential cash crops, a farming systems approach incorporating LP was used.

3.3.1 Linear programming (LP)

LP is a systematic, mathematical procedure for finding the optimum, or best possible, plan for a given set of conditions (Upton, 1973, p. 299). Thus, given suitably formulated data, an LP is capable of producing optimal, mathematical solutions in terms of maximizing or minimizing some stated objective. LP best examines production constraints when the objective function is known and clearly stated without risk.

According to Bartlett (1978), subsistence or smallholder farmers have multiple goals that combine desires for a reliable and palatable supply of chiefly home-produced food with that for a relatively stable or rising cash income based on scarce resources of which family labour in key months normally is the most critical single factor. In this case, however, land was the limiting factor in most plans tested. The farmers' objective function in the LP model discussed in this study was identified as maximizing farm cash income with given constraints after providing enough food under average conditions to meet caloric and protein needs of the typical farm family.

This model does not, however, directly incorporate stochastic, environmental, cultural and institutional factors which are regarded as production constraints, such as restriction of rainfall adequate to promote crop growth to a few months in most years and year-to-year variability in its amount and timing, availability of capital and credit to farmers, complexity of the farm-household systems and insistence on growing certain traditional crops such as cassava. Some of these, such as a minimum area for cassava, could have been incorporated into the model and others, like rainfall, were partially allowed for by using only crops commonly grown in the area. The LP analysis discussed here is based on four main assumptions:
(1) Farmers decide and implement their decisions in order that goals of family cash income maximization in terms of GM based on farm output valued at current market prices are met; (2) Farmers perform specified farm operations with family labour within a specified ~~limited~~ time period; (3) Farm families are restricted in decisions they can make by constraints such as land, available family labour for farm work, minimum food requirement for family subsistence and, for some analyses, government policy to grow a minimum area of tea; (4) Input-output relations are estimated from the sample.

There are three basic equations of the LP model:

(1) Maximise $Z = \sum_{j=1}^{n} C_j X_j$

where Z is the farmer's objective function, C_j is the GM of output per unit of crop or activity j and X_j is the number of units of each activity. The farmer maximises Z subject to meeting the following conditions:

(2) $b_i \geq \sum_{j=1}^{n} a_{ij} X_j$

where a_{ij} is the number of units of resource i required for each unit of activity j in the matrix and b_i is the available number of units of resource i = 1, 2, 3 - - - - n. Equation (2) signifies that the total resources required in the production process can not exceed the amount available.

(3) $X_j \geq 0$ for all values of j.

This non-negativity requirement specifies that no activity can enter the solution at a negative level.

Activities can be defined in any way that suits the researcher and as many activities as desired, within computer limits, can be included in the analysis. Restraints also can cover a variety of circumstances such as labour availability and requirements by months, certain soils restricted to certain crops, rotational requirements, minimums or maximums for specified activities, preferences for certain foods, etc.

Having met these conditions, an optimal solution obtained from the LP analysis provides information as regards the opportunity cost of using resources to make marginal adjustments to the optimal solution and indicates how sensitive the optimal plan is to price changes for any single item.

3.3.2 Handling of long-term investments as applied to tree crops

Handling of tree crops pose some problems especially in deciding which among a variety of such crops is most economically-sound for investment. The reason is that tree crops have a polyperiodic nature of production and they differ in period of useful life.

Once tree crops are established, they continue to give yields for the rest of their "economic life" and the cost of replanting does not arise every year and so maintaining a tree crop farm may involve a large item of cost for replanting at the end of the trees' "economic life" (Upton, 1973).

One common way to handle this problem is to distribute replanting costs over the life of the trees. The annual cost may be called depreciation although, since trees appreciate in value over their early years, the term is not a very applicable one. This approach is called the "limited economic life" approach by Upton (1973).

The difference in time period can be bridged by compounding or discounting. Compounding means adding interest charges on the cumulative debt at the end of each year (Upton, 1973). Thus, if r is the rate of interest expressed in decimal and P, the principal, the debt V_1 after one year is given by:

$$V_1 = P + r P = (1 + r)P = P(1 + r).$$

After two years, the debt $V_2 = P(1 + r)^2$ and after three years the debt $V_3 = P(1 + r)^3$. In general, the debt V_n at any year n is given by the general formula for compounding, $V_n = P(1 + r)^n$.

It is often more convenient to look at the long-term investments from the starting point when decisions on whether to invest are made. To be able to do this, the expected future return of an investment is changed into present value by a method of discounting. Discounting is the opposite of compounding. If the general formula for compounding $V_n = P(1 + r)^n$ is divided by 1 + r on both sides, one gets

$$\frac{V_n}{1 + r} = \frac{P(1 + r)^n}{1 + r} .$$

By simplifying this expression, we obtain a general formula for discounting a future return into present value (P), as

$$P = \frac{V_n}{(1 + r)^n} .$$

However, costs and returns for tree crops normally spread over many years to give a series of different cash flows year after year. If V_1, V_2 and V_3 are cash flows at the end of years 1, 2 and 3 respectively, up to V_n, the cash flow at the end of the final year n of the trees' useful life, becomes

$$P = \frac{V_1}{(1 + r)} + \frac{V_2}{(1 + r)^2} + \frac{V_3}{(1 + r)^3} + \text{- - - - - - - -} + \frac{V_n}{(1 + r)^n}$$

Both compounding and discounting tables are available to hold the involved arithmetic to a minimum (see, for example, Upton, 1973, Appendix pp. 331-334).

Discounting procedures were not adopted for the study, as it was considered that the complications involved were not warrented. Discounting methods are applicable to studies of replacement policy, with which this study was not concerned. The simplest "limited economic life" approach based on averages over the life of the tree was therefore used for calculating GM's per ha and per man-day and adopted for the LP analysis of this study and is discussed for each specific perennial crop in section 4.8.

CHAPTER IV

SURVEY RESULTS AND THEIR IMPLICATIONS

4.1 Land Use, Production and Income of Sample Farms

4.1.1 Land use by major crop enterprises

Major cash crops identified in Bungu area are tea, coffee and cardamom. Food crops grown are maize, cassava, bananas and beans. A typical farm family cultivates on average 2.3 ha of which 42 percent is for cash crops and the rest is for subsistence food crops (table 4-1). All sample farmers by definition grew tea which covered on average 23 percent of the total area under crops, and by coincidence all the sample farmers had bananas. Average production per farm and per ha for each crop grown are also indicated.

4.1.2 Crop production and returns

Table 4-2 shows gross returns per farm and per ha based on 1979 areas, yields and prices. The gross returns per farm are highest for tea and lowest for coffee but on a per ha basis were highest for cardamom. The estimated cash returns assume selling all cash crop output and half of bananas and three-quarters of beans produced. On this basis a typical farm family obtained a cash income of Shs. 7.3 thousand in 1979 of which tea contributes 42 percent and the rest is contributed by other crops.

4.1.3 Characteristics of tea farms

Classification of tea bush by age groups and their respective production is shown in table 4-3. Among the sample farmers, 54 percent had mature bush covering 73 percent of the total area under

Table 4-1. Sample farms: Cash and food crops, proportion of farmers growing, average area and production, 1979

Crop	Proportion of farmers growing	Average area per farm for--		Proportion of area for a typical farm	Production		
					Per farm for--		Per ha
		Those growing	Over all farms		Those growing	Over all farms	
	Percent	- - - Ha - -		Percent	-- - Kg - -- - - -		
Cash crops:							
Tea[a]	100	0.52	0.52	23	2,050	2,050	3,900
Cardamom	74	.35	.26	11	70	52	200
Coffee	72	.25	.18	8	100	54	300
Total	-	-	.96	42	-	-	-
Food crops:							
Maize	96	.45	.45	20	500	500	1,100
Cassava[b]	96	.30	.30	14	400	400	1,400
Bananas	100	.29	.29	13	3,300	3,300	11,400
Beans	78	.37	.29	13	400	319	1,100
Total	-	-	1.32	58	-	-	-
Grand total	-	-	2.28	100	-	-	-

Source: Survey data, 1979.
a/ By definition, all farmers in the sample grew tea.
b/ Per ha estimates based on dried cassava from areas actually harvested divided by total area in cassava.

tea, which on average yielded 4,400 kg of green leaf per ha. The rest had semi-mature and immature trees.

4.2 Sociological Characteristics of the Sample Farmers

4.2.1 Educational characteristics

Among the sample farmers, 66 percent attended primary school and were on average 41 years old. Sixteen percent with an average age of 59 years attended adult classes only and another 16 percent, averaging 54 years, had no formal classes. Only one farmer, of age 39 years, had an opportunity for secondary education. The educational

Table 4-2. Sample farms: Gross returns and estimated cash returns from crops based on 1979 areas, yields and prices

Crop	Producer price per kg	Gross return			Estimated cash return over all farms a/	
		Per farm for--		Per ha	Amount	Proportion of total
		Those growing	Over all farms			
	- - - - - - - - Shs.	- - - - - -	- - - - -	- - -	- - -	Percent
Cash crops:						
Tea	1.50 b/	3,075	3,075	5,913	3,075	42
Cardamom	45.00	3,150	2,340	9,000	2,340	32
Coffee	9.50	950	513	2,850	513	7
Total	-	-	5,928	-	5,928	81
Food crops:						
Beans	3.50	1,400	1,116	3,850	837	11
Bananas	.35	1,155	1,155	3,990	577	8
Total	-	-	2,271	-	1,414	19
Grand total	-	-	8,199	-	7,342	100

Source: Gross returns computed from price shown here and production in table 4-1. Other figures are derived.

a/ Assuming that ½ of bananas and ¾ of beans are sold and other food crops are used directly by the farm family.

b/ The farmer receives only Shs. 1.10 net after deduction of 0.40 for input loan repayment. However, to give gross returns that are comparable for other crops, the full price is shown here.

characteristics indicate that on average older farmers had little opportunity for formal education.

4.2.2 Family structure

Farm families were classified into four main groups by size of tea plots (table 4-5). Families with tea plots larger than 1 ha had a larger number of able-bodied workers on average compared to the other groups. Overall, a typical farm family had 3.2 able-bodied workers who could supply farming labour and a total of 9 people eating at home. Families in the smallest tea-group size had a smaller number of people on average eating at home.

Table 4-3. Sample farms: Area and production of tea bushes by age groups, 1979

Maturity group	Proportion of farmers within this group	Average area per farm for-- Those within this group	Average area per farm for-- Over all farms	Proportion of area for a typical farm	Production Per farm for-- Those within this group	Production Per farm for-- Over all farms	Production Per ha
	Percent	- - Ha	- - -	Percent	- - - - - -	Kg	- - -
Immature (1-5 yrs)	18	0.24	0.04	8	300	50	1,200
Semi-mature (6-9 yrs)	28	.34	.10	19	1,100	320	3,200
Mature (10 yrs or more)	54	.70	.38	73	3,100	1,680	4,400
Total or average	100	-	.52	100	-	2,050	3,900[a]

Source: Survey data, 1979.
a/ Calculated as follows: $\frac{\sum(\text{Column 4})(\text{Last column})}{100}$

Table 4-4. Sample farmers: Age of farmers by educational background, 1979

Educational group	Proportion of total	Average age
	Percent	Years
Primary education only	66	41
Adult education only	16	59
No formal class	16	54
Secondary education	2	39
Total or average	100	48

Source: Survey data, 1979.

4.3 Supply of Resources

The major agricultural resources farmers use are land and family labour. Other subsidiary resources include credit facilities for tea supplied in material form.

