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A FARMING SYSTEMS ANALYSIS OF FACTORS THAT AFFECT AREA AND PRODUCTION OF COTTON: A CASE STUDY IN SHINYANGA REGION, TANZANIA

By

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS IN THE UNIVERSITY OF DAR ES SALAAM

1980

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ABSTRACT

This study describes factors that affect area and production of cotton as part of the overall farming system for smallholders in Shinyanga Region, Tanzania. It involves a description of the characteristics of the existing farming systems and assessment of the production efficiency of the cotton producer. Based on farmer's resources, priorities and production decision, plans to improve cotton production are studied simultaneously with the other crops in the systems and desirable improvements are suggested.

Primary data were collected from 50 randomly-selected farmers in the area for the 1976/77 and 1977/78 crop seasons. Direct programme planning was used to determine optimum resource allocation. Relations between specified variables were tested by means of Chi-square and correlation analyses.

Two major types of farming systems were identified, namely (1) Larger farms with livestock which were characterized by having more land in crops, slightly bigger families, use of ox-ploughs for land preparation, and much higher per capita income (Sh 710). These farms produced about twice the food they actually required for subsistence, and sold the surplus for cash, but had serious labour problems. (2) Smaller farms without livestock, characterized by less land in crops and use of hand hoes for land preparation. They produced 14 percent less protein and 4 percent less calories than required for subsistence based on FAO norms and had a very low per capita income (Sh 170). They made up over half of the farms.

Based on these two types of farms, the study has developed alternative feasible farming systems typical to the area which satisfy family food needs throughout the year and increase family incomes based on a more reasonable work schedule for each type and utilizing family labour only. They are developed on the following assumptions: (1) Yields per ha of the common food items equal to 80 percent of those believed to be normal for the area so that the determined area for subsistence meets full family food needs in most years. (2) Family labour remaining after meeting subsistence requirements is used as required for optimum cash-crop combinations, (3) Net family incomes are calculated based on 1977/78 crop-year prices and 80 percent of yields as found for RIDEP. The crop which gives the highest net cash return per limiting-month man-day is considered since family labour in peak months is the limiting factor to increased production.

For smaller farms without livestock, a cash crop combination of 0.8 ha of sorghum/groundnuts and 0.8 ha of late-planted cotton is suggested. This would give these farms a total net family income of Sh 1,590 or a per capita income of Sh 240, which is about one-third higher than present incomes. However, by hiring ox-ploughing services for land preparation while school holidays for children staying at home were made to coincide with the critical work peak of weeding, farmers could improve their farming system by growing 1.9 ha of sorghum/groundnuts and 0.8 ha of late-planted cotton. This system would triple their net family income to Sh 3,120 or a per capita income of Sh 470.

For larger farms with livestock, the optimum cash crop combination includes 3.1 ha of sorghum/groundnuts intercrop, 0.8 ha of late-planted cotton, and 0.6 ha of paddy, from which these farms likely would realize a total net family income of Sh 5,630 or a per capita income of Sh 790. This is about 10 percent higher than present, excluding returns from livestock.

It is concluded therefore that if the aim is to increase farmer's income, the crop which gives the highest net cash return per limiting-month man-day after meeting subsistence requirements, namely sorghum/groundnuts intercrop, should be encouraged. From the Government point of view, (a) school holiday schedules for children staying at home should be made to coincide with the critical work peak of weeding, and (b) an increase by 35 percent over prices used in the systems analyses for cotton, while keeping those of other crops and inputs unchanged, would make cotton more profitable and increase the cash benefit/cost ratio to 3:1 to warrant the risk and costs of using fertilizers and insecticides. If producer prices of other crops and inputs increase simultaneously with those of cotton, farmers will always be tempted to grow the most profitable crop relative to cotton. Research on cotton improvement should be considered not only for specified cotton operations but in relation to all crops of the systems, given the resources on typical individual farm units.

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For inspiration and guidance in my fulfilment of writing this thesis, I am indebted to Dr. G.C.C. Sunni, my supervisor. I am especially greatful to Prof. R.J.Foote for his invaluable assistance in analytical and editorial suggestions. All others who helped me, in however small a way, by assisting me to get the information I needed are entitled to my heartfelt thanks. But I am particularly thankful to Messrs. O. Ishumi of Kilimo, Dr. Karibuhoye of Mifugo, B. Mwasakafyuka of the Tanzania Cotton Authority, Mmari of the Tanzania Rural Development Bank, Divisions and Wards Secretaries of Mondo and Nindo, all from Shinyanga Region. Finally I would like to say thank you to the farmers who answered my questions and to Miss S.F. Hassanali for typing the final manuscript.

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LIST OF ACRONYMS

AR	First Grade Seed Cotton
BR	Second Grade Seed Cotton
CIMMYT	Centre for Maize and Wheat Improvement
DDC	District Development Corporation
FAO	Food and Agriculture Organization
KILIMO	Ministry of Agriculture
L.U.	Livestock Unit
NMC	National Milling Corporation
RIDEP	Regional Integrated Development Plan
TCA	Tanzania Cotton Authority
TRDB	Tanzania Rural Development Bank
UPE	Universal Primary Education

CHAPTER I

INTRODUCTION

This study is concerned with cotton production as part of the overall farming system for smallholders in Shinyanga Region, Tanzania. A detailed description of the characteristics of the existing farming system is made while assessing the factors which motivate farmers to expand or contract the area of cotton. Along with this, the production efficiency of cotton producers is assessed and, based on farmer's priority and production decisions, plans to improve cotton production are studied simultaneously with the other crops in the system in order to allocate production resources efficiently. From this analysis desirable improvements are suggested.

1.1. General Description of the Area of Study

1.1.1 Location and land use

This study contains the results of a survey conducted in Shinyanga Region. Figure 1.1 shows the area of study. The Region is situated in the northwestern part of Tanzania, south of Lake Victoria and lies from 1,100 to 1,500 m above sea level. The Wasukuma as the major tribe exercise a semi-permanent cultivation type of farming (Ruthenberg, 1976). The Region with its four Districts, namely Kahama, Bariadi, Maswa, and Shinyanga, has a total of 1.3 million people (Daily News, Jan. 17th, 1979) and an area of 5.1 million ha of which 3.1 million are available for crop growing and livestock keeping (RIDEP, 1975)[1.1/] The balance consists of

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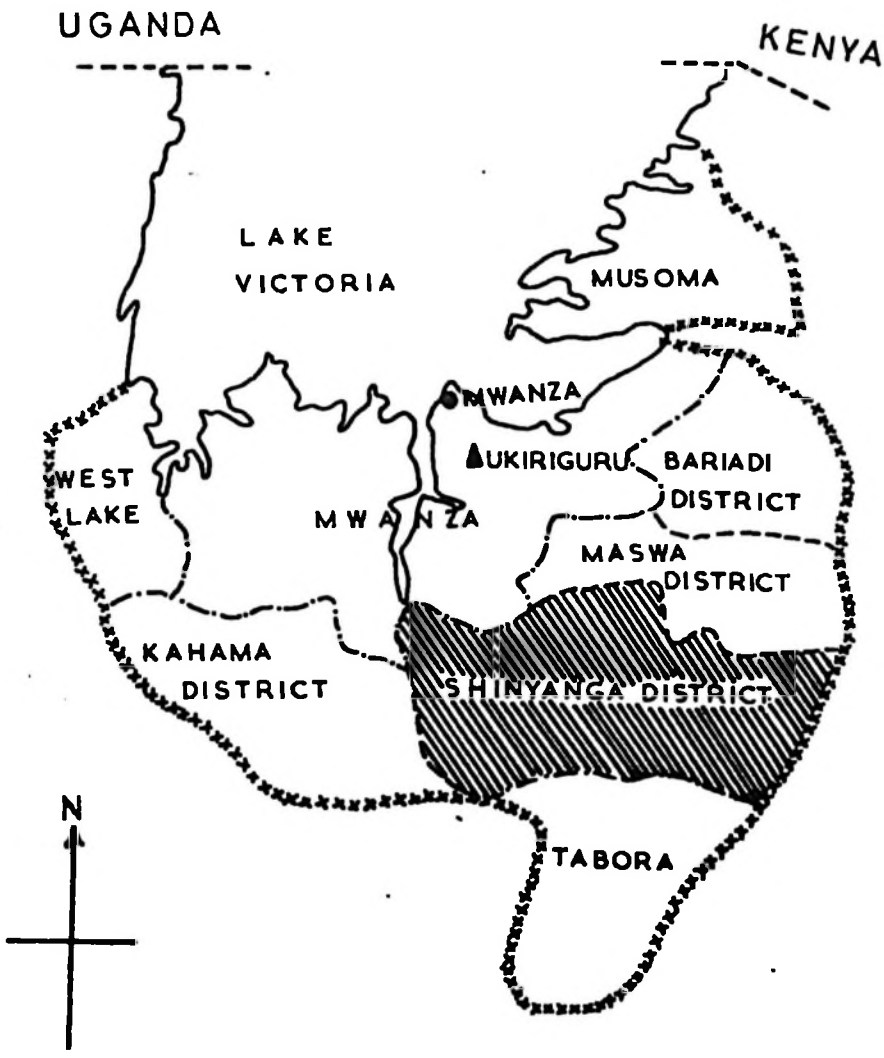
1.1/ RIDEP - Regional Integrated Development Plan - Shinyanga.

Fig 1-1· West zone: Shinyanga Region by Districts showing the area of study and Ukiriguru Research Institute



×××××××...West Cotton Growing Area·

▲.....··Ukiriguru Research Institute

▨.....··Study area

—·—·—·—···Regional boundary

— — — — — —···District boundary

1.8 million ha of gazetted areas and 0.1 million ha of unsuitable areas such as rock hills and outcrops. Out of the land available for agricultural purposes, 55 percent is suitable for crop growing and 45 percent for grazing only, and about a third of the suitable land for crop growing is cultivated annually. The area of study is about 100 km from the Ukiriguru Research Institute near Mwanza.

1.1.2 Climate and topography

The topography is generally uniform with gentle undulating and flat to depressed plains. Natural vegetation on the flat and gently rolling land has largely been removed and trees are scarce. Soils vary from highly permeable light hill sands in Kahama District to heavy and often water-logged cotton soils (mbuga) in the rest of the Districts.[1.2/]

The rainy season opens in October with rather small average amounts which increase through November and December, then decline through January and February before increasing again in March and April. The dry period thus lasts from late May to October or early November (table 1.1).

The mean monthly rainfall for 1972-1977 is shown in figure 1.2. The rainfall distribution is weakly bimodal. It varies greatly from year-to-year and from place-to-place, even within a few km, a factor

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1.2/ Mbuga soils are black clay soils, with poor drainage. They are sticky when wet and very hard when dry and thus are difficult to work with but are very fertile. Usually cambered beds (broad ridges of about 11 m wide and 130 m long) are used on mbuga soils to eliminate excess water during heavy rains and to prevent floodings.

Table 1.1. Shinyanga District: Rainfall distribution by months, 1972-1977

Month	Calendar year						Average 1972-1977
	1972	1973	1974	1975	1976	1977	
	mm						
January	139	194	117	74	107	224	143
February	132	73	56	94	108	58	87
March	155	93	195	80	102	116	123
April	91	112	159	88	96	97	107
May	28	25	16	31	33	67	33
June	32	0	10	49	1	0	15
July	0	0	49	19	0	0	11
August	0	0	0	1	0	0	0
September	0	39	0	22	0	0	10
October	88	25	0	14	0	24	25
November	188	101	0	17	158	91	92
December	90	114	139	125	128	273	145
Average	79	65	62	51	61	79	66

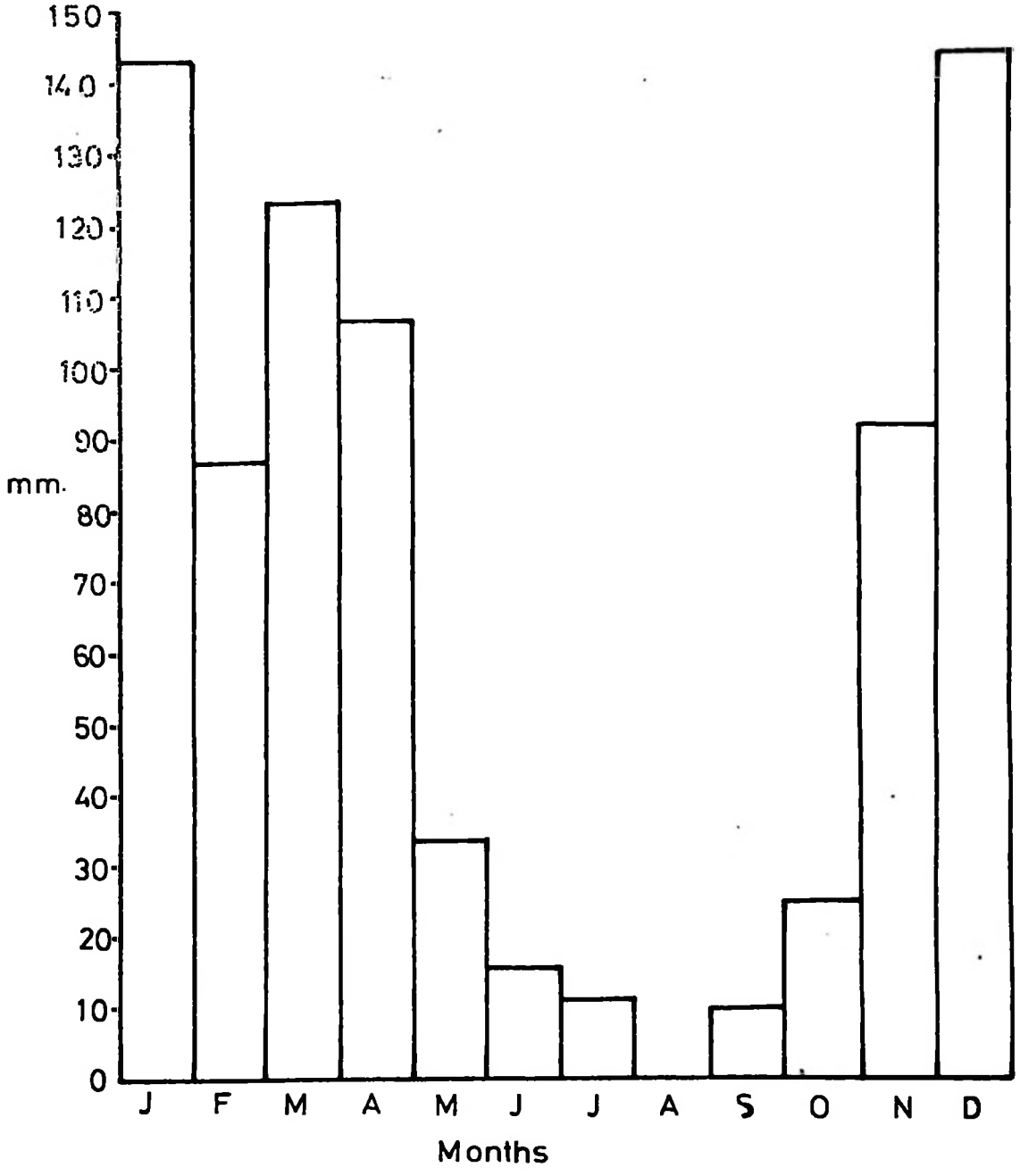
Source: Lubaga Research Sub-station, the nearest weather station in the area of study.

which increases the uncertainty of the rewards from the efforts put into cultivation of the land. Rainfall ranges between 800 to 900 mm per annum.

1.1.3 Agricultural enterprises

The main occupations of the people include livestock keeping and crop production. In Shinyanga and the whole of Sukumaland there is a traditional interest in livestock keeping, particularly cattle. About 20 percent of the national herd is found in the Region which comprises cattle (East African Shorthorn Zebu), goats, sheep, donkeys, and to a small extent poultry. Although the Region harbours an appreciable percent of the national herd, the productivity of the livestock enterprise is low mainly because of insufficient

Fig1-2 Shinyanga District: Mean monthly rainfall, 1972–1977 average.



Source: Lubaga Research Sub-station.

institutional support and indiscriminate overgrazing. However, this study found that less than half of the farmers keep livestock.

The major crops grown in the Region are cotton, maize and sorghum and, to a lesser extent, paddy, groundnuts, millets, cassava, and sweet potatoes. In 1972, two tobacco complexes were introduced in the southern part of Kahama District. Although, as a rule, the rural population has enough crops to meet basic food needs, per capita food production on sample farms was below the standard per capita food consumption for some families as estimated by FAO (1973).

1.1.4 The farming system

Agriculture is basically subsistence, with cotton as the major cash crop and to a lesser extent paddy. While average farm size remained constant at 3.1 ha in the decade ending in 1967, the average land allocated to cotton increased five-fold from 0.3 ha to 1.4 ha over the same period (Collinson, 1972). In this study the average farm size was 33 percent larger than that found by Collinson in 1967 and the average land allocated to cotton was 20 percent larger.

Two types of farming systems were identified based on family size, farm size, farming techniques and ownership of livestock (section 3.7). Fourty percent of the farmers surveyed kept livestock and most of these used ox-ploughs to prepare their land. However, about a quarter of these farmers kept sheep and goats and hired ploughing services. Since these non-cattle farmers were a minority, they were ignored in the systems analysis. The farmers with

livestock cultivated an average area of 6.8 ha of which 2.4 ha were for cotton, 0.3 ha for paddy and the remaining 4.1 ha for food crops. These farmers also had relatively large families with 5.8 adult male consumption equivalents of calories and 6.1 adult male consumption equivalents of protein. They tended to work very hard as indicated by the survey. The smaller farms, making up about sixty percent of the total, mostly used hand hoes for land preparation and cultivated an average area of 3.4 ha of which 1.3 ha were for cotton, 0.1 ha for paddy and the remaining 2.0 ha for food crops. They had an average family size of 5.4 adult male consumption units of calories and 5.6 adult male consumption equivalents of protein. Their ability to prepare land tended to limit overall farming activities, so that surplus family labour appeared to be available during most of the year.

Agricultural activities in the Region are closely related to the rainfall pattern. Cultivation starts at the beginning of the rains and the major part of the harvest falls in the beginning of the dry period.

Most food crops are intercropped. In addition to cotton and paddy, sweet potatoes and/or cassava are commonly grown in pure stands. The most important food crops are maize or sorghum as staple foods, interplanted with legumes, mainly groundnuts and to a minor extent chickpeas and green gram. The general tendency of rotation is to move the cotton crop around more often than any other crop and, after 3 years under cassava or sweet potatoes, the plot is put back into cotton.

Due to the unreliability of the rains, farmers try to spread the risks of crop failure by distributing the planting over a long period. This staggered sowing is partially necessitated by the labour requirements of land preparation, sowing and harvesting. In this way farmers tend to spread the risk instead of aiming at maximum yields in years of "normal" rainfall. Household requirements offer an additional explanation, planting being so timed that the family can get food from the garden or field for consumption in most months. Thus the planting of subsistence crops, in particular maize, sorghum, sweet potatoes, cassava and groundnuts, is spread over several months. The crop husbandry practices the farmers follow, though alleviating the risk uncertainties to a degree, do not allow for years of major rain/crop failures. As an insurance against such failures, keeping of livestock has become a highly integrated part of the traditional mixed farming system of the area for many farmers, a factor of great importance in the social structure of the people.

Farming is carried out exclusively on small family farms. The individual farm units are operated on a family basis and the employment of hired labour is generally negligible. The use of yield-increasing inputs such as fertilizers and sprays is low, and labour-intensive purchased equipment apart from the hand hoe is limited to ox-ploughs or hired ploughing services.

1.2. The Cotton Economy

1.2.1 World situation

Cotton is by far the most important non-food agricultural commodity in the world. Total world exports reached a peak of 18 million bales in the 1963/64 marketing year (Sinclair, 1968) but, because of the establishment of domestic cotton industries in many developing countries, exports steadily declined to 16 million bales by 1975 (International Cotton Advisory Committee, 1976), even though world consumption was increasing.

World cotton production in 1976 recovered by 6 percent from the steep fall of the previous year although it remained substantially lower than in earlier years. The rise in output resulted mainly from increased plantings, especially in the United States and in certain Latin American countries following favourable price prospects at planting time and changes in production policies which had previously favoured food crops at the expense of cotton in some countries (United States Department of Agriculture, 1978).

The quantities produced tended to increase up to the 1973/74 crop year and then started to decline. Consumption of lint however had tended to increase over the same period. The world cotton consumption in 1966/67 was 52 million bales and had reached 59 million bales in 1975/76. The upward climb has continued at a sluggish pace which mirrors the increasing challenge by synthetics. Cotton's lead in consumption over the synthetics is more marked in the developing countries where the share is currently about 80 percent as compared to 60 percent in the developed countries.

Cotton supplies tightened considerably in 1976, since the 6 percent increase in production from the low level of the previous year was not sufficient to meet consumption requirements. As a result, stocks were drawn down further and prices rose appreciably. Reduced export availabilities also led to some decline in the volume of world trade in raw cotton, though higher prices boosted the value of this trade by 13 percent (FAO, 1976).

World export prices followed a steady downtrend from the mid-1950's through 1966 but in 1967, due to the unusually short supply, showed an upturn. Prices rose rapidly during the first half of 1976, reflecting recovery in textile activity and tightening supplies. Lower growth in textile output led to receding prices towards the end of the year, but the upward trend was resumed in mid-1977 when supply prospects deteriorated along with the rapid depletion of stocks, and when significant increases in man-made fibre prices were announced in the United States and Western Europe. The downward trend in prices was a product of many factors, but the crucial long-term factor has been the price trend in competing synthetics especially rayon. This was followed by a decline in cotton consumption in the developed world where changing consumer tastes and expectations led to a rapid intrusion of the non-cellulose fibres. The downward trend in production is likely to reverse in future if cotton prices increase in world markets. A factor that could bring about higher prices, in addition to reduced production, is the rise in prices of synthetics because of the rise in prices of petroleum and petroleum products which are the basic materials for synthetics.

1.2.2 Tanzania's perspective

Cotton was introduced in Tanzania by the Germans who started to sell it to world markets in the 1920's. Pronounced production increases were realized in the 1950's, mainly in the West zone areas which reached a peak of just over 400 thousand bales in 1966 (TCA, 1978).[1.3/] Since then production has fluctuated between 350 and 400 thousand bales (table 1.2).

Table 1.2. Tanzania: Seed cotton production by zones, 1966/67 to 1977/78[1/]

July-June crop year	Cotton-growing zones				Total		Grand total
	West[2/]		East[3/]				
	AR	BR	AR	BR	AR	BR	
	1,000 bales						
Average:							
1966/67-1971/72	345	20	14	2	359	22	381
Annual:							
1972/73	386	26	9	2	395	28	423
1973/74	329	17	10	2	339	19	358
1974/75	349	21	18	3	367	24	391
1975/76	197	22	11	2	208	24	232
1976/77	326	24	17	3	343	27	370
1977/78[4/]	317	23	17	1	334	24	358
1972/73-1977/78 average omitting 1975/76	341	22	14	2	357	24	380
	Percent						
Increase, later average over earlier average	-2	9	0	0	-1	9	0

Source: 1966/67-1971/72 from TCA, Regional Offices, Shinyanga and Morogoro.
1972/73-1976/77 from Ministry of Agriculture, 1977b, table 1(a), page 1.
1977/78 from Tanzania, United Republic of, 1979, table 34, page 60.

1/ AR refers to first grade and BR to second grade cotton.
2/ Mwanza, Shinyanga, Mara, West Lake, Kigoma, Tabora, and Singida Regions.
3/ Morogoro, Coast, Tanga, Mbeya, and Kilimanjaro Regions.
4/ Provisional.

1.3/ TCA - Tanzania Cotton Authority.

The highest output during the period of German rule was 3.7 thousand bales recorded in 1913, but this increased steadily during the British period, averaging 35 thousand bales between 1935 and 1939 (Lele, 1976). The increase in production in the decade ending in 1960 resulted from individual farmers taking-up cotton growing (Percy, 1975). The increase in production up to 1967 was mainly through the introduction of improved seed varieties for which yields per unit area increased by 40 percent, from 336 kg to 472 kg of seed cotton per ha, and efforts put into pest control programmes.

Since 1967 government efforts to improve yields through better husbandry and provision of credit, extension services, and modern inputs have not had significant results. Efforts to introduce new systems of production through villagization and the introduction of block farms are known to have been largely failures (Cliffe, Lawrence, and Saul, 1975).