Table 4-5. Sample farmers: Average family size and structure by size of tea plots, 1979

Group	Average per family by--				Proportion of total
	Size of tea plots			Over all farms[a]	
	0.1-0.4 ha	0.5-1.0 ha	Above 1 ha		
	No.				Percent
Able workers[b]	3.1	3.3	3.6	3.2	35
Under school age (1-6 yrs)	2.4	3.5	3.2	2.8	31
School age (7-15 yrs)	1.7	3.7	2.8	2.4	27
Aged and other dependents	.8	.3	.6	.6	7
Total	8.0	10.8	10.2	9.0	100

Source: Survey data, 1979.

a/ Computed as $\bar{x} = \frac{n_j \bar{X}_j}{n_j}$,

where $\bar{x}$ = Average number of people in group,

n_j = Stratum size and $\bar{X}_j$ = stratum mean.

b/ Includes heads of family and other adults able to supply farming labour.

4.3.1 Land

Based on the high population density, land shortage appears to be spectacular in the study area. The average area available for farming per farm family was 2.75 ha.[4-1] Sample farms averaged a bit below the TIRDEP average. However there was an unequal distribution of land because of the past tenure system under which land was inherited. Despite the present tenure system advocated by the government under which land is the property of all and should be shared equally among village members, land is still distributed disproportionately. This is largely because a greater proportion of the land

4-1/ Total available land for cultivation divided by number of families in the area based on TIRDEP, 1975.

area is occupied by perennial crops owned by individuals.

Table 4-6 shows a breakdown of total farming area by size of tea plots. On average, sample farmers who own larger tea plots have somewhat smaller areas of other crops. Sample farmers with smaller tea plots have smaller plots of other cash crops than the middle-size group but have on average larger plots of food crops than the larger group. On the other hand, per ha tea yield for sample farmers is on average superior for those with medium-size tea plots, likely reflecting better management for this group.

Table 4-6. Sample farms: Cash and food crops, average area and yield per ha by size of tea plots, 1979

Crop	Average area by size of tea plots			Yield per ha by size of tea plots		
	0.1-0.4 ha	0.5-1.0 ha	Above 1.0 ha	0.1-0.4 ha	0.5-1.0 ha	Above 1.0 ha
	------ Ha ------			------ Kg ------		
Cash crops:						
Tea	0.30	0.68	1.32	3,317	4,804	3,086
Cardamom	.24	.32	.16	171	203	231
Coffee	.16	.23	.24	200	209	337
Total	.70	1.23	1.72	-	-	-
Food crops:						
Maize	.40	.49	.40	927	1,300	900
Beans	.31	.25	.26	1,064	1,300	1,119
Bananas	.31	.28	.22	10,506	12,544	15,000
Cassava	.30	.31	.20	1,303	1,545	1,625
Total	1.32	1.33	1.08	-	-	-
Grand total	2.02	2.56	2.80	-	-	-

Source: Survey data, 1979.

4.3.2 Working capital

Smallholder tea growers are supplied with establishment and seasonal credits. The establishment credit was supplied in the form of the stumps and fertilizers through TRDB and was to be repaid as the tea bushes came into bearing. Under this agreement, Shs. 0.40 per kg of green leaf sold is now deducted. The rate of repayment thus accelerates as yields increase annually to maturity. The loan was expected to be repaid in full after 13 to 15 years based on 1971 costs.

Seasonal credits are also issued to the farmers in terms of fertilizers from the third year after planting. These credits are issued by TADB at an interest rate of 8.5 percent per annum and farmers are expected to repay annually. Under the present policy, part of the Shs. 0.40 deducted per kg of green leaf sold is used to meet seasonal credits annually and the balance is applied against the long-term establishment credits.

4.3.3 Labour supply and requirements

Family labour is the major source of farm labour supply. Based on the assumption that farmers spend 22 days on average for farm work every month, total man-days available per family based on 3.2 able-bodied workers in each month was 70. Table 4-7 shows average monthly labour requirements per average farm for specified crops grown in 1979. For a typical farm of 2.3 ha, 321 man-days were required per year to meet labour needs. Cash crops required in total 204 man-days and food crops, 117 man-days per year. The different proportions of labour use by crop by operation and activities for each month are also indicated. Among tea operations, plucking used the lion's share of 74 percent, with weeding second on the list. Maximum labour required in any single month was 38 man-days in April, 54 percent of the family labour available for a typical farm. Thus, land appears to be the major constraint.

Family labour available and required by month and total for the year by size of tea plots is shown in table 4-8. Farm families with larger tea plots required more labour per year to meet farm needs while those with smaller tea plots required less than the overall average. Labour surplus is substantial in every month for all three groups, implying available labour for off-farm activities.

A summary of monthly labour requirement per ha for the major crops grown in Bungu Division is shown in table 4-9. Among cash crops, tea had the highest labour needs per ha per year followed by coffee and cardamom. The labour for tea allows for pruning 0.30/0.52 = 58 percent of the total area in tea, with 8 percent of the area as immature and 19 percent as semi-mature. Replanting requirement of these perennials is discussed in section 4.8.

Among food crops, cassava required the most labour per ha but was only slightly above maize; bananas were lowest based on this criterion.

4.4 Food Production and Family Requirements

4.4.1 Production and available nutrients

The type of crops to be grown in any area is influenced by climatic factors. The choice as to the particular crops for food depends on individual preferences and average yields related to input requirements and their relative reliability when weather is unfavourable. Table 4-10 shows total food production in 1979 by a

Table 4-7. Sample farms: Average monthly labour requirement per farm for specified crops by operation, 1979[a]

Operation	Labour requirement													Proportion of total	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	For each crop	Over all crops
	Man-days													Percent	
	Cash crops														
	0.52 ha of tea, of which 0.30 ha was pruned														
Plucking	16.0	12.0	13.0	9.0	9.0	5.0	4.0	6.0	12.0	8.0	5.0	14.0	113.0	74	35
Weeding	5.5	0	0	7.0	0	0	5.0	0	0	4.0	0	0	21.5	14	7
Tipping in	0	0	0	0	0	0	0	5.5	3.0	0	0	0	8.5	6	3
Pruning	0	0	0	0	0	6.0	0	0	0	0	0	0	6.0	4	2
Fertilizing	0	0	3.5	0	0	0	0	0	0	0	0	0	3.5	2	1
Total	21.5	12.0	16.5	16.0	9.0	11.0	9.0	11.5	15.0	12.0	5.0	14.0	152.5	100	48
	0.35 ha of cardamom														
Harvesting and drying	0	0	0	0	1.5	2.5	2.5	3.5	1.5	.5	.5	1.5	14.0	51	4
Weeding and pruning	0	0	0	4.0	5.5	0	2.0	0	0	0	0	2.0	13.5	49	4
Total	0	0	0	4.0	7.0	2.5	4.5	3.5	1.5	.5	.5	3.5	27.5	100	8

Cont.

Table 4-7 Cont.

Operation	Labour requirement													Proportion of total	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	For each crop	Over all crops
	Man-days													Percent	
	0.25 ha of coffee														
Harvesting and processing	0	0	0	0	0	0	0	.5	3.5	3.5	2.0	1.0	10.5	44	3
Weeding	2.5	0	0	3.5	0	0	2.5	0	0	1.5	0	0	10.0	42	3
Pruning	1.5	0	0	0	1.0	1.0	0	0	0	0	0	0	3.5	14	1
Total	4.0	0	0	3.5	1.0	1.0	2.5	.5	3.5	5.0	2.0	1.0	24.0	100	7
Total cash crops	25.0	12.0	16.5	23.5	17.0	14.5	16.0	15.5	20.0	17.5	7.5	18.5	203.5	-	63
	Food crops														
	0.45 ha of maize														
Land preparation	6.0	6.0	0	0	0	0	0	0	0	0	0	5.0	17.0	41	5
Weeding and thinning	0	0	0	11.0	2.0	0	0	0	0	0	0	0	13.0	32	4
Harvesting	0	0	0	0	0	0	.5	.5	5.0	0	0	0	6.0	15	2
Planting	0	0	5.0	0	0	0	0	0	0	0	0	0	5.0	12	2
Total	6.0	6.0	5.0	11.0	2.0	0	.5	.5	5.0	0	0	5.0	41.0	100	13

Cont.

Table 4-7 Cont.

Operation	Labour requirement													Proportion of total	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	For each crop	Over all crops
	Man-days													Percent	
	0.37 ha of beans														
Land preparation	0	0	0	0	4.0	5.0	0	0	0	0	0	0	9.0	32	3
Harvesting	0	0	0	0	0	0	0	0	2.0	6.0	0	0	8.0	29	3
Planting	0	0	0	0	0	6.0	0	0	0	0	0	0	6.0	21	2
Weeding	0	0	0	0	0	0	4.0	1.0	0	0	0	0	5.0	18	1
Total	0	0	0	0	4.0	11.0	4.0	1.0	2.0	6.0	0	0	28.0	100	9
	0.29 ha of bananas														
Weeding and pruning	0	0	0	0	3.0	3.0	3.0	0	0	0	2.0	0	11.0	54	3
Harvesting	.5	.5	.5	.5	.5	.5	2.0	2.0	.5	.5	.5	1.0	9.5	46	3
Total	.5	.5	.5	.5	3.5	3.5	5.0	2.0	.5	.5	2.5	1.0	20.5	100	6

Cont.

Table 4-7. Cont.

Operation	Labour requirement													Proportion of total	
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	For each crop	Over all crops
	Man-days													Percent	
	0.20 ha of maintained cassava plus 0.10 ha harvested and replanted annually														
Harvesting and replanting	.5	3.5	4.5	3.0	1.0	1.0	1.0	1.0	.5	.5	.5	1.0	18.0	64	6
Weeding	0	0	1.0	0	3.0	4.0	0	0	0	2.0	0	0	10.0	36	3
Total	.5	3.5	5.5	3.0	4.0	5.0	1.0	1.0	.5	2.5	.5	1.0	28.0	100	9
Total food crops	7.0	10.0	11.0	14.5	13.5	19.5	10.5	4.5	8.0	9.0	3.0	7.0	117.5	-	37
Total cash and food crops	32.0	22.0	27.5	38.0	30.5	34.5	26.5	20.0	28.0	26.5	10.5	25.5	321.0	-	100

Source: Survey data, 1979.

a/ No perennial crops except cassava were replanted during the survey year.

Table 4-8. Sample farms: Total labour requirement and availability by month by size of tea plots based on family labour only and crops grown in 1979

Month	Required by --				Surplus by -- a/			
	Size of tea plots			Over all	Size of tea plots			Over all
	0.1-0.4 ha	0.5-1.0 ha	Above 1 ha		0.1-0.4 ha	0.5-1.0 ha	Above 1 ha	
	Man-days							
Jan	22	38	64	32	46	34	15	38
Feb	17	25	38	22	51	37	41	48
Mar	21	32	50	28	47	40	29	42
Apr	30	41	58	38	38	31	21	32
May	24	29	36	30	44	43	43	40
June	26	31	44	35	42	41	35	35
July	20	31	34	27	48	41	45	43
Aug	14	23	35	20	54	49	44	50
Sept	20	31	48	28	48	41	31	42
Oct	19	28	42	26	49	44	37	44
Nov	8	12	18	10	60	60	61	60
Dec	18	29	44	25	50	43	35	45
Total	239	350	511	321	577	514	437	519

Source: Survey data, 1979.

a/ Average number of able workers per family in stratum (table 4-5) multiplied by assumed 22 working days available each month less monthly requirements. Monthly labour available was 68 man-days for the 0.1-0.4 ha group; 72 man-days for the 0.5-1.0 ha group; 79 man-days for the above 1 ha group, and 70 man-days over all farms.

typical farm family. After adjusting for likely losses, of the foods considered bananas produced the most food in terms of calories per typical farm, and maize was lowest on this aspect. In terms of protein production per farm, beans were top on the list and cassava at the bottom.