Cotton production fell by 18 percent between the 1972/73 and 1973/74 crop years, at the same time that world market prices increased by 42 percent. Cotton prices to growers (Table 1.3) remained the same on the hope that Government revenues accruing from increased world prices could be used to reduce farmers' costs of inputs through subsidizing fertilizers, sprays, and related equipment. In the 1975/76 crop year, cotton production slumped to a low level of 232 thousand bales, attributed to the heavy concentration on food crop production in the main cotton-growing areas following the latter's failure in the previous year. Production however rose by 57 percent during the 1976/77 crop year from the low figure for the previous

year. This recovery in production was mainly due to good rainfall through November to April during the crop's growth (Table 1.1). At the same time producer prices were increased by 15 percent. Average production of all cotton in the period 1972/73 to 1977/78 (omitting 1975/76) was nearly the same as during 1966/67 to 1971/72. But second grade (BR) cotton was 9 percent more over the same period, thus indicating a deterioration in cotton quality.

TCA sets prices to growers in cooperation with the Ministry of Agriculture. Table 1.3 summarise cotton producer prices and average sales price of TCA by type over the specified years. The upward trend in prices to growers has not been matched by an increase in production, at least in part because prices of competing crops, such as maize, also have increased sharply, particularly at a free-market level. Also increases in prices to growers have been less percentage-wise than the sharp increases in the price realized from sales since marketing margins for AR have increased five-fold. All cotton must be sold to TCA but many of the food crops are sold mainly in local markets at prices that at times are far above the official levels.

1.2.3 Cotton production in Shinyanga Region

Approximately 95 percent of Tanzania's cotton is grown in the West zone areas and Shinyanga Region contributes about one-third of this (Table 1.4). The bulk of the Region's population, particularly the rural people, depend on cotton as a chief source of their cash incomes. Other sources include sales from food crop surpluses (in good years), mainly paddy. Average production of cotton in the period 1972/73 to 1977/78 (omitting 1975/76) was 5 percent less than

Table 1.3. Tanzania: Price to growers and average sales price of TCA, cents per kg, 1970/71 to 1979/80

July-June crop year	Type AR			Type BR		
	To growers		Sales price3/	To growers		Sales price3/
	Seed basis1/	Lint basis2/		Seed basis1/	Lint basis2/	
1970/71	110	330	404	55	165	319
1971/72	110	330	490	55	165	399
1972/73	113	339	517	60	180	301
1973/74	113	339	737	60	180	500
1974/75	150	450	939	65	195	414
1975/76	200	600	949	100	300	727
1976/77	230	690	1202	115	345	929
1977/78	240	720	1279	120	360	
1978/79	300	900		130	390	
1979/80 4/	320	960		150	450	

1/ Source: Ministry of Agriculture, 1977a, table 4, page 3.
2/ Seed basis times 3 to allow for 34 percent outturn.
3/ Ministry of Agriculture, 1977b, Annex 4, Cotton, table 3, page 5.
4/ Source: Daily News, 6th October, 1979, p. 1.

during 1966/67 to 1971/72. Production fell by 35 percent between the 1972/73 and 1973/74 crop years, attributed to lower acreage planted with cotton than in the previous year. In 1974/75 there was an increase of 23 percent and then a slump to a low level of 69 thousand bales the following year. This big fall was attributed to the production policy which favoured food crops following failure of the latter due to severe drought in the previous two years. The upturn in cotton production in 1976/77 by 38 percent to 119 thousand bales was mainly due to favourable weather and increased cotton producer prices, although it was below the 6-year average 1972/73 to date omitting 1975/76. There was a fall of 11 percent in production in the 1977/78 crop year due to heavy rainfall which flooded the cotton black soils during the long rains, thus submerging the crop. The

recovery in production of about 12 percent in the following year was likely due to favourable rainfall.

Table 1.4. Shinyanga Region: Area and production of seed cotton and related series, 1966/67 to 1978/79

July-June crop year	Area	Production			Regional production as a proportion of total for	
		AR	BR	Total	West zone	Tanzania
	1,000 ha	1,000 bales			Percent	
Average 1966/67-1971/72	N.A.	134	10	144	39	37
Annual:						
1972/73	141	173	13	186	45	44
1973/74	113	112	6	118	34	33
1974/75	134	145	9	154	42	39
1975/76	91	69	8	77	35	33
1976/77	134	111	8	119	34	33
1977/78	119	98	9	107	32	30
1978/79 1/	120	126	14	140		
1972/73-1977/78 average omitting 1975/76	127	127	10	137		
		Percent				
Increase, later average over earlier average	-	-5	0	-5		

Source: Shinyanga Regional Development Office.
1/ Estimate.

The decline in production for the Region since 1972/73 is mainly due to a configuration of factors discussed hitherto. Farmers have given a higher priority to production of food crops because of continuous food crop failures in order to avoid the problem of hunger. This has tended to reduce the area devoted to cotton. Favourable producer prices for food crops have made these more profitable than cotton, particularly since cotton requires about twice as much labour

per ha as for maize or sorghum. Thus, given high input costs for cotton, farmers tended to use little cash outlays for cotton improvement. The weather has been unfavourable in many years since 1973/74 (table 1.1) and this is most likely why farmers tend to concentrate more on food crops at the expense of cotton production. Even in better years, such as the 1976/77 crop year, rainfall was erratic and caused floods in some parts, making weeding difficult. The damage from rodents, mainly rats, is becoming a serious problem as they destroy the crop at all stages of its growth.

1.2.4 Importance of cotton in Tanzania relative to other enterprises

The desire on the part of the Tanzania Government for a favourable long-term growth of cotton production cannot be overemphasized. Cotton has brought important economic and social changes to the people who grow it (Nyerere, 1967). Cotton has been the second major export for many years, accounting for around 20 percent of the country's exports in terms of value. The value of cotton exports has shown an upward trend since 1970 (table 1.5), with a peak in 1976. The increase in value however has been mainly a result of increased world market prices rather than due to increased physical exports despite Government's efforts to stimulate production through:

1) Devaluation of the Tanzania shilling in 1971, 1973, 1975 and 1979 (Sunni and Mbiha, 1979).
2) Improving distribution of seasonal inputs and encouraging modern farming techniques.
3) Raising and announcing producer prices early in each crop season.

4) Subsidizing fertilizers and insecticides to farmers.

Table 1.5. Tanzania: Value of exports by principal items, 1970 to 1977

Item	Calendar year							
	1970	1971	1972	1973	1974	1975	1976	1977
	T.Shs. Million							
Coffee	312	227	383	495	375	483	1,282	1,870
Cotton	247	245	336	333	473	297	613	542
Cloves	109	179	240	253	88	321	261	244
Sisal	134	134	145	222	463	302	240	228
Tobacco	45	43	49	56	82	92	188	206
Cashews	115	120	150	141	196	177	131	188
Tea	42	49	154	45	69	81	134	180

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

Export sales of cotton lint are made on the basis of invitations to tender and the main buyers of Tanzania's cotton include Taiwan, Hong Kong, Japan, Singapore, China, and Belgium. The crop is normally sold "forward," with the West Zone area's crops preceding the East Zone area's crop. By selling the crop before it is actually purchased from growers, TCA is likely to realize greater revenues in a falling market situation, and so farmers are likely to get a better price. But in some years, the opposite would be true. For most farmers in the main cotton growing areas, cotton is almost the sole source of cash income.

Domestic demand for cotton lint is increasing rapidly to cope with the expanding and increasing number of textile mills. Table 1.6 shows the consumption of cotton lint by local mills through 1976/77. Four new textile mills are expected to be set up in the country before the end of 1981 in order to meet the Nation's

production target of 200 million m^2 of cloth by 1985 (Daily News, April 27, 1978). The Mwanza textile mill has been expanded to raise its annual production from 25 to 45 million m^2. The annual production capacity of the Sungura textile mill in Dar es Salaam has also increased from 14 to 21 million m^2 of cloth. A new textile mill is under construction in Musoma which is expected to produce 25 million m^2 of cloth annually. The small purchases of lint in 1976/77 is probably due to the unusually low production of 232 thousand bales in the previous year.

Table 1.6. Tanzania: Purchases of cotton lint by local mills, 1970/71 to 1976/77

July-June crop year	Purchases	Value
	1,000 tons	T.Shs. Million
1970/71	7.9	N.A.
1971/72	8.5	N.A.
1972/73	9.5	N.A.
1973/74	10.8	96
1974/75	14.7	109
1975/76	10.0	105
1976/77	8.1	104

Source: Ministry of Agriculture, 1977a, table 2, page 2, and table 4, page 6.

Cotton seed cake, a by-product of seed cotton, is becoming increasingly important because of the high demand for vegetable oils for human use and cotton seed cake as a feed to livestock.

For all of these reasons, Government planning policy has laid emphasis on expansion of cotton production as an important factor in rural and National development. A further factor likely is the high net return per unit of land. As discussed later in this

thesis (Chapter IV), this is not an economically viable reason for expansion. Instead one should look at relative returns per man-day of family labour during periods when labour is extremely scarce. On this basis cotton is less attractive than certain food crops based on prices at the time of this study.

1.3. Tanzania Cotton Authority (TCA)

The Tanzania Cotton Authority was established in 1972, taking over from the defunct Lint and Seed Marketing Board. It was commissioned as a parastatal organization responsible for the purchasing, processing, and marketing of all cotton in the country. In addition, it supports extension personnel, provides seasonal inputs on credit, and undertakes crop promotion programmes to increase cotton production.

After the dissolving of co-operative societies in March 1976, the villages became multipurpose co-operative societies under the Village and Ujamaa Village Act of 1975. The parastatals in the Region, i.e. TCA for cotton, National Milling Corporation (NMC) for maize, beans, rice and cassava and General Agricultural Products Export Corporation for groundnuts, now deal directly with the village societies in crop marketing operations. In some villages TCA may act on behalf of the other parastatals as the sole marketing agent because of its comparatively improved infrastructure of storage and transport in the Region. The following is a simplified marketing procedure for cotton:

1) Individual growers deliver seed cotton to collective points

known as buying posts.

2) Collected seed cotton is transported from buying posts to ginneries.

3) Ginneries process the seed cotton, producing lint and seed.

4) A proportion of the seed is dusted and re-distributed to farmers free of charge for the following season.

5) Lint and the remaining undusted seed are sold and transported to places of final use. These may be foreign buyers, local textile mills or seed crushing mills.

TCA also sets cotton producer prices by deducting from the sales price (a) the export tax, (b) the Authority margin, and (c) a co-operative margin. From the remaining, producer prices for AR and BR are computed for that particular year. The pricing structure is shown in table 1.7.

1.4. Literature Review

Numerous farm economic investigations on cotton growing have been made in Tanzania and elsewhere. Collinson (1963) attempted farm management studies in Tanzania in the West. Working with a Trial Management Farm Unit in Mwanza, Collinson (1969) was able to show improvement in farm efficiency over a 3-year period as measured by specified criteria. The study concluded that the success or failure of any farming system is really whether they are technically and economically feasible.

A study by Shapiro (1976), undertaken to analyse the theoretical and empirical work on allocative efficiency in traditional agriculture,

Table 1.7. Tanzania: Percentage distribution of marketing margin between sales and producer price of seed cotton, 1973/74 and 1974/75[1]

Item	1973/74	1974/75
	Percent	
Sales price	100	100
Export tax	2.3	7.1
TCA margin:		
Direct and indirect marketing costs Salaries and administration Transport and subsidization Finance and insurance	50.6	40.5
Co-operative margin:		
Marketing expenditure allowance Union levy[2] Society levy Ginning fees	11.4	11.9
Producer price (average)[3]	35.7	40.5

Source: Ministry of Agriculture, 1977a, table 22, page 39.
1/ Data for more recent years are not available.
2/ Now shared between TCA and Village Societies.
3/ Average producer price assuming 88 percent is purchased as Grade AR and 12 percent as Grade BR.

used Tanzania small-scale cotton farmers in Geita to illustrate the concept and relevance of technical efficiency on peasant agricultural development. He concluded that the theoretical arguments apply primarily in a competitive context that differs significantly from that in which peasant farmers operate. Another attempt in farm economic analysis was by Shao (1975) whereby he found that better organization of farm resources such as family labour could result in increased farm output and productivity especially in areas where land is scarce. He further argued that significant increases on smallholder farm production could be achieved through injection of appropriate technologies and improved husbandry practices.

A study by Percy (1975) was concerned with the agronomical aspects of cotton growing. He identified the increased reliance on maize as the major factor accounting for late planting of cotton since maize must be planted early to ensure food supply for the family.

Cotton research conducted from the Agricultural Research Institute, Ukiriguru, has been directed mainly at improving cotton yields by improved seed issues and husbandry recommendations. This orientation towards return per unit of land, rather than per unit of labour or capital investment, has often been criticised, e.g. Collinson (1972), except for the work on breeding and insecticide testing programmes. With the exception of cotton breeding programmes, the results of research are of little value unless accepted and utilized by farmers (Percy, 1975).