4.4.2 Food requirement against production

Table 4-11 shows calculations of standard food requirements based on very active East African people by specified groups. The average minimum annual food requirement per family per year is 6.8

Table 4-9. Sample farms: Average monthly labour requirement per ha for specified crops

Month	Cash crops			Food crops			
	Tea	Coffee	Cardamom	Cassava	Maize	Beans	Bananas
				Man-days			
Jan	41	16	0	2	13	0	2
Feb	23	0	0	12	13	0	2
Mar	32	0	0	18	11	0	2
Apr	31	14	11	10	25	0	2
May	17	4	20	13	5	11	12
June	21	4	7	17	0	30	12
July	17	10	13	3	1	11	17
Aug	22	2	10	3	1	3	7
Sept	29	14	4	2	11	5	2
Oct	23	20	2	8	0	16	2
Nov	10	8	2	2	0	0	9
Dec	27	4	10	3	11	0	3
Total	293	96	80	93	91	77	69

Source: Total in table 4-7 divided by areas for each crop, then rounded to the nearest man-day.

Table 4-10. Sample farms: Annual food production per farm in terms of protein and calories, 1979

Item	Unit	Maize	Cassava	Beans	Bananas	Total[a/]
Estimated waste	Percent	40	10	5	33	-
Energy per 0.1 kg.	Calories	354	342	339	128	-
Protein per 0.1 kg	Gm	8	1.5	24	1	-
Average per farm:						
Production	Kg	500	400	400	3,300	-
Edible portion	Kg	300	360	380	2,210	-
Energy produced	1,000 K calories	1,062	1,231	1,288	2,829	6,410
Protein produced	1,000 gm	24	5	91	22	143

Source: First three items, Latham, 1965, p. 249. Balance calculated from sample survey, 1979.

a/ Based on unrounded data.

million k calories and 194 kg of protein. Thus, in relation to table 4-10, energy produced in terms of calories was 6 percent less and protein 37 percent less than the specified minimum annual requirements. When allowance is made for crops assumed to be sold, this deficit increases to 41 percent for calories and 67 percent for protein. This deficit indicates a need for increased production of foods to meet family requirements if farm families are to be self-sufficient.

Table 4-11. Sample farms: Energy and protein requirement per average farm family

Item	Unit	Adult workers (very active)	Children (4 years average)[a]	Adolescents (11 years average)[b]	Dependent adults	Total
Average per family	No.	3.2	2.8	2.4	0.6	9.0
Energy requirement:						
Per head per day	K calories	2,750	1,200	2,100	2,350	-
Annual per head	1,000 K calories	1,006	439	769	860	-
Family annual total	1,000 K calories	3,219	1,229	1,846	514	6,810
Protein requirement:						
Per head per day	Gm	68	45	60	65	-
Annual per head	Kg	25	17	22	24	-
Family annual total	Kg	80	47	53	14	194

Source: Daily requirement for energy and protein from Latham, 1965, p. 243. Balance calculated from sample survey, 1979.

a/ Assumed to apply to 1-6 year age group.

b/ Assumed to apply to 7-15 year age group.

4.5 Other Variables Affecting Tea Production

4.5.1 Distance from farms to leaf collecting posts

Leaf collecting centres were located at an average radius of 2.5 km. Farmers carried plucked green leaf to these centres according to a time scheduled by TTA. Thus farmers whose plots were relatively far from the centres had to stop plucking earlier than those close-by. The amount of green leaf a farmer sent to a collecting centre was therefore restricted by relative distance to walk and the weight he could carry. Similar findings for smallholder tea growers were noted in Kenya by Etherington (1973).

4.5.2 Supply of inputs and transport

The production functions of perennial crops like tea are poly-periodic in nature and their output is thus determined by past inputs in planting, current maintenance inputs, harvesting and their botanical characteristics. Thus, planting material and fertilizers (after land preparation) are the main material inputs likely to affect tea production.

In practice, stumps for planting are supplied and transported by TTA vehicles from central nursuries to farmers. During the year of study, however, none of the sample farmers replanted any tea. Fertilizer was transported directly from Tanzania Fertilizer Company (TFC) in Tanga to villages by TRDB following allocation by TTA, but it rarely reached farmers in time. Another problem was that most farmers had tea farms a distance from villages, which posed difficulties in carrying bags of fertilizers. Consequently, some farmers applied fertilizers below the recommended rates.

Vehicles for leaf transport from weighing posts to factories frequently were inadequate. Green leaf transport is a sophiscated practice because the crop is bulky and must not be squeezed. It must be well aired and reach the factory within six hours after plucking and without being bruised to prevent pre-fermentation that would lead to loss of quality of made tea. The transport problem in the study area increased during the 1978/79 season because farmers plucked as much as possible to take advantage of high tea prices which were already turning down. There were only two old lorries, one of 3 tons and another of 7 tons and an old tractor, all of which were more often than not out of order. On top of this, feeder roads and part of the main Bungu-Korogwe road were in poor condition during the rainy season.

4.5.3 Effect of changes in producer price

All sample farmers indicated that the 1979 producer price of Shs. 1.10 per kg net of Shs. 0.40 deduction for loan repayment was not attractive to increased tea production. Nevertheless, when farmers were asked what they would do to their tea bushes if prices went up by about 30 percent, it was recorded that 10 percent of the sample farmers would maintain the same area and current maintenance. Twenty percent showed they would expand current plots and 70 percent indicated that they would maintain the same plot size but greatly improve husbandry practices to realise higher yields. This last group owned on average larger plots.

In case of lowered tea prices, 18 percent of the farmers expressed intention to abandon their tea farms and switch to relatively more attractive crops such as cardamom, while the rest said they would maintain the already established area. These again owned on average larger plots. An LP analysis of optimum behavior in respect to changing prices of the three cash crops is given in section 5.3.

4.5.4 Effectiveness of extension services

The International Bank for Reconstruction and Development (1971) estimated an extension requirement of one Field Officer (FO) per 300-500 smallholder tea growers, and one Assistant Field Officer (AFO) per 100 smallholders. Based on these estimates, the Korogwe tea scheme with 1,500 tea growers would require 3-5 FO's and 15 AFO's. In 1979 there were only two FO's (a deficit of 1-3) and also only two AFO's (a deficit of 13). To offset this deficit, TTA has trained Field Assistants (FA's) in a crash program of three months on tea husbandry and a team of four such trainees has been dispatched to the scheme. It is not known how many tea growers these FA's can handle effectively. Extension effects are discussed more fully in section 4.6 based on a multiple regression analysis.

4.5.5 Likely effect of cardamom on tea production

In 1973, cardamom was the third most important crop in Tanga Region, following sisal and tea (table 1-12). Based on TIRDEP (1975), it was the most important source of income for smallholder farmers in the Region but for sample farms, who were required to grow tea, it was second to tea (table 4-2). Over half of the sample farmers expressed fears of theft or of losses due to lack of drying facilities and the balance noted that recommended husbandry practices had not been furnished to them and that picking was laborious because they had to kneel down or bend their backs sharply. Further economic relations between cardamom and tea are explored in the section on regression analysis and in the LP analyses discussed in chapter V.

4.5.6 <u>Effect of coffee on tea production</u>

Coffee in the area required less labour per ha than tea but a large proportion of the sample farmers indicated unwillingness to expand or give much weight to coffee because of its irregular income. Some farmers were concerned because of serious attack of the coffee trees by white coffee borer and others expressed concern over a lack of coffee extension workers. Further relations between coffee and tea are discussed in the sections on regression analysis and the LP analyses.

4.5.7 <u>Use of recommended husbandry practices for tea</u>

<u>Land Preparation</u>

Three main aspects must be taken into account when land is being prepared for tea planting. (1) Adequate protection from soil erosion, (2) good preliminary cultivation to assist root development and weed suppression, and (3) shade to protect both the soil and the young developing plant. For one reason or another, farmers rarely are able to adhere to these requirements. Preparation of land normally starts two years before planting for forested land and about six months before for clear land. The preparation includes clearing, destumping, cultivation and digging of planting holes at the TTA recommended spacing of 1.2 m between rows and 0.9 m within rows.

The planting holes should have minimum depth of 50 cm and a diameter of 35 cm. Planting at this recommended spacing gives on average 9.7 thousand plants per ha.

Planting

The planting variables that determine the development of the tea bush throughout its economic lifetime include clonal selection for stumps and cultural conditions at initial planting. For outstanding success therefore, tea should be planted with all the care and refinement of a horticultural operation. It is, however, difficult to fulfill all such conditions because of economic, climatic and, above all, human factors but the closer a farmer approaches them the better will be the expected performance of the tea bushes in future. Tea grows in widely separated geographical spheres and varying climatic conditions. It is therefore difficult to specify the most favourable planting time for the crop. With a bimodal rainfall pattern, tea can be planted successfully over the greater part of the year. The time suggested by TTA is at the onset of the long rains between February and March in the study area. All farmers planting tea adhere to this planting time following timely provision of stumps by the TTA.

Weeding

The preparation of land for planting invariably causes the germination over a short period of myriads of soft annual weeds. In the early stages succeeding tea planting, these weeds are, on balance, a favourable factor in protecting the young plants, but with approaching dry weather their systematic removal is of great importance. Frequent weeding is required up to six times per year for young tea. For the fully-mature tea bush, the canopy covers the ground and weed growth is largely suppressed so that weeding is less frequent. On average, however, tea farms are weeded four times per year if they are to be free of weeds. Smallholders in the area use hand tools such as the hoe to eradicate weeds, whereas estates may use weedkillers as well.

Fertilizer application

This is a critical husbandry input determining tea output. More tea leaf is harvested from tea receiving the recommended fertilizer dosage when other necessary conditions are optimum. Two types of fertilizers are currently in use with the following recommendations:

(1) A mixed fertilizer, Nitrogen-Phosphorus-Potassium (NPK) in the proportions 20:10:10, at the rate of 180 kg per ha applied during planting and also top dressed when trees are growing.

(2) Sulphate of ammonia (SA) at the rate of 270 kg per ha. This is a top dressing fertilizer applied once a year during the long rains or twice if split: Part in the long rains and the balance at the beginning of the short rains.

Pruning

Pruning in tea is of two main categories: Pruning young tea trees for bush formation and routine pruning which involves the cutting down of lateral branches to form a broad plucking table. Bush formation pruning is done at early stages of tea development. The procedure followed, when a young tea plant is established in the field, in order to form a bush of spreading habit and of convenient height for plucking, consists of subjecting the bush to several pruning operations interspersed with periods of growth. This practice continues for the first three years after planting.

Routine pruning for established plants starts in the fourth year after planting and is carried out at a 3-year interval. The objectives of pruning were summarised by Eden (1976) as:

(1) to maintain the plant permanently in the vegetative phase,

(2) to stimulate, in particular, the young shoots that constitute the cropped portion of the bush,

(3) to form as extensive a frame as possible in two dimensions, on which in the third dimension, the 'flush' will rapidly and continuously regenerate,

(4) to keep the height of the bush within the bounds of easy and efficient plucking,

(5) to renew the actively growing branches so that replacement of healthy wood and foliage keeps pace with the ravages of death or damage to maintain a sufficient volume of mature foliage to meet the physiological needs of the plant, and to promote rapid renewal of flush suitable for manufacture into tea of quality.

The objectives of pruning are similar for all tea growers but the manner of pruning is different.[4-2] The practice followed in Bungu Division is to cut across all branches above the recommended pruning level which varies with the age of trees, being lower for younger plants and as high as 1 m for mature plants. Most farmers prune their tea according to recommended intervals and during the June-July period when flushing is minimal.

[4-2] See for example Eden (1976), pp. 59-62.