Research at Ukiriguru by Peat and Brown (1960) shows that timely planting of cotton is probably the most important single factor in increasing yields. Early planting on the average increased yields by 169 kg of seed cotton per ha which at 1976/77 prices was worth Shs. 390 (Keregero, De Vries and Bartlett, 1977). Research has led to recommendations that cotton should be sown on cross-tied ridges between late November and mid-December (Brown, 1963). The method by which ridges are constructed with a hoe over the old furrow is also efficient for weed control, old vegetation and weed seeds being buried in the base of the new ridge. Collinson (1963) found no difference in cotton yields between flat and ridged fields, but the former required almost twice the number of man-days in

preparation and weeding. The tie-ridging gives useful yield increases in a dry year according to Brown (1963) and has been considered of central importance in raising yields by Bounce (1951) but has seldom been accepted by farmers, and Collinson (1972) considered it uneconomical when compared with alternative investments of labour

Spence and Smithson (1968) stressed the importance of early thinning of cotton 2-3 weeks after planting. Once more than 2 seedlings have established growth, the excess ones are nothing more than weeds competing for water, light, and nutrients. Based on trials at Ukiriguru, Spence (1967) concluded that spacing wider than that recommended gave lower yields per unit of land. Scaife (1967) concluded the same and added further that sowing under correct spacing permits inter-row cultivation with animal-drawn or tractor-drawn equipment. He concluded that without such equipment it is difficult to see how the peasant farmer will ever manage a satisfactorily large area and still keep weeds under control.

Time of planting has a profound effect on yield. Spence (1968) found a reduction in yield of 16 percent when sowing is delayed by 3 weeks and 46 percent with a delay of 6 weeks. Late-planted cotton does not give adequate returns for fertilizers and insecticides expended upon them. Le Mare (1967) argued that fertilizer application should be accompanied with insecticides because it is only when insect damage is prevented that fertilizers have their greatest effects. Reed (1967) looked into the closing of the season (i.e. uprooting and burning of cotton residues) which is primarily intended to reduce the number of cotton insect pests and reduction of disease

incidences. He concluded that there is no point in even thinking of "advanced farming" through fertilizers and insecticides unless this simple measure is first adopted by all cotton growers (this now is required by law).

Opinions differ about the degree of success of the extension services in transmitting these recommendations to farmers. Hulls (1971) concluded that the extension services had had no measurable influence on growing practices and he considered it unlikely that any real improvements in husbandry practices had occurred. The study by Keregero, De Vries and Bartlett (1977) examined recommendations for improved methods of production in relation to other aspects of the traditional farming system in Mara Region. Their study concluded "If the aim is to evolve appropriate recommendations that will be sought eagerly by the farmers rather than resisted, farmers and extension workers must be involved from the beginning." Percy (1975) expressed his views that farmers have been well aware of the advantages of early sowing and weeding for many years, and that the reason that these recommendations are not always adopted is competition for labour rather than ignorance.

Studies have also been done on economic aspects of the crop. Malima (1971) dealt with producer price manipulations as means to speed up diffusion of innovations, absorption of new inputs, and increasing the efficiency of the cotton producer. Aldington (1973) in Kenya concluded that better prices for seed cotton were prerequisites for increasing cotton production in the short-run. A study by Alibaruho (1976) in Uganda also concluded that adequate producer

prices for seed cotton announced well in advance of the season were essential for stimulating production. Odero-Ogwel (1974) looked into risk constraints as serious problems that hamper rational decision-making in peasant agriculture. Heyer and Waweri (1976) compared large-scale farms and smallholder farms in Kenya and concluded that the latter have a relative scarcity of land and capital, large quantities of labour, low incomes, and limited access to research, technical advice, information, markets and transport. The findings of Heyer and Waweri for Kenya are in part not true for Tanzania because land is generally not a limiting factor. At the same time labour is increasingly becoming a constraint because children can no longer help with farm work because of the Universal Primary Education (UPE) endeavour throughout the country, and inputs are heavily subsidized by the respective crop authorities.

1.5. The Problem Studied

1.5.1 Description of the problem

Attempts to improve cotton production have met with many difficulties which in turn have hindered increased production. These difficulties could be categorised into (a) natural ones such as climatic factors, (b) physical ones such as salinity and water-logging, (c) economic problems such as high costs and demand for working capital, favorable returns for competing enterprises, and lack of inputs, and (d) technical problems such as poor husbandry practices and lack of proper planning and control of farm operations (e.g. labour constraints, organization of weeding and spraying, etc.).

Such problems frequently cause farmers to revert to less intensive programmes, for example at times farmers use disproportionate amounts of labour to grow crops which are far beyond their capacity to manage in order to spread the risks of crop failures.[1.4]

1.5.2 Objectives of the study

This study is concerned with the following three objectives:

1) To identify and assess factors that motivate farmers to expand or contract area and production of cotton.
2) To determine the productive efficiency of the cotton producers.
3) To determine, based on characteristics found for the system, a feasible plan for increasing aggregate output of the whole farm unit in the area of study.

1.5.3 Hypotheses tested

In light of the foregoing objectives, the following hypotheses were put forward for testing: First, that the present technological-mix (i.e. package of innovations), cropping pattern and labour disposition may be inconsistent with optimal production. Secondly, there is considerable potential for expanding cotton production if the farms can be planned in a more optimal manner than is currently done. In the past many farmers had unlimited resources of labour and land. However because of the present policy of Villagization and UPE, they need to be helped to re-structure the production-mix on their farms inorder to achieve effective development. This could be done hopefully by developing a clear conception of the farmers' objectives

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[1.4] Author's own observations as District Agricultural Development Officer in the area of study.

and restraints by using a farming systems analysis approach as a planning technique based on the pioneer work by Collinson (CIMMYT, 1977) and Bartlett (1978).

CHAPTER II

METHODOLOGY

2.1. Source and Collection of Data

2.1.1 Questionnaire formulation and testing

The farm households as the primary sampling units and farmer interviews based on a questionnaire.[2.1] were the main source of primary data. The questionnaire contained both closed and open-end questions and was supplemented by limited observations on the farms by the author, and informal conversations with the farmers. The questions were designed to collect basic information on the farmers' activities, possessions, immediate goals and problems, and how they solve them. This was a single-visit survey and the quality of the data depended in part on the memory of the farmers who were interviewed.

Before conducting the actual survey, a pilot study was made in one village (Mwantini) based on 5 farmers chosen at random. The initial draft of the questionnaire was revised following this pretest.

2.1.2 Sampling technique and interviewing

A multi-stage random sample of 50 respondents was chosen as follows: One out of the four Districts in the Region was selected for convenience of transport for the first sampling stage. This was Shinyanga. Agriculture in the Region is basically homogenous with respect to cropping patterns, intercropping, types and timing of crops, topography, rainfall, livestock keeping, with minor differences

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2.1/ Available on request from the author.

in soil types (see sub-section 1.1.2). However, two major types of farms were identified as discussed later. This District had seven Divisions from which two were randomly chosen (Mondo and Mindo). Two out of the 12 wards in the two Divisions were picked at random. The two wards had 27 villages from which 5 villages in each were chosen at random. For each village five 10-cell leaders were randomly chosen and for each leader, one family was picked at random. This gave a total sample of 50 respondents.

The survey was conducted during July to September 1978 and sought information covering the 1976/77 and 1977/78 crop years. Based on conversations with Regional and District officials, the 1977/78 crop year was believed to have been relatively normal in terms of crop yields and weather effects (see also table 1.4).

Permission to conduct the survey was obtained from the office of the Regional Development Director. To encourage co-operation by farmers, an introductory letter was sent to Ward secretaries. Contact then was made with the village leaders. Farmers in the sample were then told that the purpose of the study was to try to understand their problems, with emphasis on cotton, and that this information would be conveyed to the proper authorities. Collection of data from the farmers was by direct interview by the author based on a questionnaire designed for this study.

For secondary data, officers in Shinyanga of the Regional Development Office (Kilimo), TCA, Tanzania Rural Development Bank (TRDB) and NMC were visited. Use was made of their annual reports and the relevant files supplemented with informal conversations.

Additional information of a secondary nature was obtained from the Ukiriguru Agricultural Research Centre in Mwanza, publications from the Ministry of Agriculture and TCA in Dar es Salaam, and the University Library, Morogoro.

2.2. Tools of Analysis

The peasant farm-household system is highly complex and complete quantitative analysis of it in general is not practicable (Bartlett, 1978). One type of quantitative method of analysis includes "optimizing" mathematical models which solve by maximizing or minimizing a function subject to constraints made explicit in the formulation of the model. These models include budgeting and linear programming methods which frequently make use of electronic computers. These models may have certain gaps as far as individual farm design for improvement, particularly in developing countries, is concerned. These gaps are necessitated by:-

1) The complex situation in peasant farm-households.
2) The data collection procedures by survey which often minimize the opportunity for the researcher to obtain full understanding of the interactions of the farm-household system.
3) The measurement problems of survey data, both general and specific.
4) The mathematical complexity of the models.
5) The difficulty in communicating results to non-professionals in the field of economics.

An intensive qualitative investigation of the interactions of

the farm-household system followed by a brief review for each agro-economic zone frequently can solve some of these problems and yield information of value in the design of improvements for farm-households. Such investigations may lead to a step where quantitative analysis will be useful for design of improvement of the aggregate agro-economic zone.

The qualitative analysis approach was pioneered by Bartlett (1978) for which he analysed farm information that is required in the design of improvements for small-scale agriculture, based on a case study of beans in lowland areas of Morogoro Region. The same approach was undertaken by CIMMYT (1977), based on a case study in the drier areas of Morogoro and Kilosa Districts.

This same qualitative analysis approach is undertaken in this study to assess factors that affect area and production of cotton in Shinyanga Region. However, in order to suggest possible improvements in the adoption of innovations which for many years have been recommended by research and advocated by extension departments with little success, a more sophisticated quantitative method of analysis (called direct programme planning after Foote, 1978) was used. Relationships of certain variables also were tested by means of chi-square and correlation analyses.

The following are the main assumptions of the study: (1) The innovations must be guided by the immediate goals the family has in mind, (2) The innovations must be geared to the special conditions of the farm that the family operates, (3) The innovations must be

geared to the time and skill that the family members can put into the farming operations, and (4) They must match the available resources for the family and risks the family is willing to undertake.

2.3. Analysis of Key Variables

2.3.1 Identification of farmer's objectives

A farmer usually has several goals and the emphasis may vary from case to case. In larger holdings, market production and profits are the main objectives. For smallholder farmers, particularly in developing countries, more important than saleable products is the provision of food for the household (Ruthenberg, 1976). A farmer's objectives are generally to maintain throughout the year a reliable and palatable supply of food balanced between legumes, starchy staples, and green vegetables (CIMMYT, 1977; Bartlett, 1978). In one of the systems under study another objective is to safeguard the future by accumulation of capital in the form of animals which in turn increases the social status. The importance of livestock is shown by the fact that 21 out of 50 farm-households in the sample owned stock, with the average holding per farmer owning stock being 23 Livestock Units (LU). The next objective is to obtain cash incomes in order to accumulate goods of wealth such as clothes, building materials, bicycles, radios, farm implements, and to buy food and livestock in some cases. The major source of farmers' cash incomes in the area is from cotton sales and to a minor extent from food-crop surpluses (in good years), particularly paddy.

Thus a Sukuma householder farm is a multi-objective system and, when livestock is kept, can be termed a cash crop - staple food - livestock farming system. Based on the survey, the following are evaluated: (1) family needs of the basic foods, i.e. cereals, roots, and legumes and (2) available cash incomes.

2.3.2 Assessment of resources

The major resource of importance in this study is family labour availability and utilization efficiency. Family labour has been found to be a limiting resource in peasant farming in most developing countries in certain peak labour-demanding periods. It is also considered as the main reason why farmers adopt staggered planting and intercropping, practices which usually increase total yield per ha over growth of the same crops under mono-culture and (1) allow greater flexibility in the use of labour, (2) assure a continuous supply of food over a longer period, and (3) reduce risks of total crop failure in bad years. It is for these reasons that Rotenham (1968) noted that farmers prefer lower but more secure net returns instead of maximum yields in good years. Attempts were made to record the actual labour used by the family on their farms as a whole. Farmers were asked to enumerate from memory what month and how many days each farm operation was performed by the active members of the family, and how many hours per day they spent in the field. These findings are compiled in appendix tables A.1 and A.2 and form the basis for detailed calculations in Chapter III relating to labour availability after meeting subsistence requirements, labour allocation to different crops and operations, and in Chapter IV, changes

in the farming system that make optimum use of family labour in critical months.