Plucking

A technical term for tea harvesting is plucking. Plucking rate influences tea yield and is affected by type of plucking (fine or coarse), age of tea bush, amount of leaf flush and tree spacing. Fine plucking involves the picking of one leaf and a bud while coarse plucking includes up to three leaves and a bud. Coarse plucking is relatively efficient because less time is used in choosing which leaves to pluck, but results in tea of low quality. The converse is true with fine plucking. TTA recommends medium plucking which employs plucking two leaves and a bud and results in tea of good quality. Green leaf is inspected at the collecting and weighing posts so that smallholders invariably follow the recommended plucking. All smallholders use hand plucking which goes on the whole year round with peak months determined by the timing of rainfall.

4.6 Multiple Regression Results

Several variables thought to influence total farmers' income, tea yield per ha and husbandry practices on tea were identified. By merely looking at means arranged in various ways, it was not possible to measure the effect of each variable. A multiple regression analysis which combines the effect of several variables in one equation was therefore adopted. This tells the relative influence of each variable on the one treated as dependent, as well as their combined influence.

Linear equations were run for each of the three dependent variables on the ICL 1902 Dar es Salaam University Computer. In the first equation total farmer income (INCØM) in shillings was regressed on tea yield (YIELD) in kg per ha, tea ha (THA), average age of tea bush (TAGE) in years, fertilize application (FERT) in kg per ha, years of farmer education (ED), age of farmer (FAGE) in years, cardamom ha (CAHA), coffee ha (KØHA), food ha (FØHA) and plucking rate per day (PLUCK) in kg. Brackets indicate code names used in the computer.

In the second equation, YIELD per ha was run against THA, husbandry practices for tea (HUSB) measured in scores, TAGE, FERT, ED, FAGE, contact with extension agent (CØNT) measured by scores, CAHA, KØHA, FØHA and PLUCK.

The last equation on HUSB was run against THA, TAGE, ED, FAGE, CØNT, CAHA, KØHA, FØHA, number of able-bodied workers in a family (FAMSZ) and years a farmer worked in a nearby tea estate (ESTYR).

4.6.1 Measurement of variables used in the analysis

YIELD, THA, TAGE, ED, FAGE, CAHA, KØHA, FØHA, PLUCK, FAMSZ and ESTYR were recorded directly from the survey.

INCØM was computed from actual sale of all cash crops produced where, in the case of tea, the price used was Shs. 1.10 per kg of green leaf net of Shs. 0.40 for input loan repayment. This price was used here because it represents the disposable income effective for farmers' decisions on tea production. To get total farmer's income, the assumed sale of half of the bananas and three-quarters of the beans produced were added for each farmer owning these crops.

HUSB and CØNT were measured using scores for the main items involved in either of these. A farmer scored the following maximum points for following recommended husbandry practices:

(1) Weeding: The recommended number of weedings per year is four. A farmer scored ½ point for each weeding. The total score for 4 weedings was 2 points.

(2) Pruning: This is an important husbandry input affecting tea production. There are two recommendations for this. (a) Pruning time, and (b) pruning cycle. A farmer pruning in June-July, the recommended time, scored 1 point, and he scored another point if he pruned after every three years. Total score for pruning equals 2 points. A farmer scored zero if he did not comply with either of these recommendations.

(3) Fertilizer: Two types of chemical fertilizers were used, one or the other: SA at 270 kg per ha or NPK at 180 kg per ha. The recommended time of application is during rains (section 4.5.7). A farmer who applied the recommended rate scored 1 point and, if he applied at the specified time, he scored another point for a total score of 2 points.

(4) Plucking: This is an important husbandry practice stimulating leaf flushing. A recommended plucking round (time between one plucking and the next) varies between 7-14 days. All sample farmers plucked two leaves and a bud as recommended because if they did otherwise their leaf was rejected by tea officers. However, the farmers differed in plucking interval, and this aspect was therefore regarded as influencing husbandry practices. A farmer scored a maximum of 2 points if he plucked within a 7-14 day interval and zero otherwise. Total maximum score for HUSB thus was 8 points.

These are the major tea husbandry practices.

CØNT was measured by the following practices and scores regarded as the main types of contacts by tea extension staff.

(a) A farmer knowing the name of the tea extension officer scored 1 point.

(b) On average, farmers were visited 2 times per month by an extension officer. If visited 2 times or more per month, a farmer scored a maximum of 2 points, 1 point if visited once and zero if not visited at all in a month.

(c) Extension officers gave four main technical advices to farmers and those who remembered specific items scored as follows:

  (i) Knowing name of fertilizer used in tea scored ½ point.

  (ii) Knowing the importance of the fertilizer to tea scored ½ point.

  (iii) Knowing whether the fertilizer applied to tea could also be used beneficially to other crops scored 1 point.

  (iv) A farmer who knew that tea is pruned following the land slope to attain as wide a plucking table as possible scored 1 point. The maximum score for CØNT thus was 6 points.

4.6.2 Total farmer income as the dependent variable

Based on the R^2, variables in this analysis explained 81% of the variation in total income among farmers, and an F-test showed that this result differed from zero by a highly significant amount. Table 4-12 lists the independent variables involved and the partial regression coefficients and their associated t-ratios. Area under cardomom was the most important single variable; each one ha increase would tend to raise income by Shs. 8,900 after adjusting for other factors in the analysis. If this variable were dropped from the analysis, the percentage of variation explained would drop to 41 percent. Yield of tea was the second most important variable, with each one kg per ha increase tending to increase income by 70 cents. Other statistically significant variables, based on a 1-tailed t-test, were age of tea bush in years and area under coffee. All signs were consistent with expectations.

Table 4-12. Sample farmers: Partial regression coefficients for factors affecting total farmer income in shillings, 1979

Independent variable	Partial regression coefficient	t-statistic[a/]
Area under cardamom in ha	8,908	8.92***
Yield of tea in kg per ha	.7027	3.10**
Average age of tea bush in years	142.1	1.81*
Area under coffee in ha	3,871	1.71*
Rate of plucking in kg per day	33.75	.76
Area of tea farm in ha	1,116	.66
Food crops area in ha	373.9	.61
Farmer's education in years	77.13	.59
Rate of fertilizer application in kg/ha	.9796	.27
Age of farmer in years	-5.636	.20

Source: Computer print out.
a/ Based on sample of 50 farmers and 39 df, using a 1-tailed t-test since signs were specified in advance for most variables.

The equation for INCØM was:

$$\begin{aligned} INC\O M = &-2{,}246.3 + 0.7027\ YIELD + 1{,}116\ THA + 142.1\ TAGE \\ &\ (2{,}115.4)\quad (.2270)\qquad\quad (1{,}703)\qquad (78.6) \\ &+ 0.9796\ FERT + 77.13\ ED - 5.636\ FAGE + 8{,}908\ CAHA \\ &\quad (.3683)\qquad (130.27)\quad (27.963)\qquad (999) \\ &+ 3{,}870\ K\O HA + 373.9\ F\O HA + 33.75\ PLUCK \\ &\quad (2{,}269)\qquad (614.5)\qquad (44.62) \end{aligned}$$

$R^2 = 0.81$. F-test for R = 7.22** with 10/39 degrees of freedom (df).

The numbers in brackets indicate standard errors of the respective regression coefficients.

Table 4-13 shows all simple correlation coefficients that were statistically significant in relation to the three dependent variables used in these analyses.

Had cardamom area been used alone in a simple regression to explain total farmer income, 67 percent of the variation would have been explained. Thus a substantial improvement in percentage of variation explained is obtained by a multiple over a simple regression approach.

Table 4-13. Sample farms: Simple correlations that were statistically significant with specified dependent variables[a]

Total farmer income		Tea yield per ha		Tea husbandry	
Variable	r	Variable	r	Variable	r
Cardamom ha	0.82**	Age of tea bush	0.42**	Extension contact	0.47**
Tea yield per ha	.45**	Husbandry	.36*		
Age of tea bush	.28*	Plucking rate	.35*		
		Tea ha	-.29*		
		Food crop ha	.28*		

Source: Computer print out.
a/ Based on 50 farmers and 48 df.

4.6.3 Tea yield per ha as the dependent variable

Based on the R^2, variables in this analysis explained 74 percent of the variation in yield per ha among farmers, and an F-test showed that this result differed from zero by a highly significant amount. Table 4-14 shows the independent variables involved and the partial regression coefficients and their associated t-ratios. No single variable per se appeared to show pronounced influence on variation of tea yield among farmers. With age of tea bush, each 1-year increase in average age tends to raise yield by 143 kg of green leaf per ha after adjusting for other factors in the analysis. If this variable were dropped from the analysis, the percentage of variation explained would drop to 69 percent. Other statistically significant variables, based on a 1-tailed t-test, were tea husbandry practices, rate of plucking, a strong negative effect of tea ha and food crop area, which had a positive effect on tea yield per ha likely because this is a proxy for family labour.

Table 4-14. Sample farms: Partial regression coefficients for factors affecting tea yield per ha, 1979

Independent variable	Partial regression coefficient	t-statistic[a/]
Age of tea bush in years	142.8	2.83**
Tea husbandry practices	631.7	2.41*
Rate of plucking in kg per day	66.43	2.34*
Ha of tea	-2,068	1.86*
Food crop area in ha	706.7	1.79*
Extension contact	237.5	1.18
Rate of fertilizer application in kg/ha	3.104	1.11
Area under cardamom in ha	-671.7	1.02
Farmer's education in years	73.78	.86
Age of farmer in years	8.011	.43
Area under coffee in ha	-181.9	.12

Source: Computer print out.
a/ Based on sample of 50 farmers and 38 df, using a 1-tailed t-test since signs were specified in advance for most variables.

The equation for YIELD is:

$$\text{YIELD} = \underset{(1,408.1)}{-2,866.2} - \underset{(1,110)}{2,068\ \text{THA}} + \underset{(262.2)}{631.7\ \text{HUSB}} + \underset{(50.6)}{142.8\ \text{TAGE}} + \underset{(2.808)}{3.104\ \text{FERT}}$$

$$+ \underset{(85.93)}{73.78\ \text{ED}} + \underset{(18.709)}{8.011\ \text{FAGE}} + \underset{(200.7)}{237.5\ \text{CØNT}} - \underset{(656.4)}{671.7\ \text{CAHA}} - \underset{(154.6)}{181.8\ \text{KØHA}}$$

$$+ \underset{(394.7)}{706.7\ \text{FØHA}} + \underset{(28.44)}{66.43\ \text{PLUCK}}$$

$R^2 = 0.74$, and F-test for $R^2 = 40.18^{**}$ with 10/39 df.

Numbers in brackets indicate standard errors of the respective regression coefficients.

Had age of tea bush been used alone in a simple regression to explain yield of tea bush per ha, only 18 percent of the variation would have been explained (table 4-13). Thus a large improvement in percentage of variation explained is obtained by a multiple over a simple regression approach.

4.6.4 Husbandry practices as the dependent variable

Based on the R^2, variables in this analysis explained 43 percent of the variation in tea husbandry practices among farmers, and an F-test showed that this result differed from zero by a highly significant amount. Table 4-15 lists the independent variables involved and the partial regression coefficients and their associated t-ratios. Contact with extension agent was the most important single variable; each unit increase tends to raise husbandry practices by 0.5 units after adjusting for other factors in the analysis. If this variable were dropped from the analysis, the percentage of variation explained would drop to 27 percent. There were no other statistically significant variables based on a 1-tailed t-test. Food crop area tends to have a positive effect on husbandry practices likely because food availability to families acts as a proxy for family labour. Age of tea bush tends to affect husbandry negatively because tea grows closer with age and tends to restrict movement between rows when performing tea operations. Also less weeding is needed. Farmer's age is negative on income but positive on tea yield per ha and positive on husbandry practices. This is expected because older farmers tend to control small farm areas because part is inherited by family members. On the other hand, they may show better management on these small areas and have therefore higher per ha yield.

Table 4-15. Sample farmers: Partial regression coefficients for factors affecting tea husbandry practices, 1979

Independent variable	Partial regression coefficient	t-statistic[a]
Contact with extension agent	0.4823	3.25**
Years a farmer worked in tea estate	.0567	1.67
Tea ha	-1.002	1.56
Food crop area in ha	.4749	1.48
Coffee area in ha	-1.804	1.45
Area under cardamom in ha	- .4652	.84
No. of able-bodied workers in family	.1099	.76
Farmer's education in years	.0401	.55
Average age of tea bush in years	- .0214	.45
Age of farmer in years	.0040	.25

Source: Computer print out.
a/ Based on sample of 50 farmers and 39 df, using a 1-tailed t-test since signs were specified in advance for most variables.

The equation for HUSB was:

$$\begin{aligned} HUSB = \underset{(1.179)}{2.321} - \underset{(.641)}{1.002}\ THA - \underset{(.04729)}{0.02137}\ TAGE + \underset{(.07252)}{0.04012}\ ED + \underset{(.015986)}{0.004038}\ FAGE \\ + \underset{(.1470)}{0.4823}\ C\O NT - \underset{(.5507)}{0.4653}\ CAHA - \underset{(1.243)}{1.804}\ K\O HA + \underset{(.3207)}{0.4749}\ F\O HA \\ + \underset{(.1450)}{.1098}\ FAMSZ + \underset{(.03424)}{.05667}\ ESTYR \end{aligned}$$

$R^2 = 0.43$, and F-test for $R^2 = 2.95^{**}$ with df 10/39.

Numbers in brackets indicate standard errors of the respective regression coefficients.

Had contact with extension agent been used alone in a simple regression to explain husbandry practices for tea, 22 percent of the variation would have been explained (table 4-13). Thus a substantial improvement in percentage of variation explained is obtained by a multiple over a simple regression approach.

4.6.5 Simple correlations among independent variables

Table 4-16 lists simple correlations among independent variables that were statistically significant. Rate of fertilizer application increases with a rise in tea ha. Farmers with large tea ha tend to have older tea bushes because under the tea expansion programme farmers are supplied with extra stumps after some years of proven good husbandry practices on the current farm. Those farmers who apply higher rates of fertilizer tend to pluck more leaf, and the plucking rate rises with increase in tea ha. Similar arguments based on the positive correlations can be raised from table 4-16.

For the negative correlations, it is indicated that older farmers tend to have low education, likely because of less opportunities for schooling in the past. Farmers with a large coffee area tend to have less tea extension contact because of likely much involvement on coffee against tea.

These results appear reasonable as shown by their respective signs in the different partial regression coefficients. None of

Table 4-16. Sample farms: Simple correlations that were statistically significant among independent variables[a/]

Independent variables		Simple correlation
X	Y	r
Rate of fertilizer application	Tea ha	0.674**
Age of tea bush	" "	.582**
Plucking rate	Fertilizer application	.568**
Plucking rate	Tea ha	.522**
Age of tea bush	Fertilizer application	.428**
Plucking rate	Extension contact	.405**
Coffee ha	Age of farmer	.394**
Farmer's education	Age of farmer	-.389**
Cardamom ha	Food crop ha	.380**
Plucking rate	Age of tea bush	.334**
Extension contact	Fertilizer application	.287*
Extension contact	Coffee ha	-.285*
Family size	Age of farmer	.283*

Source: Computer print out.
a/ Based on sample of 50 farmers and 48 df.

these correlations were large enough to cause concern with respect to multicollinearity.

4.7 Variable Costs and Gross Margins (GM) Based on 1979 Yields and Prices For Annual Crops

Variable and fixed costs are important concepts in economic theory that are fundamental to planning decisions and techniques. When costs of production change as the level of output alters, they are called variable costs. Costs of production which do not change when the level of output alters are known as fixed costs. Both fixed and variable costs described here refer to total costs per ha and not costs per unit of production. In the short run, the fixed costs do not influence any decision being made but the variable costs do.

Some confusion has arisen over the terms fixed and variable costs with the wide use of the GM concept in farm management since about 1960 (Barnard and Nix, 1973). This is because the same terms are applied in defining GM but the interpretation of fixed and variable costs assumes a specific planning situation and period. For the purpose of defining GM, a farm is assumed to have land, labour and capital as fixed resources and the decision being made is how to utilise these fixed resources over the next production period. Variable costs in this context are therefore defined as those costs which differ according to enterprises selected and their relative size, that is, in relation to crops, the number of ha grown. To be regarded as variable costs in the GM sense, costs have to (a) be specific to a single enterprise, and (b) vary approximately in proportion to the size of the enterprise. Thus, the GM of an enterprise is defined as the value of its enterprise total output less the variable costs attributed to it. GM per ha for annual crops are shown in table 4-17.

Table 4-17. Sample farms: GM per ha for annual food crops based on 1979 average survey data and prices

Item	Unit	Crop		
		Beans	Maize	Cassava
Average yield per ha	Kg	1,100	1,100	1,400
Price per kg	Shs	3.50	1.00	.65
Gross return[a]	Shs	3,850	1,100	910
Variable cost[b]	Shs	0	0	0
GM[c]	Shs	3,850	1,100	910

Source: Survey data and text.
a/ Gross return = Price per kg x output in kg.
b/ No items of cost in this category (see section 4.7.1).
c/ GM = Gross return less total variable cost.

4.7.1 Variable costs

Farmers in Bungu Division cultivated all the annual food crops traditionally, utilizing only family labour and their own seeds from previous harvests. They did not use improved methods of production including the use of chemical fertilizer, where desirable, insecticides or improved seeds. Thus, there were no costs identified for variable input items for the annuals.

4.7.2 Basis for yields and output prices

Based on 1979 survey data, yields for annual food crops were computed on a per farm and then on a per ha basis on average for all farmers growing a given crop (table 4-1). Average yields were computed as total production divided by total area. Yields in 1979 were regarded as normal by most sample farmers but slightly lower by local KILIMO staff (see section 3.2.3).

Gross price per kg times the average yield for each crop was used. Prices of maize, beans and dried cassava are fixed by the government and relate at buying posts by National Milling Corporation. The price of bananas relate at local village markets and is negotiated.

4.8 Derivation of Gross Margins for Perennial Crops

Section 3.3.2 concluded by mentioning the reason for adopting the use of average data for the expected useful life of the tree crops in the LP analysis. Prices for tea relate at the leaf-buying centres and both coffee and cardamom at the village co-operative buying centres. The following sections discuss the derivation of these GM's for each specific perennial crop.

4.8.1 Tea

Table 4-18 presents total cash costs and expected returns per ha based on 1979 prices over 30 years, the expected useful life of tea trees. Significant yields start in the fourth year after planting and reach peak production in the tenth year, after which roughly constant yields are obtained for the rest of its useful life. The cost of replanting will only arise after every 30 years if desirable.

Table 4-18. Tea based on total cash costs and expected annual returns: Cumulative net cash returns over the useful life of the tree per ha based on 1979 prices

Period after planting	Yield of green leaf	Expected revenue[a]	Cost			Net cash flow (GM)	
			Establish-ment	Mainte-nance	Total	Annual	Cumu-lative
Year	1,000 kg	Shs 1,000					
1	0	0	0.04	0	0.04	-.04	-.04
2	0	0	.04	0	.04	-.04	-.08
3	0	0	.04	0	.04	-.04	-.12
4	1.44	2.16	0	.62	.62	1.54	1.42
5	1.92	2.88	0	.81	.81	2.07	3.49
6	2.40	3.60	0	1.00	1.00	2.60	6.09
7	3.12	4.68	0	1.29	1.29	3.39	9.48
8	3.60	5.40	0	1.48	1.48	3.92	13.40
9	3.91	5.87	0	1.60	1.60	4.27	17.67
10	4.40	6.60	0	1.96	1.96	4.64	22.31
11-30[b]	88.00	132.00	0	39.20	39.20	92.80	115.07
Total	108.79	163.19	.12	47.96	48.08	115.07	-

Source: Column for yield: First 9 years from MDB, 1979b, table 3.5, p. 11. Balance from table 4-3 in text. Other columns were calculated.

a/ Yield in kg multiplied by constant 1979 gross tea price of Shs. 1.50 per kg of green leaf.

b/ Cumulative over this 20-year period.

As indicated in table 4-18, the investment costs for tea spread over three years before any production is obtained. The amount of capital invested per ha builds up from the first year of planting to a peak of Shs 120 in the third year. This point is shown by the peak cumulative negative margin and it represents the total capital requirement of a tea ha. The pattern of these capital values over the life of a tree such as tea is known as the capital profile (Harrison, 1956; Upton, 1969; Barnard and Nix, 1973).

The investment cost for tea and subsequent perennials cover simple farm tools - the hoe and bush-knife replaced annually and cost of planting materials (stumps in the case of tea). Fertilizer is a variable input for tea only in this study. Farmers were issued planting stumps, and fertilizer is supplied annually to them on a credit basis (section 4.3.2). Loan repayment deductions of 40 cents per kg of green leaf sold (to cover both stumps and fertilizers) are used as costs, although since these are paid on actual output only, they are not true "risk-type" costs.

The average GM per ha per year for tea was calculated as the total cumulative net cash flow at the end of 30 years divided by 30 years, the expected useful life of tea, and is equal to Shs 3,830 per ha.

4.8.2 Cardamom

Total cash costs and returns for cardamom over 15 years, its expected useful life, are shown in table 4-19, based on 1979 costs and prices. Cardamom starts production in the fourth year after planting, reaches peak production in the 8th year, and continues to give roughly constant yields for the rest of its useful life. Establishment costs for cardamom cover 900 plants per ha sold at

Shs 1.00 each plus farm tools as for tea. Maintenance costs include similar farm tools replaced annually.

Table 4-19. Cardamom based on total cash costs and expected annual returns: Cumulative net cash returns over the useful life of the plant per ha based on 1979 prices

Period after planting	Yield of sun-dried cardamom	Expected revenue[a/]	Cost			Net cash flow (GM)	
			Establish-ment	Mainte-nance	Total	Annual	Cumu-lative
Year	Kg	- - - - - - - - - -	Shs	- - - - - -	- - - - - -	- - - - - -	- - - - - -
1	0	0	1,030	0	1,030	-1,030	-1,030
2	0	0	40	0	40	- 40	-1,070
3	0	0	40	0	40	- 40	-1,110
4	30	1,350	0	40	40	1,310	200
5	50	2,250	0	40	40	2,210	2,410
6	100	4,500	0	40	40	4,460	6,870
7	150	6,750	0	40	40	6,710	13,580
8	200	9,000	0	40	40	8,960	22,540
9-15[b/]	1,400	63,000	0	280	280	62,720	85,260
Total	1,930	86,850	1,110	480	1,590	85,260	-

Source: Yield from MDB, 1979a, table 5.6, p. 60 and survey data, 1979.

a/ Yield multiplied by 1979 sun-dried cardamom price of Shs 45 per kg.

b/ Cumulative over the 6-year period.

The cumulative net cash flow for cardamom at the end of the 15th year equals Shs 85.3 thousand and the average annual GM per ha equals Shs 5,680.

4.8.3 Coffee

Table 4-20 lists total cash costs and expected returns for coffee over the 30 years of its expected useful life. Coffee starts to give significant yield on the fourth year after planting and reaches peak production on the 11th year, after which the yield remains roughly constant through its useful life. Establishment costs for coffee covers simple farm tools and 1,300 seedlings per ha costing Shs 1.00 each. Maintenance costs cover similar farm tools replaced annually plus pulping costs for a rented hand pulper for pulping coffee berries at Shs 1.00 per kg of clean dry coffee based on a conversion ratio of ripe berries: clean dry coffee of 8:1.