Livestock and capital were considered together because the question of capital injection into the traditional peasant farming system in the area is inextricably linked with the possession of livestock. Within the sample, 19 farmers (about 40 percent) used ox-ploughs to prepare the land and out of these 16 owned both oxen and ploughs. The survey approach, however, was not appropriate for irregular and fluctuating livestock outputs such as milk based only on memory of the farmer. Since milk production is an important part of the livestock enterprise, an average milk yield of 0.8 kg per day for an indigenous cow per lactation of 7 months based on the study by Chikaka and Foote (1979) was assumed. No economic assessment of the livestock enterprise in terms of returns to land was made because of the management system of communal grazing. However returns to labour were evaluated based on the assumption that one active member of the family was required for half a day to care for livestock. This gave a figure of 15 man-day equivalents per month, compared with the same figure of 15 man-day equivalents per month deduced by Collinson (1963) for the average family herd of 14 L.U.

2.3.3 Husbandry operations

The husbandry operations that are critically analysed in this study include (1) land preparation, (2) time of planting, (3) spacing, (4) weeding, (5) thinning, (6) fertilizer application, (7) spraying, (8) harvesting and grading, and (9) field sanitation

for cotton production. Required inputs also are evaluated i.e. types and rates of (1) seeds, (2) insecticides, (3) fertilizers, (4) implements such as the hand hoe, ox-plough and tractor, and (5) family labour. The main argument in this context is that farmers are intentionally rational in organizing the farming operations to fulfill their objectives, and that they will adopt any innovation to changing circumstances provided the change is satisfying in terms of the additional net benefits involved relative to the implied risks. The effects of wealth, education, age, and extension contact on adoption of recommended operations are tested by statistical means. Under this section the hypothesis that "the technological-mix, cropping pattern and labour disposition prevailing on the peasant farms may not be conducive to a fast increase of area and production of cotton," is tested.

2.3.4 Planning for improvements

Peasant farm planning in most cases is informal, i.e. the kind of planning in which the decisions are all in the head and nothing is written down on paper (Bibangambah, 1975). Most farmers are faced with a range of alternative crops they could grow and livestock they could keep. In the past, many farmers had access to unlimited resources of land and hired labour. However, because of the present policy of villagization and UPE, farmers may need to be advised on allocation and utilization of their limited resources so that each resource is used where it will earn the greatest returns. For example farmers have persisted on growing local varieties of maize, which are not only low yielding but also susceptible to drought, for the

only reason that maize is palatable, and have given little emphasis to improved varieties of sorghum which are early maturing or drought resisting and high yielding but are not as palatable as maize. This argument is supported by a productivity of 5 and 7 bags per ha for maize and sorghum and the average area of 1.6 and 0.6 ha for each crop respectively found for the sample.

Evaluation of possible improvements are made by comparing the yields from the complete package (complete adoption) and piece-meal package (partial adoption) approaches for cotton and the consequences involved. The comparisons are based on the net cash returns for each enterprise as found for the sample. Lastly, the second hypothesis that "there is considerable potential for expanding cotton production if the farms can be planned in a more optimal manner than is currently done", is tested.

CHAPTER III

CHARACTERISTICS OF SAMPLE FARMS

Investigation has shown that peasant farmers put first priority on a stable and palatable food supply. Along with this, the study involves analysis of two multi-objective farming systems (identified on the basis of sample farms). These farming systems include the staple food - cash crop - livestock farming system exercised by farmers with larger families and the staple food - cash crop - no livestock farming system exercised by farmers with smaller families on average.

The study essentially involves determination of (1) subsistence requirements in terms of land, nutrients and labour and (2) family incomes, and a comparison of different production-mixes in relation to available family resources in order to make suggestions for improvement. But to make such analyses, one must study the characteristics of the presently-existing farming systems. These aspects are covered in detail in this chapter.

3.1. Land Use by Major Enterprises

Production for self-sufficiency in food and cash is essential if families are to be properly nourished, clothed and well-housed. Farmers in the Region have for many years cropped for self sufficiency and in good years they have usually attained this goal. That is, with their available resources of land and labour, they have managed their production pattern in relation to the local circumstances.

3.1.1 Land availability per family

At present land is not considered a limiting factor in peasant production in the Region but there is a danger for it to become a problem in future. Based on the 1978 National population census, the population in the Region is 1.3 million people (Daily News, Jan. 17th, 1979). The available land for agricultural purposes is 3.1 million ha. Thus the man/land ratio is 1:2. With an overall average family size of 6.8 persons, as found for the survey, approximately 14 ha per family is available for subsistence, cash crop and livestock farming. Families on the average cultivate 4.5 ha. Since the present carrying capacity of the land is one L.U. per ha, the balance of 9.5 ha just meets requirements for the average livestock herd of 10 L.U. for all families in the sample. In planned villages, 0.5 ha is devoted to buildings and growing of a few fruit trees, mostly pawpaws, and green leaves, mainly amaranthus spp. Fruit and vegetable growing in the Region are of minor importance because of the semi-arid type of climate and lack of permanent rivers and springs which might be used for irrigation. Population pressure is building up rapidly in the Region. The increasing subsistence demands, cash cropping, and farmers' resistance to de-stock their animals are likely to lead into involution, since increased arable farming necessitates a reduction of the grazing area while the proceeds from crop farming are partly invested in cattle. Grazing land is already a problem as evidenced by a worsening condition of cattle and increasing erosion, both reflecting low land productivity. Thus if steps are not taken, particularly to de-stock livestock and intensify crop production,

agriculture is likely to be in the limbo in the near future.

Available evidence (RIDEP, 1975) suggests that as a result of concentrated villagization, with an average size of 340-460 families per village, walking distances to outlying fields have increased so as to make it more difficult for farmers to make frequent return trips required for good cultivation, including protection against pests and wild animals. Consequently many fertile fields lying at the periphery of the village territories are left uncultivated because of their distances to homesteads, while virtually all fields close to the villages are being cropped continuously irrespective of their fertility. However, because of the fertile mbuga soils which predominate in the surveyed area, and on which all major crops are grown, 82 percent of the farmers expressed opinions of being contented with its fertility. Research has confirmed that mbuga soils are fertile. However, extension agents make use of blanket recommendations from the Ukiriguru Agricultural Research Institute and so recommended fertilizers for the whole Region. Research relating directly to the soils in this area would be of great benefit to the farmers involved.

3.1.2 Crop acreage and livestock numbers

The average farm size was 4.5 ha, of which 57 percent was allocated to subsistence crops, 39 percent to cotton, and 4 percent to paddy. Paddy is primarily grown for sale and is thus considered a cash crop. Since the mid-1960's, cotton acreages have continued to increase. A study by Percy (1975) in the West zone showed that

cotton acreage per farm was 0.3 ha in 1945, increased to 1.2 ha by 1962, and this survey shows a further increase to 1.8 ha (Table 3.1). Food crop acreages however have shown no trend. Maize has replaced sorghum in importance as shown in table 3.1. A slight reduction in the number of cattle since 1945, but a sharper fall for sheep and goats, has been noticed. Also a moderate reduction in family size is evident, most likely due to migration into towns for wage employment.

Table 3.1. West zone: Average area by crops, livestock by types and family size, 1945, 1962 and 1978

Item	1945 [1]	1962 [1]	1978 average over — [2]		
			All farms	Farm with — Livestock	No livestock
			Ha		
Cash crops:					
Cotton	0.34	1.18	1.77	2.40	1.30
Paddy	.21	.32	.15	.30	.10
Total cash crops	.55	1.50	1.92	2.70	1.40
Food crops:					
Maize [2] [3]	.32	.75	1.62	2.30	1.10
Sorghum [3]	1.19	.04	.57	1.30	.50
Cassava	.56	.59	.44	.50	.40
Total food crops	2.07	1.38	2.57	4.10	2.00
Total land in crops	2.62	2.88	4.54	6.80	3.40
			Numbers		
Livestock:					
Cattle	14.9	9.3	11.6	21.7	0
Sheep	9.3	6.1	1.3	4.8	0
Goats	6.9	4.9	2.0	6.7	0
Family size	7.8	8.2	6.8	7.1	6.6

1/ Source: Percy (1975), table 2, page 259.
2/ Source: Thesis sample survey.
3/ Groundnuts are grown in mixture with these crops.

However there are differences in cropping areas for farms with livestock and those without livestock which have been necessitated by differences in family sizes and brought about by possession of ox-ploughs for land preparation. Hence the two distinct farming systems.

Legumes, in particular groundnuts and to a minor extent cowpeas and green gram, are customarily intercropped with either maize or sorghum. Studies in India, Nigeria, Ethiopia, Uganda, Zaire and Tanzania at Morogoro (Monyo, Ker, and Campbell, 1976) to find which combinations of crops are most satisfactory, which morphological characteristics are desirable for plants being intercropped, and to assess the benefits of intercropping, have shown that intercropping is highly desirable in semi-arid areas where husbandry is non-mechanized. However findings by Jana and Masseri (1977), due to poor rainfall for that season, showed the contrary, namely that inter-cropping appeared to have no land-use advantage. Based on their findings of the 1976 crop year, a land equivalent ratio of 0.86 was found for the cropping arrangement of alternate rows, suggesting a slightly smaller output in kg than by mono-cropping. The practical implications of their findings lay in the suggestion that mixed cropping is only worthy when water is not severely limiting to any of the crop-mixture components.

In order to determine the area occupied by each crop under intercrop, yield figures for those crops were taken for the sample farms, and a maize/groundnuts ratio of 2:1 (470 kg/200 kg) was obtained, suggesting that maize occupied $\frac{2}{3}$ and groundnuts occupied $\frac{1}{3}$ of the intercropped area. Based on the same notion, a sorghum/

groundnuts ratio of 3:1 was obtained, suggesting that sorghum and groundnuts occupied $\frac{3}{4}$ and $\frac{1}{4}$ of the intercropped land respectively. Millets yield about the same as sorghum under similar conditions. Thus millet/groundnuts intercrop is likely to yield the same ratio as a sorghum/groundnuts intercrop.

3.1.3 Livestock units (L.U.)

About two-fifths of the farmers surveyed owned livestock. The average family herd and total livestock units for farms having some livestock were determined according to standards developed by Semple (1972) and are based on requirements for pasture consumption.[3.1/] The L.U. in this context thus refer to one mature head of cattle fed on enough natural pasture for good growth and production in a given period.[3.2/] The L.U. can then be used to determine the quantity of range/pasture needed annually in a livestock enterprise. The herd size ranged from 1 to 106 L.U. for the farms owning livestock, with an average family herd for those owning of 23 L.U. (Table 3.2). Factors for sheep and goats however relate to mature animals but, since the data were collected on number of animals on each farm regardless of age, the L.U. shown in table 3.2 for these animals are likely too high.

3.1/ Pasture includes all grazing land.

3.2/

Item	Livestock Unit
Beef or dairy cow, 2 years and over	1.00
Calf, 4–8 months	.30
Yearling steer or heifer, 270–320 kg	.75
Bull or ox, 2 years and over	1.00
Ewe, ram, or wether, over 1 year	.20
Goat or billy, over 1 year	.20

Table 3.2. Sample farms: Average family herd by type and total livestock units, 1977/78

Type	Proportion owning this type	Average over—	
		All farms	Owners[1/]
	Percent	L.U.	
Cattle:			
Dairy cows	42	3.1	7.4
Calves	42	.7	1.8
Heifers	32	2.4	7.4
Bulls	28	1.4	4.9
Oxen	32	1.5	4.0
Total	42	9.1	21.1[2/]
Goats, composite herd	30	.4	1.3
Sheep, composite herd	28	.3	1.0
Grand total	42	9.8	22.7[2/]

Source: Survey data.

1/ Average for owners of that particular type of livestock. A different concept is used for the total covered by note 2 since these numbers do not lend themselves to addition because each has its own devisor.

2/ Total L.U. on all sample farms having some livestock of type specified divided by the number of such farms. The last row thus represents the total for a typical farm within the type of farm specified.

3.1.4 Crop yields

Crop yield performance in table 3.3 for the crop year 1977/78 was on average neither bad nor good when compared to the average performance of the same crops for the 11 years 1966/67 to 1976/77 (RIDEP, 1975). Cotton and paddy on livestock farms were above the RIDEP average by significant amounts, while cotton on non-livestock farms was below average. Groundnuts for both intercrops was below average and sorghum on livestock farms also was below. All others were within ± 20 percent of the average. Cassava yields could not be obtained at the time of the survey because the crop was still in the ground. Thus yields for RIDEP were assumed for all farms and systems. Yield figures

for maize, sorghum and groundnuts were on the intercrop basis, both for RIDEP and sample farms. Yields for the sample survey farms were obtained by dividing the total produce for a particular crop by the area under each crop for each farm, and an average for the sample by crop was obtained for all farms and by system. RIDEP figures were obtained from KILIMO Regional Office. Since most parts of the Region, except one District Kahama, are dominated by mbuga soils and the yields for sample farms and RIDEP do not differ greatly, it is likely that the 1977/78 crop year was a normal year and thus either of the yields could be used for further analysis in this study. But yields for RIDEP have been used.

Table 3.3. Sample farms: Average production and yield per ha by major crops for all farms and by system, 1966/67 - 1976/77 average and 1977/78

Crop	Sample farms for 1977/78						RIDEP, 1966/67-1976/77 average
	Production			Yield per ha			
	All farms	With live-stock	No live-stock	All farms	With live-stock	No live-stock	
	1,000 kg						
Cash crops:							
Cotton	0.90	1.28	0.47	0.43	0.53	0.36	0.51
Paddy	.17	.27	.01	1.13	1.33	1.00	.95
Food crops:							
Maize/groundnuts intercrop:							
Maize	.76	1.03	.55	.47	.45	.50	.52
Groundnuts 1/	.08	.11	.06	.20	.19	.22	.32
Sorghum/groundnuts intercrop:							
Sorghum	.30	.63	.29	.53	.48	.58	.61
Groundnuts 1/	.02	.04	.01	.15	.20	.12	.32
Cassava 2/	.61	.69	.58	(1.38)	(1.38)	(1.38)	1.38

Source: Survey data and RIDEP (1975), table B.1.3.4(a), page 14. 1976/77 yields for RIDEP were obtained from the KILIMO Regional Office, Shinyanga.

1/ Decorticated.

2/ Dry weight basis. Sample farm yields assumed to equal those for RIDEP.

3.2 Family Income

The first Tanzania Five-Year Plan (Tanzania, United Republic of, 1964) emphasized raising the per capita income of Tanzanians from Sh. 386 to 900 per annum. In addition, it aimed at self-sufficiency in trained man-power requirements by 1980 and raising the expectation of life to 50 years for every individual. The Second-Five Year Plan (Tanzania, United Republic of, 1969), on the other hand, aimed at equal distribution of incomes so that each individual had an adequate and balanced diet, sufficient, good and if possible attractive clothing, and decent housing plus education facilities by 1980. The extent to which these goals have been achieved is questionable. It is clear that enough and good clothing and housing are difficult to achieve unless peasant farmers have enough disposable income, although this also depends on the farmer's priorities and norms.

In Shinyanga Region, family incomes are mainly obtained from crop sales, particularly cotton and small amounts from paddy and livestock. Since there is no reservation demand for cotton among producers, all that is harvested tends to be sold at official producer prices. Food crops however are sold lucratively in local markets. Paddy for example was sold at 160 cents per kg in 1977/78 instead of the official price of 120 cents. Maize and sorghum went as high as 200 and 167 cents per kg respectively at the same time, although sorghum was officially purchased at 100 cents and 85 cents for maize (Table 3.4).

Table 3.4. Tanzania: Official producer prices for specified crops per kg, 1970/71 to 1979/80

Year	Cassava	Maize	Sorghum	Paddy	Groundnuts
			Cents		
1970/71	N.A.	24	N.A.	50	93
1971/72	N.A.	26	30	55	95
1972/73	25	33	35	56	100
1973/74	31	50	55	57	115
1974/75	36	75	55	65	150
1975/76	40	80	75	100	200
1976/77	50	85	90	100	250
1977/78	60	85	100	120	400
1978/79	65	85	100	150	400
1979/80 1/	65	100	100	175	420

Source: Ministry of Agriculture (1973b), tables 36, 39, 43(c), 46, 48, pages 25, 27, 30, 32 and 33 respectively.
1/ Source: Daily News, 6th October, 1979.

In 1975 the per capita income for Shinyanga Region was estimated to be Sh. 364 (RIDEP, 1975), and in this study it averaged Sh. 171 for smaller farmers without livestock and Sh. 712 for larger farmers with livestock respectively (Table 3.5). Smaller farmers without livestock obtained their incomes from crop sales only and, since they did not produce more than enough food for subsistence, it is likely that their cash income came entirely from cotton and paddy. Larger farmers on the other hand produced more food than they required. It is thus likely that the surplus food harvests were either sold for cash or exchanged for livestock.

The Livestock Development Authority assessed a 2 percent off-take for the Region for 1978 (Shinyanga Livestock Regional Office, 1978). Thus, assuming that each family owning livestock of the order of 23 L.U. sold 2 percent of this at a weighted farm-gate price of

Table 3.5. Sample farms: Family and per capita income by type of farming system, 1978

Source	With cows		Without cows	
	Per family	Per capita	Per family	Per capita
	Sh			
Cash crops:				
Cotton	2,565	360	942	142
Paddy	576	81	192	29
Food crops 1/:				
Maize	119	17	0	0
Sorghum	630	88	0	0
Cassava	276	39	0	0
Groundnuts	440	62	0	0
Livestock	463	65	0	0
Total	5,069	712	1,134	171

Source: Survey data.
1/ Surplus after meeting subsistence requirements.

Sh. 994 per L.U., family income from livestock was Sh. 463.[3.3/] Milk was assumed to be consumed at home.

Crop production figures for each type of farming system (see section 3.7) were multiplied by the respective official producer prices for each crop from table 3.4 to obtain the family income. In order to obtain the per capita income by system, family incomes were divided by the respective family sizes (see section 3.7). Nearly half of the family income for farms with livestock came from cotton, while 83 percent of that for smaller farms without livestock came from cotton. Overall, per capita income for small farmers was low. Livestock on livestock farms contributed about 9 percent of the total income from farming.

3.3/ In determining the farm-gate price per L.U., the price of a mature cow was taken from the Tanzania Livestock Marketing Company, Shinyanga Branch, and it was assumed that other animals (young stock, sheep and goats) would be comparable on an L.U. basis.

3.3. Use of Recommended Practices for Production of Cotton

In order to get good cotton harvests, Ukiriguru Agricultural Research Institute recommends 10 husbandry practices including (1) Early land preparation, (2) Planting between mid-November and mid-December, (3) Planting five seeds per hole, (4) Planting at correct spacing, (5) Thinning, (6) Weeding at least three times, (7) Using fertilisers, (8) Spraying, (9) Early picking and grading of seed cotton, and (10) Uprooting and burning of cotton residues. The extent to which various practices were followed by sample farmers is shown in table 3.6, and discussed individually in this section. Three of these practices (see table 3.6, footnote 1/) were not covered in the survey as the author was of the opinion that certain practices are preceded by others. For example planting between mid-November and mid-December is preceded by early land preparation, and thinning is preceded by planting five or more seeds per hole. Farmers are always supplied free of charge with improved planting seeds which are dusted with "perlcot", or more recently "bronopol", cuprous formulations to prevent a notorious disease, Bacterial blight, Xanthomonas malvacearum.

3.3.1 Land preparation

Land preparation, including tie-ridging, consists of removing the cover of weeds and placing them in the old furrow, whilst splitting the old ridge to bury the weeds and make a new ridge. Land preparation in this way is slow and requires large amounts of labour (Figure 3.1). The aims of land preparation are to (1) get the land in a good state to receive the cotton seed, (2) allow it to germinate

Table 3.6. Sample farms: Farmers following specified practices on cotton[1/]

Recommended practice	Farmers reporting
	Percent
Planting between mid-November and mid-December	54
Correct spacing:	
In rows	16
In ridges	0
Thinning	24
Weeding three or more times	42
Use of fertilizers:	
Inorganic	4
Organic	8
Spraying:	
Once	16
Twice	14
Thrice	14
Four or more times	8
Uprooting and burning of cotton residues	40

Source: Survey data.

1/ The following are recommended but were not covered in the survey:
(a) Early land preparation.
(b) Planting five or more seeds per hole.
(c) Early picking and grading of seed cotton.

and grow vigorously with the least interferences from weeds, (3) guard the soil against loss through erosion, and (4) conserve soil moisture (Spence, 1968). Correct timing of land preparation is of paramount importance in good cotton production as delay in sowing can result in large losses in cotton yield. It is important that land be ready for sowing towards the end of November so that sowing may be completed before the end of December. Ridges made on a contour and cross-tied have been found to increase yields by 170 kg per ha which at 1977/78 prices was worth Sh. 408. This finding was supported by Collinson (1972) that additional labour needed for ridging and making tie-ridges may give a higher return than extending the hectarage of other

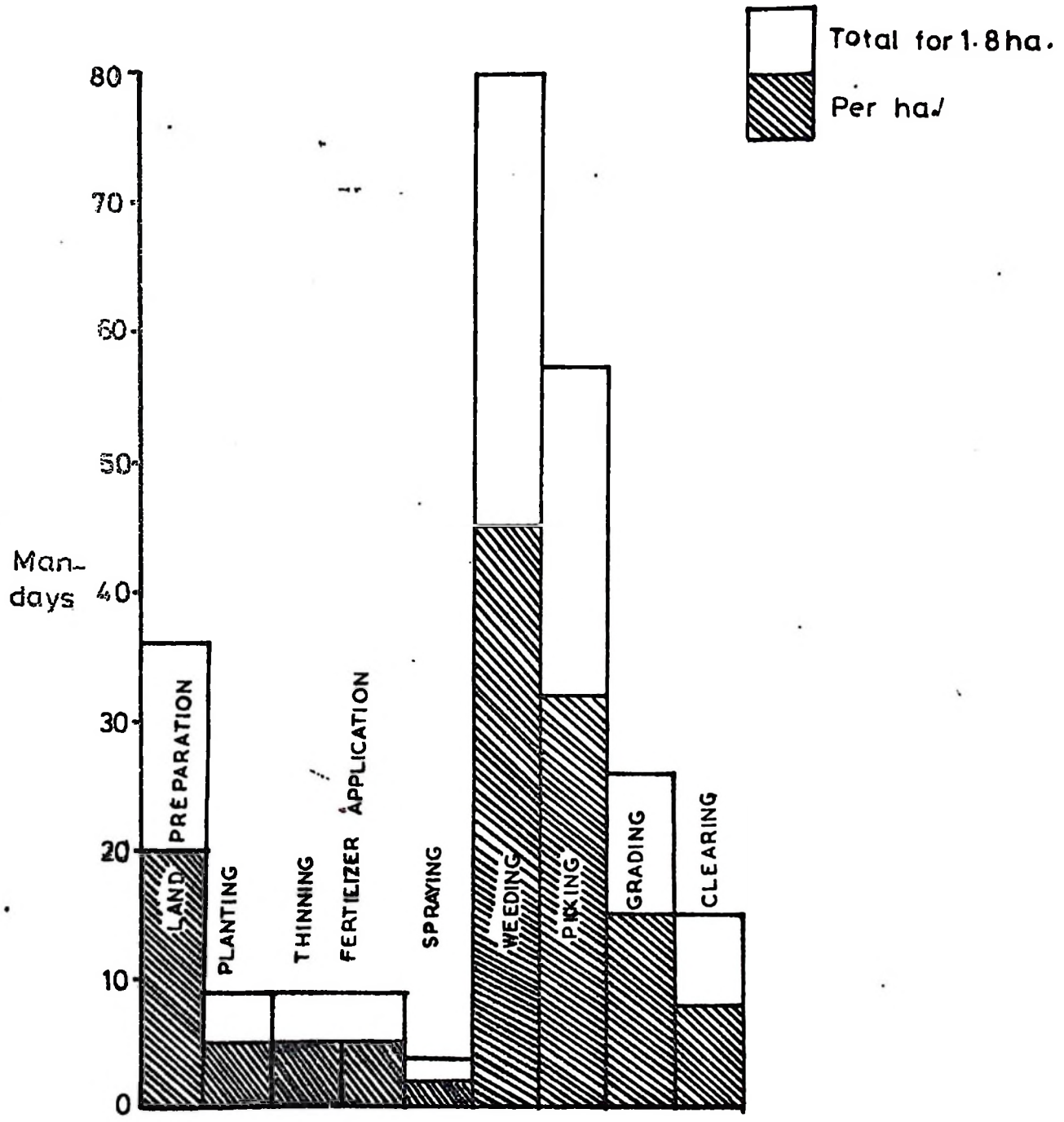
crops and that flat cultivation demanded twice the labour for weeding as did cotton grown on ridges. According to Spence (1967) tie-ridging provides improved weed control for young cotton. Flat cultivation is discouraged even in mbuga soils, and cambered beds have been found to be successful at Ukiriguru in overcoming the effects of waterlogging (Reed, 1968). Cambered beds however require heavy mechanical equipment and careful land planning. Thus they are most unlikely to find general application by peasant farmers.