Table 4-20. Coffee based on total cash costs and expected annual returns: Cumulative net cash returns over the useful life of the tree per ha based on 1979 prices

Period after planting	Yield of coffee	Expected revenue[a]	Cost			Net cash flow (GM)	
			Establishment	Maintenance	Total	Annual	Cumulative
Year	Kg	Shs					
1	0	0	1,340	0	1,340	-1,340	-1,340
2	0	0	40	0	40	- 40	-1,380
3	0	0	40	0	40	- 40	-1,420
4	40	380	0	80	80	300	-1,120
5	50	475	0	90	90	385	- 735
6	60	570	0	100	100	470	- 265
7	100	950	0	140	140	810	545
8	150	1,425	0	190	190	1,235	1,780
9	200	1,900	0	240	240	1,660	3,440
10	250	2,375	0	290	290	2,085	5,525
11	300	2,850	0	340	340	2,510	8,035
12-30[b]	5,700	54,150	0	6,460	6,460	47,690	55,725
Total	6,850	65,075	1,420	7,930	9,350	55,725	-

Source: Yield from MDB, 1977a, table 3.4, p. 14 for year 11 onwards, and from year 1 to 10 estimated based on MDB, 1977a.

a/ Yield multiplied by 1979 constant coffee price of Shs 9.50 per kg.

b/ Cumulative over the 19-year period.

The cumulative net cash flow at the end of the 30th year equals Shs 55.7 thousand, giving an average annual GM per ha of Shs 1,860.

4.5.4 Bananas

Total cash costs and expected returns for bananas over its expected useful life of 15 years based on 1979 costs and prices are shown on table 4-21. Yields of bananas are obtained from the 3rd year after planting and full production is reached on the 7th year. Thereafter yields remain roughly constant for the rest of the expected useful life. Establishment costs cover 600 plantings per ha at Shs 3.00 each and necessary farm tools.

Table 4-21. Bananas based on total cash costs and expected annual returns: Cumulative net cash returns over the useful life of the plant per ha based on 1979 prices

Period after planting	Yield	Expected revenue[a]	Cost			Net cash flow (GM)	
			Establishment	Maintenance	Total	Annual	Cumulative
Year	1,000 kg	- - - - - -	- - - - - -	-Shs-	- - - - - -	- - - - - -	- - - - - -
1	0	0	1,840	0	1,840	-1,840	-1,840
2	0	0	40	0	40	- 40	-1,880
3	1.62	567	0	40	40	527	-1,353
4	3.24	1,134	0	40	40	1,094	- 259
5	8.10	2,835	0	40	40	2,795	2,536
6	12.15	4,253	0	40	40	4,213	6,749
7	16.21	5,673	0	40	40	5,633	12,382
8-15[b]	129.68	45,388	0	320	320	45,068	57,450
Total	171.00	59,850	1,880	520	2,400	57,450	-

Source: Yield in years 3 through 6 estimated to equal 1/10, 1/5, 1/2 and 3/4 respectively of 16.21 thousand kg per ha at full maturity production based on survey data.

a/ Yield multiplied by 1979 negotiable banana price of Shs 0.35 per kg.

b/ Cumulative over this 8-year period.

The cumulative net cash flow at the end of the 15th year is Shs 57.4 thousand and the average GM per ha per year equals Shs 3,830.

CHAPTER V

THE FARMING SYSTEMS ANALYSIS

5.1 Introduction

A system refers to a complex of factors that are interrelated and therefore interact among and between themselves within limits of a given boundary (Dent, 1971). A systems analysis, therefore, seeks to integrate this framework of factors. Farming systems from this point of view imply the various inter-related farm activities and production processes that are frequently influenced by uncontrollable dynamic biological factors such that their future outcomes cannot be predicted precisely. Important economic links between farm processes are also involved so that man is attempting to control both economic and biological systems in an uncertain environment to achieve some goal which is predominantly economic in nature. The environment of farming systems is much influenced by weather and prices which in turn affect management decisions. The climatic factors, on the other hand, affect farm production activities and may provide essential system inputs such as water, whereas, the socio-economic environment provides system inputs in the form of goods and services, and thus determine the economic outcome of the systems' operation. Socio-economic conditions also influence the farmer and determine his goals or objectives which are incorporated into management policies for operating the system. It can therefore be concluded that a farmer is a component of both the farming system and a wide socio-economic system.

Farmer's goals for most smallholders in developing countries have been described as profit maximization once they have obtained a plentiful supply of chiefly home-produced food-stuffs to meet subsistence family food requirement, and, like farmers everywhere, they are risk averters. In this connection, an LP was used as a planning tool to analyse a set of inter-related farm enterprises to determine a combination that maximises farm income after meeting subsistence food requirement in terms of calories and protein, subject to given constraints, for a typical farm from the sample. In so doing, it is hoped that the resulting optimum farm plan also would yield the greatest advantage to the economy of Bungu Division.

The enterprises included are perennial cash crops, namely cardamom, coffee and tea, which constitute the major focus of interest in this study. Food crops included to meet farm family food requirement for subsistence are bananas, beans, maize and cassava. The LP model discussed here applies to a typical farm for an average tea-growing farm family. This decision is believed rational because farmers in the three strata (according to size of tea plots) appear to be constrained by common restraints, particularly land and nutritional requirements. For all the groups, family labour supply was abundant relative to 1979 requirements in all months. On the other hand, Bungu Division is ecologically homogeneous with socially-related inhabitants despite the variation in farm size. This consideration encourages the use of an LP model in the exercise of planning a typical farm for the area, where typical is defined as the aggregate over all farms divided by number of farms in the sample.

Table 5-1 presents the detailed LP matrix with data entered in a series of rows and columns. Each column in the matrix is used for an activity which can be defined in any way that suits the researcher but generally applies to a specified full operation. For example cardamom production, selling beans and consuming maize are all activities. The rows represent constraints, which cover a variety of circumstances but generally restrict the combination of activities which are feasible.

5.1.1 Production activities

Columns 1 to 7 in table 5-1 represent production activities. These differ according to the kind and yield ratio of their products as well as to the kind and intensity ratio of their use of resources. The production activities are competitive with respect to the two principal production resources, land and labour. However, food crops compete among themselves as suppliers of calories and protein for farm families as well. The production activities cover perennial cash crops, namely cardamom, tea and coffee. Food crops include bananas, also a perennial, and annuals, namely maize, beans and cassava.

5.1.2 Consumption activities

Consumption activities have been included in the model largely to supply the required nutrients. They originate from four widely-grown food crops in Bungu Division for family subsistence and are listed in columns 12 to 15 of table 5-1.

Table 5-1. LP model: Matrix for Plan 1 for a typical farm in Korogwe tea sch

Constraints	Row No.	Units	Production activities						
			Cardamom	Tea	Coffee	Bananas	Beans	Maize	Ca
Column No.			1	2	3	4	5	6	
Objective function	(1)	Shs	5,680	3,830	1,860	0	0	0	
Available land	(2)	Ha	1	1	1	1	1	1	
Land for tea	(3)	Ha	0	1	0	0	0	0	
Labour:									
Jan	(4)	Man-days	0	41	16	2	0	13	
Feb	(5)	"	0	23	0	2	0	13	
Mar	(6)	"	0	32	0	2	0	11	
Apr	(7)	"	11	31	14	2	0	25	
May	(8)	"	20	17	4	12	11	5	
June	(9)	"	7	21	4	12	30	0	
July	(10)	"	13	17	10	17	11	1	
Aug	(11)	"	10	22	2	7	3	1	
Sept	(12)	"	4	29	14	2	5	11	
Oct	(13)	"	2	23	20	2	16	0	
Nov	(14)	"	2	10	8	9	0	0	
Dec	(15)	"	10	27	4	3	0	11	
Yied per ha of:									
Bananas	(16)	Kg	0	0	0	-11,400	0	0	
Beans	(17)	"	0	0	0	0	-1,100	0	
Maize	(18)	"	0	0	0	0	0	-1,100	
Cassava	(19)	"	0	0	0	0	0	0	-1
Nutrients per kg:									
Calories	(20)	1,000 Cal.	0	0	0	0	0	0	
Protein	(21)	Kg	0	0	0	0	0	0	

Source: See text.

of 1979 yields and prices

Selling activities				Consumption activities				Sign	Constraint level
ll nanas	Sell beans	Sell maize	Sell cassava	Consume bananas	Consume beans	Consume maize	Consume cassava		
8	9	10	11	12	13	14	15		
0.35	3.50	1.00	0.65	0	0	0	0	Maximise	
0	0	0	0	0	0	0	0	≤	2.75
0	0	0	0	0	0	0	0	=	.60
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
0	0	0	0	0	0	0	0	≤	70
1	0	0	0	1	0	0	0	=	0
0	1	0	0	0	1	0	0	=	0
0	0	1	0	0	0	1	0	=	0
0	0	0	1	0	0	0	1	=	0
0	0	0	0	.86	3.22	2.12	3.08	≥	6,810
0	0	0	0	.007	.228	.048	.013	≥	194

5.1.3 Selling activities

The LP model specifies that farm families must meet full calorie and protein requirments from farm sources but can sell some food crops for cash if that is desirable. The needed selling activities for the food crops are listed in columns 8 to 11 in table 5-1. Although farmers do not normally sell maize and cassava, these were included in the model to provide flexibility since markets for these crops are available. On the other hand, the selling activities exclude the sale of cash crops because these are taken care of directly in the production activities by including their GM's since all that is produced is sold.

5.1.4 The objective function

The objective function is shown in the first row of the matrix. The object is to maximise profit given by the sum of GM's from cardamom, tea and coffee (production activities) together with revenue from sales of surplus beans, bananas, maize and cassava (selling activities) after meeting full subsistence needs from farm activities.

5.1.5 Constraints

There are three basic categories of constraints, namely maximum, minimum and equality. Constraints may also be referred to as restraints or restrictions, all of the three terms having the same meaning in relation to an LP matrix. Constraints mostly relate to the use of the principal factors of production, and are shown in the right hand column of this matrix. These are:-

Row 2: Land available for production is not more than 2.75 ha.

Row 3: Land available for tea production constrained to be exactly 0.60 ha for plan 1 only based on a government tea quota (see section 5.1.7).

Row 4-15: Labour available is 70 man-days per month in each month of the year.

Row 16-19: These are tie-rows designed to make sure that production of food crops is exactly used up by the sum of selling and consumption activities.

Row 20-21: These specify minimum levels for the total energy and protein content of consumed food to be met from farm sources.

5.1.6 Input-output coefficients

Input-output coefficients show the amount of input required to produce a unit of output for a given activity or how the magnitude of a constraint or transfer row is influenced by an increase of one unit of each activity. Input-output coefficients, therefore, reflect the demand one unit of activity makes on the resource represented by the row in which the coefficient appears. Conventionally, coefficients signifying a demand on a row carry a positive sign. Those coefficients signifying that an activity will add to the supply of a resource or other restricting element represented by a row to which the coefficient is augmented carry a negative sign in that row.

5.1.7 Alternative constraint columns

The alternative constraint columns permit changes in the LP solution when alterations are made in specified minimum, maximum and/or equality constraints. Two different sets of constraints were used in the basic analysis. These were:

Plan 1: This covers farmers fulfilling a government quota to grow 0.60 ha of tea, as given in table 5-1.

Plan 2: In this plan, the area of tea is not fixed at 0.60 ha but is allowed to vary. In other words, it permits farmers to respond solely to direct economic influences. For this plan, the second row of the matrix in table 5-1 is deleted.