All farmers surveyed grew cotton on flat land, and only 16 percent planted in rows. Farmers may be aware of the advantages of making tie-ridges but value their time spent on subsistence crops more highly than the extra return from cotton. Therefore, while timely land preparation and ridging is necessary to allow early sowing and consequently increased yields of cotton, farmers put higher priority on production of food crops especially maize which is planted at this time. Percy (1975) identified increased reliance on maize as the major factor accounting for late planting of cotton, since maize must be planted early to ensure a quick food supply for the family. This will continue to be a problem in the area until farmers have good food reserves or at least are assured of an adequate food supply between planting and harvesting of the new food crops.

3.3.2 Planting between mid-November and mid-December

The planting date for cotton in the Region is between mid-November and mid-December based on research at Ukiriguru by Peat and Brown (1960), who singled timely-planting as being probably the most important factor in increasing yields. Early planting forms the base for

Fig.3-1·Sample farms: Labour allocated to specified cotton production operations per ha and total for 1·8 ha



Source: Survey data.

many other practices in the recommended package. Delay in sowing after December results in loss in yield through patchy growth and delayed germination. Spence (1969) quotes a reduction in yield of 16 percent when sowing is delayed 3 weeks, and 46 percent with a delay of 6 weeks. Late-planted cotton does not give adequate returns for fertilizers and insecticides expended upon them. Planting before the recommended date results in cotton opening during the long rains, sometimes in April, and it has to be planted early enough for it to develop a root system capable of carrying it through the expected dry spell of January and February. Returns from fertilizers and insecticides from late-planted cotton are far less than from early-planted cotton (Le Mare, 1969), although late-planted cotton demands significantly less labour per weeding (Hulls, 1971). Over half of the surveyed farmers planted cotton at recommended dates. This agrees with findings by Keregero et al (1977) that three-fourths of the cotton farmers in Mara saw the clear benefit of timely planting. Although cotton planting does not require as much labour as land preparation, weeding or harvesting (Figure 3.1), it is because of the labour bottlenecks experienced during the mid-November through December period (Figure 3.2) and priority placed on subsistence crops that account for most late-planted cotton in the Region. Some farmers were of the opinion that planting cotton at the recommended time resulted into cotton opening during the long rains, which might be true in some years as the planting date was based on a blanket recommendation at Ukiriguru, about 100 km from the area of study. Hulls (1971) also found that late-planted cotton is closely connected with labour

shortages during planting time and probably of more importance is the farmers' preference to plant food crops first.

3.3.3 Planting five or more seeds per hole

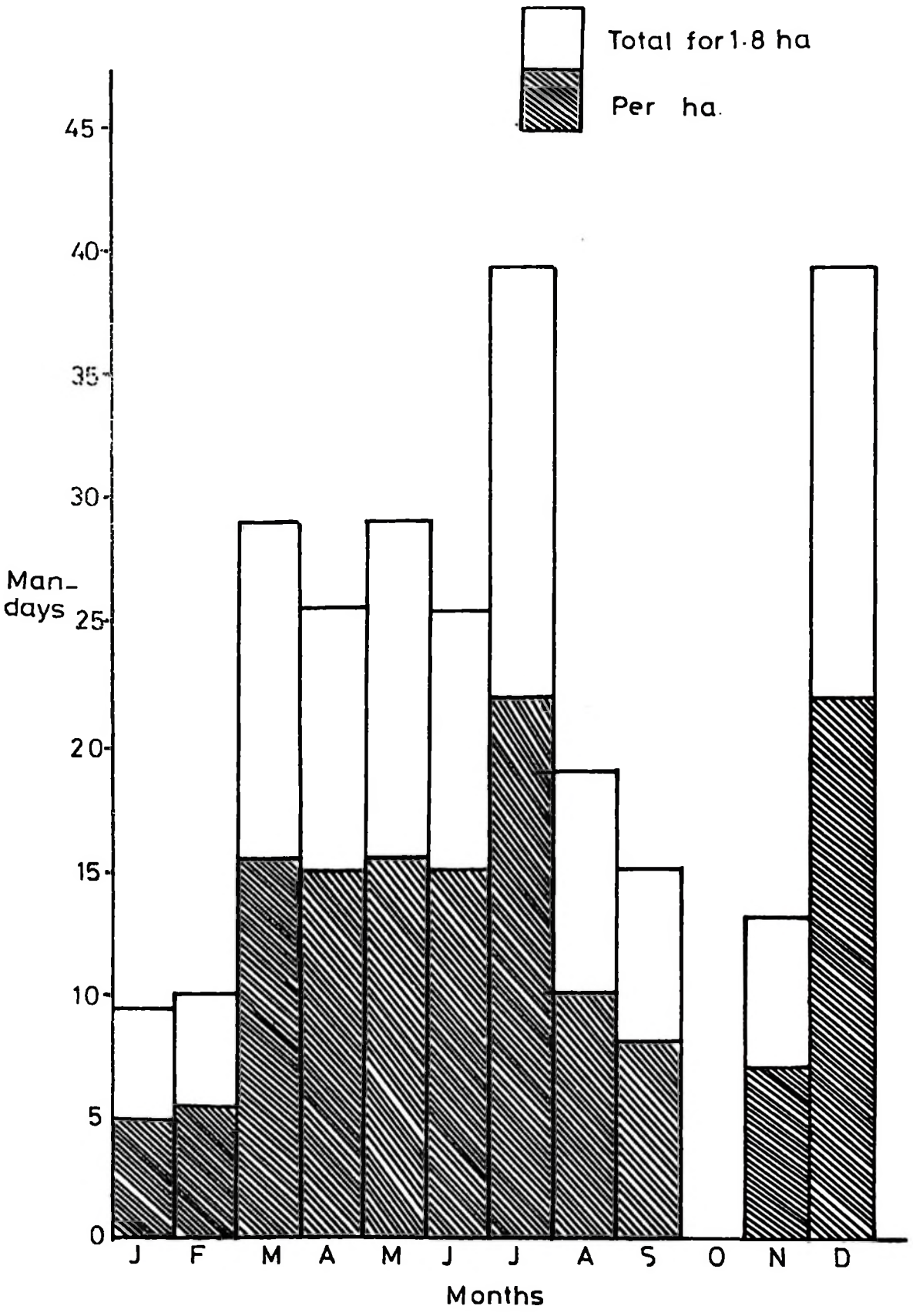
This recommendation is also based on research at Ukiriguru (Spence and Smithson, 1968) for several reasons: (1) sown seed seldom germinates 100 percent, (2) soils in most parts of the West zone form a crust after rain and a growing force of several seedlings is needed to penetrate the crust, and (3) seedling mortality from pests and diseases is highest in the first 2-3 weeks of growth. The implications of this practice are discussed under sub-section 3.3.5.

3.3.4 Planting at correct spacing

Two different spacings are recommended (Spence, 1967) to give an optimal plant population of 57,400 stands per ha, that is on ridges 1.5 m wide with two rows on top, 0.45 m between rows and 0.38 m within stands, and ridges 0.90 m wide with one row on top, 0.45 m between ridges and 0.38 m within stands. These spacings are criticised by farmers as being too close and even some extension staff do not know them.3.4/ This consistent difference between the findings of research and the experience of farmers may be due to the superior appearance of plants at wider spacings. Only 16 percent of the farmers surveyed planted cotton at recommended spacings. This compares with findings by Keregero et al (1977) that less than half of the cotton farmers surveyed in Mara Region planted at recommended spacings. Hulls (1971) reported similar results, with almost half the farmers planting at half the recommended stands.

3.4/ Author's personal experience.

Fig.3-2. Sample farms: Labour allocated to cotton operations by months when planted during mid-November to mid-December



Source: Survey data.

Several factors seem responsible. Many farmers estimate spacings rather than using measuring sticks or ropes with specified nodes to save labour and usually obtain sub-optimal stands. Keregero et al (1977) argued that the major factor seems to be the interaction between the use of fertilizers and insecticides and plant density. Farmers are given seeds depending on the size of the plot to be planted and are forced to buy on credit enough fertilizers and insecticides for their intended cotton area. In order to avoid large debts for inputs, farmers order less seed than required for the recommended stands on the total area, implying dispersion of seeds during planting. Such behaviour is likely to reduce the area planted with cotton. In Shinyanga Region, however, farmers take any amount of seed depending on what they can carry. By the time they are ready to plant cotton they are already too late and in trying to catch up with the planting date, since not growing enough cotton is illegal,[3.5] they are likely to rush the operation by broadcasting the seed as reflected by a large number of farmers (84 percent) not following the recommendation.

3.3.5 Thinning

Thinning is required under the recommendations since more seeds per hole are sown than required as plants. Once the extra seedlings have accomplished their purpose, they are nothing more than weeds competing with the crop for water, light and nutrients. Therefore they have to be removed with weeds as soon as possible, thinning

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[3.5] It is a must in the Region that every family grow a minimum of 0.8 ha (2 acres) of cotton each season.

cotton to two plants per stand when it is three weeks old, leaving the healthiest and most vigorous seedlings. Only a fourth of the farmers surveyed thinned their cotton. Among these, 8 farmers planted cotton at correct spacings and the remaining likely thinned plants which were broadcast very close to each other. As most farmers do not plant under correct spacing, it is likely that they do not see the benefits of thinning, although the operation requires only five man-days per ha.

3.3.6 Weeding

Cotton is slow growing at first and can therefore easily be overtaken by weeds. At the harvest stage, weed growth can make picking difficult and can contaminate the seed cotton with weed seeds, thus making grading difficult. The recommended practice is to suppress weeds as soon as they appear and several weedings are usually necessary, the first preferably coinciding with thinning. This is the most labour-intensive practice in cotton growing (Figure 3.1), with one weeding requiring 10-15 man-days per ha depending on intensity of weed growth, but experimental results indicate a high return. Weeding is usually spread over January to March and sometimes April or May for late-planted cotton. Two-fifths of the farmers surveyed weeded their cotton three times or more. In Mara Region Keregero et al (1977) found that over 90 percent of the farmers weeded their cotton at least three times. Farmers are quite aware of the benefits of keeping weeds under control but are faced with the problem of organizing their family labour between crops and within crops. Ridging has been found to reduce weeds (Acland, 1973) through

burying all plant material thoroughly, however it is not practiced extensively by farmers because of labour constraints. Farmers spread the risks of total crop failure through weeding at least twice for all crops, and hence fail to reap the benefits of, say, three or more weedings for cotton. Possibilities for better organization of these tasks are analysed in Chapter IV. Where possible, farmers could be advised to use ox-drawn equipment in weeding to save labour and increase the frequency of weeding. For example once the farmers grasp the advantage of sowing crops in rows, which permits inter-row weeding with animal-drawn equipment, they could manage larger hectarages and still keep weeds under control.

3.3.7 Using fertilizers and manures

Fertilizers are not a substitute for good husbandry but can increase yields on some soils, particularly when combined with other recommended practices (Keregero et al, 1977). Blanket recommendations on spacing and fertilizer use based on results at Ukiriguru have led to exaggerated estimates of potential cotton yields such as 1,100 kg per ha of seed cotton for Shinyanga Region, whereas data from various surveys since 1962 to date indicate that farmers' yields generally average 400 to 500 kg per ha (Percy, 1975 and this survey). It is recommended that farmers use 125 kg per ha of phosphate fertilizers at planting and 125 kg per ha of nitrogen fertilizers when cotton is 6 weeks old, that is after thinning and the first weeding. Manures should be applied at the rate of 5 tons per ha after 3 years. Only 4 percent of the farmers surveyed used manures and 8 percent used chemical types (table 3.6). The relevance of fertilizer recommendations

has been affected by the ever-widening gap between the well-managed soils at research stations and those of the surrounding farms. They fail to take into account the considerable variance in soil types, fertility, and residual effects of continuous fertilizer use. Some farmers reported that fertilizers burnt their cotton and some argued that they increased weeds. In fact fertilizers are not profitable without early planting, proper spacing, careful weeding, and adequate spraying (Le Mare, 1974). Farmers have failed to grasp the benefits of using fertilizers because of rushed land preparation and planting, improper weed control, and inadequate spraying as reflected by the low yields experienced. Farmers however know the value of manure in restoring and maintaining soil fertility but are put off by the drudgery of carrying it to their fields on heads by use of tins or baskets in required quantities. The corresponding remedy to this problem would be for research institutions to test findings under actual farming conditions, which differ markedly from the controlled conditions at research stations, through village trials.