5.1.8 General description of the LP analysis

Based on the survey sample, a typical farm family in Bungu Division cultivated on average 2.3 ha of land (table 4-1) per year and had an abundant labour surplus in all months (table 4-8). On the other hand, total land available for cultivation per family was on average 2.75 ha (based on TIRDEP, 1975), leaving 17 percent unused or allocated to minor crops.

The LP analyses for Plans 1 and 2 were adapted to analyse and allocate the available resources optimally when farmers grow precisely 0.60 ha of tea (plan 1) and when tea area is not fixed (plan 2).

5.2 Results of the LP Analysis

5.2.1 Results for plan 1 (tea at 0.60 ha)

Table 5-2 lists crops included in plan 1, the optimum plan for adhering to the government 0.60 ha tea quota. Based on 1979 prices, this plan tends to raise farmer's total GM by 17 percent over the 1979 average farming system. However, the LP solution assumes 20 percent more land than for sample farms, so that with the tea restriction there is no real gain in cash income per ha but production of more foods is assumed. This optimal plan excludes coffee among cash crops because of its low GM relative to that of cardamom, while tea is forced in the plan by government policy.

Table 5-2. Typical farm: LP solution for plan 1 (0.60 ha of tea required)

Activity	Area	Production	Consumption	Sales	Total GM
	Ha	--------	Kg	---------	Shs
Cardamom	1.11	142	0	142	6,305
Tea	.60	2,176	0	2,176	2,298
Bananas	.41	4,752	4,752	0	0
Beans	.63	693	693	0	0
Total	2.75	-	-	-	8,603

Source: Computer print-out and text.

Among food crops widely grown in the study area, maize and cassava, which are staple food crops of the area, were excluded by the LP solution. This optimum plan indicates that a typical farm family can obtain the minimum food requirement in terms of calories and protein by cultivating 1.04 ha of food crops (table 5-2). Bananas and beans entered the plan because the former gives higher yields in calories per ha than the other crops and uses less labour, while beans yield higher per ha in terms of protein. Although the indicated use of bananas and beans only by farm families in the study area meets minimum nutrient requirements, it is doubtful whether this would be acceptable to provide the required palatability.

Cardamom has a limited world market (section 1.4). Increasing its production over the 1979 levels for the farmers by two fold might be alright if confined to Bungu Division. If this is done throughout Tanzania, it might drop the world price to where cardamom no longer is the most profitable crop (or is just profitable at current production levels). It may therefore be desirable to lower cardamom prices to farmers so that they don't produce too much.

The optimal plan indicates that farm families can fully utilise the available land per family by using only 40 percent of their available annual family labour (table 5-3).

Table 5-3. Typical farm: Unused labour each month for plan

Month	Unused labour[a]	Month	Unused labour[a]
	Man-days		Man-days
January	45	July	31
February	55	August	41
March	50	September	44
April	38	October	43
May	26	November	58
June	26	December	41

Source: Computer print-out.
a/ Out of the total 70 man-days per month available.

Other features were deduced from a sensitivity analysis which assumes that only one factor changes at a time:-

(1) The given combination of enterprises would hold with land for cardamom production increased up to 3.98 ha, when May labour becomes limiting.

(2) If 1 ha of coffee is substituted for 1 ha of cardamom in the optimum plan, GM decreases by Shs 3,820.

Table 5-4 lists shadow prices for specified activities in optimal plan 1. Calculations of the shadow prices indicate that if GM of coffee was doubled, the crop would enter the optimum plan.

Maize would enter if its yield per ha were trebled, sale of bananas would enter if banana price increased by 78 percent (to replace cardamom), sale of beans would enter if their price increased by 83 percent, and consumption of cassava would enter if its nutrient content in terms of calories per ha increased by 134 percent. The shadow price for cardamom is Shs. 2,553 per ha, indicating that the crop would drop out of the plan (to be replaced by bananas) if its GM dropped to this level.

Table 5-4. Typical farm: Shadow prices for specified variables in plan 1

Variable	Units	Shadow price
Coffee	Shs/ha	3,820
Maize	Kg/ha	3,128
Sell bananas	Shs/kg	0.27
Sell beans	"	2.90
Consume cassava	Energy per ha, 1,000 kg	5,783

Source: Computer print-out.

Looking at the price trends as discussed in chapter I, the likelihood of these shadow prices occurring in the short-run is low.

5.2.2 Results for plan 2 (no restrictions on tea)

Table 5-5 lists the crops included in plan 2. The same food crops as for plan 1 are listed.

This optimum plan, which permits farmers to respond to direct economic influences, excludes both tea and coffee among cash crops, reflecting the high GM per ha for cardamom. This plan is more profitable than plan 1 by 13 percent.

Table 5-5. Typical farm: LP solution for plan 2 (no restriction on tea ha)

Activity	Area	Production	Consumption	Sales	Total GM
	Ha	- - - - - - - - -	Kg	- - - - - - - -	Shs
Cardamom	1.71	220	0	220	9,713
Bananas	.41	4,752	4,752	0	0
Beans	.63	693	693	0	0
Total	2.75	-	-	-	9,713

Source: Computer print-out and text.

Plan 2 underutilises family labour by 70 percent per year (table 5-6), implying that a substantial amount of family labour could be channelled to off-farm activities. This plan would continue over similar ranges as for plan 1.

Table 5-6. Typical farm: Unused labour each month for plan 2

Month	Unused labour[a]	Month	Unused labour[a]
	Man-days		Man-days
January	69	July	34
February	69	August	48
March	69	September	59
April	50	October	56
May	24	November	63
June	34	December	52

Source: Computer print-out.
a/ Out of the total of 70 man-days per month available.

If 1 ha of tea is substituted for 1 ha of cardamom in the optimum plan, GM decreases by Shs 1,850, and by Shs 3,820 if 1 ha of coffee is substituted for 1 ha of cardamom. The shadow price for tea is Shs 1,850 per ha, indicating that tea would enter the optimal plan if its GM per ha increased by 48 percent.

5.3 Sensitivity Analysis

To examine the effect of possible future price changes on the optimal plans, the LP's were run with producer prices for cardamom, tea and coffee set at the low and high values shown in table 5-7. These values were derived by considering the high and low prices for the period 1974 to 1979. All possible combinations of low and high prices for the three crops were considered.

Table 5-7. Average producer price for cash crops: Highs and lows per kg rounded from 1974 to 1979 and related GM per ha

Crop	Price		GM
	Level	Average	
		- - - - - - - Shs	- - - -
Cardamom:	High	45.00	5,680
	Low	25.00	3,110
Tea:	High	1.50	3,830
	Low	.70	2,380
Coffee:	High	9.50	1,860
	Low	6.00	1,060

Source: Cardamom prices, MDB, 1977b, table 19, p. 20. Tea prices, MDB, 1978, table 2.5, p. 19. Coffee prices, MDB, 1977a, table 6.3, p. 45. GM's were calculated based on the indicated prices in the same way as described in section 4.8.

5.3.1 Results for plan 1

Table 5-8 lists the possible price combinations and their resulting plans. The optimal plans for all price combinations were little different from the initial solution, indicating relative insensitivity to the price changes within the range specified.

5.3.2 Results for plan 2

Table 5-9 shows that when farmers are allowed to respond to direct economic influences, the optimal plans resulting from the

Table 5-8. LP solution for plan 1: Sensitivity analysis (tea set at exactly 0.60 ha)

Price per kg			Optimal plan				
Cardamom	Tea	Coffee	Cardamom	Tea	Bananas	Beans	Total GM
------ Shs ----			------- Ha --------				Shs
45.00 45.00	1.50 1.50	9.50) 6.00)	1.11	0.60	0.41	0.63	8,603
45.00 45.00	.70 .70	9.50) 6.00)	1.11	0.60	0.41	0.63	7,802
25.00 25.00	1.50 1.50	9.50) 6.00)	1.11	0.60	0.41	0.63	5,691
25.00 25.00	.70 .70	6.00) 9.50)	1.11	0.60	0.41	0.63	4,866

Source: Text and computer print-out.

price combinations is somewhat sensitive to price changes. In this case, tea enters the optimal plan when its price is high while that of cardamom is low. However, coffee does not enter any of the plans, reflecting the low GM relative to the other crops irrespective of high or low price.

Table 5-9. LP solution for plan 2: Sensitivity analysis (tea permitted to enter at its optimum level)

Price per kg			Optimal plan				
Cardamom	Tea	Coffee	Cardamom	Tea	Bananas	Beans	Total GM
------ Shs ----			------- Ha --------				Shs
45.00 45.00 45.00 45.00	1.50 1.50 .70 .70	9.50) 6.00) 9.50) 6.00)	1.71	0	0.41	0.63	9,713
25.00 25.00	.70 .70	6.00) 9.50)	1.71	0	0.41	0.63	5,318
25.00 25.00	1.50 1.50	9.50) 6.00)	.03	1.68	0.41	0.63	6,442

Source: Text and computer print-out.

A labour restraint became apparent when tea prices were high and cardamom prices were low. Labour availability in January restricted tea to a maximum of 1.68 ha. However, cardamom required no labour in that month and hence used up the remaining land of 0.03 ha after meeting needs for subsistence crops. Because tea is a more labour-intensive crop than is cardamom, the annual labour surplus under this alternative was reduced to 30 percent of the annual total.

5.4 General Summary of the LP Results

The purpose of using an LP here was to attain an optimum farm plan for smallholder tea growers of the Korogwe tea scheme, a plan that maximises total GM and meets a minimum requirement of calories and protein for farm family subsistence. Such a plan derives from a free interplay of resources and production activities. For the plan to be feasible, a number of restrictions considered to be consistent with the farming conditions of the scheme area were imposed.

The resulting optimal plans indicated that, if the aim is to obtain highest GM after meeting minimum food requirement, a farm family will cultivate 1.71 ha of cardamom, 0.41 ha of bananas and 0.63 ha of beans under the existing conditions based on 1979 prices and yields. In so doing, a typical farm family will tend to raise its annual income by over 30 percent above the 1979 average farming system, provided it has access to 20 percent more land than cultivated on average in 1979. If on the other hand, the government insists on a 0.60 ha tea-quota, a typical farm family will tend to raise its average annual income by 17 percent over the 1979 average farming system, again with the maximum area in cardamom after allowing for the required area in tea. Cash income per ha is reduced a bit but full subsistence needs are produced on the farm.

A sensitivity analysis based on all possible combinations of low and high prices (derived from 1974 to 1979) indicated that the optimal plans for all price combinations were little different from the initial solution. However, for plan 2, tea enters the optimal plan when its price is high while that of cardamom is at its low level. Tea is produced up to the level where labour in January becomes restrictive; remaining land is then used for cardamom.

Under all of the plans considered, available family labour is underutilized in all, or at least most, months. Thus development of other sectors of the economy to use this surplus labour would be highly desirable.

5.5 Systems Analysis Using a Desk Calculator

In this particular case, an optimum solution could have been obtained far easier by use of a desk calculator than by use of LP and, in fact, would have had the added advantage of direct flexibility. From the discussion in Section 4.3.3, it was evident that land, rather than labour, likely was the limiting resource. Thus, cash crops should be chosen that give highest GM's per ha and food crops should be chosen based on highest yields of calories and protein per ha. Sections 4.7 and 4.8 show that cardamom is by far the best cash crop. By comparing tables 4-1 and 4-10, one can see that bananas give by far the highest calories per ha and beans, by for the highest protein. One might, however, wish to specify that certain minimum calories were to come from maize and cassava. (This could have been done also as a part of the LP but was not considered initially and thus would have required new runs through the computer). The balance from bananas and beans could have been determined from a direct solution of two equations in two unknowns. The entire analysis, with all of the related information discussed in this thesis, likely could have been obtained in a few hours, or less time than required to prepare the matrix in table 5-1 and to write down needed control cards for the computer. Since computers frequently are not easily available within reach of planners and extension workers in the Regions, a discussion of direct calculations to help these workers appears desirable. This section, therefore, outlines such calculations based on the analysis of this study as an example. The steps involved are as follows:

(1) Pick satisfactory subsistence crops to meet nutrient needs and compute needed ha of each. Deduct these ha from the total.

(2) Use balance for cardamom (with or without the tea restriction).

(3) Check labour by months to make sure that all are adequate. The unused balance gives table 5-3.

(4) Calculate table 5-2.

(5) Look at relative GM's per ha, or prices, or nutrient content to compute table 5-4.

(6) Look at critical months for labour to determine land needed to use up available labour. For example, if available labour equals 70 man-days each month, and cardamom requires 20 man-days

per ha in May then, if no other crops in the plan use labour in that month, the maximum area for cardamom would be 70/20 = 3.5 ha. This area is then matched with available area after meeting required area for food crops. Loss if coffee is substituted for cardamom is the difference in their GM's per ha. Etc.

(7) The sensitivity analysis also could be easily performed since cardamom remains the optimum cash crop in all but one instance.

CHAPTER VI

SUMMARY AND CONCLUSIONS

According to the Third 5-Year Development Plan for 1976-81 (Tanzania, United Republic of, 1978), Tanzania hopes to increase tea production from the 1976 level of 15 million kg to 24 million kg by 1981. By 1978 private tea estates produced about three-quarters of the total tea production and are almost stagnant at that level and have practically ceased to expand tea hectarage. Smallholder tea-growers, who cultivate 50 percent of the total area under tea, on the other hand, have low yields per ha and produce the balance. The smallholders are the main focus of attention for the 24-million kg target for 1981. So questions arise as to how best to obtain the desired increased output.

Studies so far made in Tanzania with respect to smallholder tea production are descriptive in nature. These do not shed much light on the socio-economic problems affecting smallholder tea production. Moody (1970) observed that in Bukoba land and labour were the main inputs for smallholders and that tea was very much demanding upon labour, but pointed out that the crop was profitable at 1969 prices and that family labour was ample for further tea expansion. Lukando (1973) concluded that adoption of tea by smallholders in Njombe led to either neglecting or a drop-out of the traditional cash crops namely coffee and pyrethrum. Kuandika (1973) in West Usambara pointed out that high income was associated with farmers with large tea farms. Kassiita (1974) indicated that tea production did not give economic returns to farmers' resources in Rungwe under 1973 conditions. Ndamugoba (1974) explained that at Karuku, farmers with large tea farms practiced better management and controlled larger farms of other crops as well. Mwaikugile (1976) found that scarce land, especially in areas where coffee and tea estates stood, employment opportunities on the Uhuru Railway and high investment costs were the main causes for slow growth of the tea industry in Rungwe. This study presents a case study of the Korogwe tea sub-scheme in Tanga Region, and examines, under the existing farming system, socio-economic factors affecting smallholder tea production. Particular attention was drawn to farm-level constraints, namely land and labour availability; problems with regard to supply of inputs and transport; strength of extension services; effect of price changes for tea on tea production; likely competition between tea and other potential cash crops (cardamom and coffee) for production resources; and farmers' preference for subsistence food requirements.

A stratified random sample based on plot size of tea was used to choose 50 farmers from a sampling frame covering 1,500 smallholder tea-growers in the scheme. A full survey of the sample farmers was completed in August-October 1979. Two questionnaires were used: one for farmers to collect farm-family primary data and another for extension workers to obtain background information and the nature of their work. Data were analysed first by tabulations and multiple regression to measure the effect of various tabulated variables on tea production, total farmer income and tea husbandry practices. A linear programming (LP) analysis was then run in a farming systems analysis to determine how tea fits in with the potential needs for farm-family subsistence and major cash crops based on resources for a typical farm in the scheme and 1979 yields and prices.

The study established that under the present farming system (subsistence food and cash crops) an average farm family of 9 people eating at home cultivated on average 2.3 ha which was 17 percent below the available average of 2.75 ha of farming land per farm family for Korogwe Highlands. This implies that land was distributed disproportionately as family agricultural labour supply outstripped computed demand for these smallholder farms by a significant amount. Of the total cultivated area, 42 percent was for cash and the balance was for food crops. The typical farm family had an average of 3.2 able-bodied workers who could supply agricultural family labour. On average, computed food production by the family was below its annual minimum requirement by 6 percent in terms of calories and 37 percent of proteins in 1979. When an allowance was made for an assumed sale of half of the bananas produced and three-quarters of the beans, this deficit increased to 41 percent for calories and 67 percent for proteins. Thus food production needs to be increased if farm families are to be self-sufficient.

In 1979 annual family income from sale of cash crops and the assumed proportion of food crops was Shs 7,300, of which tea contributed 42 percent and cardamom 32 percent of the total.

Several variables affecting tea production were identified. Distance from tea farms to green leaf-buying posts was one. Each post was located at a place where it could serve all farms surrounding it at an average radius of 2.5 km. A farmer carried on average 10-15 kg of green leaf to the post per trip and was therefore restricted as to the amount sent by the weight he could carry and relative distance from his farm. Buying time was scheduled by the Tanzania Tea Authority (TTA) and green leaf should normally reach a factory in six hours after plucking without being bruised to avoid pre-fermentation which lowers tea quality. Tea quality is an important aspect for tea buyers in international markets.

Effects of price changes are not easily felt in the short run for perennial crop production because these involve a gestation period between planting and harvesting and a long period of continued production from existing plantings. In the case of tea, however, the effect was noticeable as farmers plucked more than usual in the 1978/79 crop season to take advantage of high tea prices that were already turning down as a result of prior high coffee prices in the international market. The farmers' reaction to pluck more aggravated transport problem at the Korogwe TTA project whose transport problems were already critical due to old vehicles which were out-of-order most of the time. The transport problem likely will continue to be critical for some time as availability of vehicles largely depends on the country's priority on importation as dictated by the meagre available foreign exchange. However, tea is one of the sources of foreign exchange earnings, so that the government needs to put emphasis on tea when transport is considered unless other items have higher priority.

Fertilizer supply was handled by the Tanzania Rural Development Bank (TRDB) and more often than not failed to reach all farmers in time. TTA should work hand-in-hand with TRDB to re-schedule the distribution system so that all farmers benefit equally and all supplies arrive when needed.

A multiple regression analysis indicated that average age of tea bush in years affected yield per ha for individual farmers by a highly significant amount. Each one-year increase tended to increase per ha tea yield by 140 kg of green leaf. Other significant variables in increasing tea yield were husbandry practices and plucking rate. An increase in tea area per farm tended to reduce tea yield per ha, likely due to less-intensive husbandry practices. Based on the R^2, variables in this analysis explained 74 percent of the variation among farmers in yields per ha and an F-test indicated that the R differed from zero by a highly significant amount.

Based on R^2, a second analysis explained 43 percent of the variation of tea-husbandry scores among farmers and an F-test showed that this R differed from zero by a highly significant amount. Number of contacts with the extension agent was the most important single variable affecting husbandry practices adopted by individual farmers.

Total income per farmer was regressed on variables which, based on R^2, explained 81 percent of this variation and an F-test indicated that the R differed from zero by a highly significant amount. Area in cardamom was the most important single variable affecting total farmer income, each one-ha increase tending to raise total income by Shs 8,900 after adjusting for other factors in the analysis. Other significant variables influencing income were tea yield per ha, average age of tea bush in years and coffee area.

Two basic analyses were run by LP. In plan 1, each farmer was required to maintain the government quota of 0.60 ha of tea. The optimum plan included 1.11 ha of cardamom, the required 0.60 ha of tea and excluded coffee among cash crops; food crops included were 0.41 ha of bananas and 0.63 ha of beans. The optimum plan was 17 percent more profitable than the 1979 farming system but assumed 20 percent more land in cultivation. Both maize and cassava as food crops were excluded in the plan. Maize and cassava are, however, staple food crops of the area. For these crops to be included in the plan in order to supply the required nutrients based on the LP analyses, maize yield per ha would need to treble and cassava nutrient content per ha would need to increased by 134 percent. Both of these changes would require intensive research and introduction of suitable high-yielding varieties to these highland areas. LP analyses frequently fail to identify typical diets of farm families, since these may depend more on taste preferences than on least-cost sources of basic nutrients. The LP run suggests that farm families would gain by using a maximum of bananas and beans in their diets, supplemented as required by other foods (maize and cassava) to provide acceptable palatability and variety.

In plan 2, farmers were allowed to respond to direct economic influences. The same food crops were listed as for plan 1, and both tea and coffee among cash crops were excluded from the plan, reflecting the high GM per ha for cardamom. Plan 2 was more profitable than plan 1 by 13 percent, but underutilised annual family labour in man-days by 70 percent.

A sensitivity analysis based on producer price combination of lows and highs for tea, cardamom and coffee over the 1974 to 1979 period indicated that the resulting optimal plans were little different from the initial solutions when farmers were required to adhere to the 0.60 ha tea quota. When farmers were permitted to respond to direct economic influences, tea entered the optimal plan when its price was set at the high level specified while that for cardamom was at its low. Coffee does not enter any of the optimal plans, reflecting the low GM per ha for coffee relative to the other cash crops based on 1979 yields and prices.

Under all of the plans considered, available family labour is underutilized in all, or at least most, months. Thus development of other sectors of the economy to use the surplus labour would be highly desirable.

The future development of cardamom, the only cash crop in plan 2, depends largely on a limited external market dominated by India, the largest producer. The requirement that farmers grow 0.60 ha of tea, on the other hand, looks rational. Tea is labour-intensive in an almost unique manner among agricultural crops, being harvested throughout the year. It thus provides regular employment and income to the rural families, an aspect of importance to the economy and welfare of Tanzania.

Based on this analysis, either tea prices need to be increased or cardamom prices need to be reduced (or both) if tea is to be an economically-viable crop. An international tea agreement was discussed by the United Nations Committee for Trade and Development (1978a). The agreement is, however, in a talking stage but, if implemented, it may help to stabilise tea prices. On the other hand, if domestic tea consumption in India (the largest traditional tea producer in the world) reaches 70 percent of its national production in 1980, as expected, then tea prices under the international tea agreement (yet to be in force) likely will follow an upward trend. This would then tend to improve the smallholder tea industry in Tanzania provided the increased returns are passed-down to the farmer.

Reaching the national target of 24 million kg of tea based on past planting policy will depend on a number of factors: (1) Good weather, (2) improved husbandry practices, including frequent weeding, application of recommended rates and type of fertilizer and good pruning practices, (3) strengthening of the extension system in both expertise and number of qualified extension workers, (4) provision of suitable transport for both workers and green leaf, (5) improved roads to make them passable in all seasons, and (6) increased producer tea prices.

The 24 million kg target by 1981 looks unrealistic. In that year 14 thousand ha of tea bush are expected to be mature and 4,100 ha will be immature. Based on 1979 average yields of 1,300 kg per ha achieved by estates, total production from the mature bushes would be 18.2 million kg of tea in 1981. Immature bushes would produce 3.3 million kg at an average 1979 yield of 800 kg per ha. Thus, total production in 1981 at most would be 21.5 million kg of economically-viable crop. An international tea agreement was discussed by the United Nations Committee for Trade and Development (1978a). The agreement is, however, in a talking stage but, if implemented, it may help to stabilise tea prices. On the other hand, if domestic tea consumption in India (the largest traditional tea producer in the world) reaches 70 percent of its national production in 1980, as expected, then tea prices under the international tea agreement (yet to be in force) likely will follow an upward trend. This would then tend to improve the smallholder tea industry in Tanzania provided the increased returns are passed-down to the farmer.

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