3.3.8 Spraying

Research has led to the recommendation that insecticides should be used only on good cotton, and four spray regimes should be a minimum to have economic returns. Fertilizer use should be accompanied with insecticides because only if insect damage to the crop is prevented can fertilizers have their greatest effects (Le Mare, 1968). This argument is supported by experimental results by Percy (1974) which indicate a return of Sh 550 of cotton per ha per Sh 100 invested, excluding labour costs. Profitability of spraying also depends on

early planting, optimal spacing, and proper weed control. However, returns under farmer's conditions are likely to be less due to several factors. Percy (1975) argues that spraying less than 4 times is equivalent to a waste of insecticides and insects are likely to develop resistance to insecticides and complicate the practice. Of the farmers surveyed, 16 percent sprayed once, 14 percent sprayed twice, another 14 percent sprayed three times, and 8 percent sprayed four or more times. Thus, although more than half the farmers sprayed cotton, only 8 percent were likely to benefit from the practice, although insecticides are heavily subsidised by ICA at 74 percent and the operation requires only a small amount of labour (Figure 3.1). Keregero et al (1977) noted that whereas farmers can be forced to buy inputs with relative ease, assuring their "proper" use is more difficult. Insect damage is a serious problem in the area since, despite reducing total yield, it is also responsible for staining the cotton and increasing the proportion of grade BR seed cotton. It should be stressed therefore that economically worthwhile responses are only obtained when insecticides are applied to a crop which has been sown at the correct time, correct spacing, properly thinned, and weeded.

3.3.9 Harvesting and grading

Cotton harvesting or picking is done by hand and is a labour-consuming task (Figure 3.1). It has to be done as quickly as possible at weekly intervals to prevent discolouration of lint in the field. The greater part of the harvest from a properly - sown crop will be picked in May when rains are not a problem but, as seen in Figure 3.2, a lot of picking takes place in mid-June and July because most of the

cotton is late-sown. Since early picking is essential in assuring quality and since there is usually a price increase of 5 percent per kg for cotton sold within two weeks of the start of the marketing season, farmers are likely to follow this practice voluntarily. Since most farmers planted their cotton late and no extra labour was hired to relieve the inevitable bottlenecks at that time, it follows that most farmers harvested and sold their cotton late.

3.3.10 Uprooting and burning of cotton residues

Uprooting and burning of cotton plant remains after harvesting is enforced by law to control the carry-over of insect pests from one season to the next. At least three of the major cotton pests, that is spiny bollworm, pink bollworm, and stainers, are greatly reduced if this practice is adopted (Reed, 1968). Mid-September is the date by which farmers should have finished uprooting and burning of cotton residues and it is the latest date which allows a reasonable "close season" between the old crop and a new crop expected to be planted in December. While the operation requires relatively little labour (Figure 3.1) at a time when it is readily available, many farmers fail to see any direct benefits. Two-fifths of the farmers surveyed observed the uprooting and burning of cotton residues. The majority who did not did so at the risk of the next season's crop. This problem was serious in the 1973/74 crop year when farmers were moved into new villages and had to leave their old fields uncleaned. This practice must be the first concern of Party and Government officials because it is when all farmers comply that most benefits can be obtained.

3.4. Other Factors that Affect Cotton Production

Other factors which have influenced area and production of cotton in the Region include (1) competition from subsistence crops, (2) farmer's age, education, wealth and extension services, and (3) farming hazards. These are discussed individually in this section.

3.4.1 Competition from subsistence crops

Traditionally farmers in the Region used sorghum and millets for food but in the 1960's maize and cassava replaced the former in importance (Table 3.1). When maize was first grown in the Region, it was sown in February following sorghum and millets (planted in November-December) and cotton (planted in December-January). However the optimal sowing period for maize was found to be mid-December, bringing it into direct competition with cotton for the most limiting resource, labour. Under good growing conditions, sorghum and millet yields are higher than those of maize, with similar labour requirements. Thus, although maize is still preferred for food and sorghum for brewing, the increased planting of maize has indirectly and directly increased the probability of crop failures and thus of food shortages. This condition has led farmers to operate at a subsistence level, as there is little capital to invest in increased cotton production or incentives to do so when most of their effort must be devoted to food production.

Due to extreme food shortages in the 1973/74 crop year, the Government and Party undertook initiatives to encourage farmers to

plant sufficient food crops following the policy of "Milimo chi kufa no kupona", meaning that "Agriculture is a matter of life and death". This policy unfortunately neglected the contemporary importance of cotton and, followed by sharp rises in prices of food crops, farmers concentrated on subsistence crop production.

3.4.2 Farmer's age, education, wealth, and extension services

Age, education, wealth and extension services were believed to have indirect effects on cotton production because they reflect the farmer's ability to follow various recommended practices. Their influence on the number of practices adopted was tested statistically, first by Chi-square and then by correlation analysis.[3.6] A Chi-square test showed that there was no statistically significant relation between farmer's age, education, wealth and extension contact, and adoption of the recommended practices. Correlation analysis gave similar results as shown below:[3.7]

Y = 2.7 + 0.0007 AGE	r = 0.004
Y = 2.4 + 0.1625 EDUCATION	r = 0.21
Y = 2.8 - 0.5222 WEALTH	r = -0.07
Y = 2.5 + 0.4412 EXTENSION	r = 0.10

where Y is the number of recommended practices adopted. AGE and EDUCATION are in years. WEALTH was measured using a score made up of items such as (a) radio, (b) bicycle, (c) ox-plough, (d) galvanised

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3.6/ After examining scatter diagrams, with number of adoptions on the vertical scale, and verification that the relations were approximately linear, a correlation was run. For simplicity, all recommendations were given equal weighting, as it was difficult to decide which operations were most important. It would be desirable in future to give different weightings to different operations.

3.7/ r must be 0.27 or more to be statistically significant at P = 0.05.

steel roofing and (e) cement floor for houses. Farmers were considered wealthy if they possessed all the five items. EXTCOT is extension contact which was measured using a score made up of items such as (a) visit by extension agent twice per year, (b) listening to agricultural programmes on the radio, (c) attending agricultural meetings twice per year, and (d) having seen a demonstration farm on cotton growing. Farmers were considered to have the high score of extension contact if they had done all of these.

Lack of significant influence of these variables on adoption of recommended practices on cotton is likely due to the high priority placed on subsistence farming while ignoring the recommended cotton husbandry practices. It could also be due to lack of reliable husbandry packages which are attractive to farmers or there is insufficient work programming for contact agents and poor supervision as a result of limited mobility. Another likely reason is that research programmes have been limited to cotton although they would have been more meaningful if extended to subsistence crops simultaneously, that is to the whole farming system.[3.8/]

3.4.3 Farming hazards

Hazards of rainfall failure, pests and diseases, and most recently rats are among the most important factors which have aggravated the poor performance of cotton production since the 1972/73 crop

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3.8/ At a World Bank/Ministry of Agriculture conference in Arusha in March 1979 on ways to improve agricultural research in Tanzania, emphasis was placed on testing recommendations in villages as a part of the farming system and of setting-up a special unit in each Research Institute to do this.

year and which have led to both low incomes of farmers and farmers reverting to a mainly subsistence level.

Rainfall is a severe hazard in the Region. Cotton requires an evenly-distributed rainfall of about 75 mm per month for 6 months during its growth and establishment. The overall rainfall received in the Region was enough for cotton growing for the years 1971/72 and 1977/78 but the years in between were below minimum requirements (table 1.1). Low rainfall also was reflected in poor harvests of food crops, particularly maize, thus increasing the risks and uncertainties of cotton production at the expense of food crops because buying and selling of food became more difficult in local markets. Rats were a menace, particularly in the 1976/77 crop year and, although there is no actual data to assertain the extent of damage, it was estimated by Kilimo in the Region that rats were responsible for about one-third of the loss of the crop for that year through delayed replanting, and patchy growth and destroying the mature seed cotton by eating the seeds. The incidences of crop damage by pests and diseases could not be assessed but the damage was potentially felt. Damage was further reflected by the deterioration in cotton quality through increase in BR type of seed cotton over recent years.

3.5. Sources and Use of Working Capital

The major sources of capital for most farmers is from cash crop sales, particularly cotton. No farmer surveyed obtained credit to purchase capital equipment such as ox-ploughs or a tractor. Credit was used only for seasonal inputs of fertilizers and insecticides.

All farmers depended on family income to purchase capital goods. The major items of capital equipment found on farms included ox-ploughs and hand hoes. No farmer surveyed owned a tractor, and spray equipment such as pumps and bottles were kept at cotton-buying posts. A third of the surveyed farmers owned ox-ploughs, and one farmer among them owned two sets. These varied in value, depending on the year of purchase, from Sh 135 for those bought in 1967 to Sh 276 for those bought in 1976. These ploughs had no attachments such as ox-planters, ridgers or weeders, and no farmer owned ox-transport equipment. Livestock were considered as capital because some proceeds obtained from crop sales were invested in livestock mainly to expand the herd. Herds ranged in size from 1 to 106 animal units and at a farm-gate price of Sh 994 per L.U. for 1978 represented a capital investment of 1 to 105 thousand shillings respectively.

3.5.1 Net returns by type of cotton farming system

Table 3.7 shows cash costs and net returns for sample farms which used all inputs on cotton, those which used insecticides only, and those which did not use any inputs on a per farm and per ha basis. Fertilizers and insecticides were bought on credit from TCA. One bag of Triple Superphosphate cost Sh 77 and one bag of Sulphate of Ammonia cost Sh 55. Thiodan 35 percent (Endosulphan) cost Sh 6.90 per litre and farmers needed 2.5 litres per ha times 4 sprays. Farmers who used all inputs on cotton had the largest net cash returns per ha followed by those who used neither.

The number of farmers per type of method of land preparation is shown in table 3.8. Farmers who used tractors or ox-ploughs for land preparation were likely to plant early and thus benefit from the first rains. A larger proportion of these farmers used both fertilizer and insecticides and also insecticides only than did farmers who used hand hoes.

Table 3.7. Sample farms: Gross income, cash costs and net farm income for cotton classified by type of inputs used based on 1977/78 prices

Item	Unit	Total for farm			Per ha		
		Type of input used			Type of input used		
		Fertilizers and insecticides	Insecticides only	Neither	Fertilizers and insecticides	Insecticides only	Neither
Area in cotton	Ha	1.5	2.3	1.3	-	-	-
Cotton production	Kg	1,065	759	338	710	330	260
Gross value[1]	Sh	2,134	1,521	677	1,430	661	520
Cash costs:							
Land preparation	Sh	304	350	0	203	152	0
Fertilizers[2]	"	495	0	0	330	0	0
Insecticides[2]	"	105	161	0	70	70	0
Total	"	904	511	0	603	222	0
Net cash returns	"	1,230	1,010	677	827	439	520

Source: Survey data.

1/ Based on prices for AR and BR cotton for 1977/78 and 33 percent BR outturn.

2/ At heavily subsidized prices (50 and 74 percent for fertilizers and insecticides, respectively).

Assuming that the method of land preparation did not affect yields (although it is possible that this had some effect), benefit/cost ratios for other cash inputs were as follows:

Table 3.8. Sample farms: Relation between method of land preparation and use of cash inputs

Type of input used	Method of land preparation			Total
	Tractor	Ox-plough	Hand hoe	
	No. of farmers			
Fertilizers and insecticides	4	2	0	6
Insecticides only	2	15	9	26
Neither	1	2	15	18
Total	7	19	24	50

Source: Survey data.

Fertilizers and insecticides over ----------

Insecticides only $= \frac{(1430 - 661)}{(400 - 70)} = 2.3$

Nothing $= \frac{(1430 - 520)}{(400 - 0)} = 2.3$

Insecticides over nothing $= \frac{(661 - 520)}{(70 - 0)} = 2.0$

Singh, Uriyo and Foote (1978), based on compilations from other sources, suggest that farmers in developing countries like Tanzania need at least a 2.5:1 return to warrant the risk and costs of making such cash investments although many Tanzania planners consider a 2:1 return as fully adequate. Despite the large Government subsidies for fertilizers and insecticides, their use is not quite economically viable if the 2.5:1 ratio is accepted as a criterion. Although more than half of the farmers claimed to have used insecticides on cotton (table 3.6), they failed to benefit enough from the practice to warrant the added cost and risk of investment because the majority of them sprayed once or twice only which is tantamount to a waste of insecticides. Use of fertilizers was likely to be not fully economic because the area surveyed is dominated by fertile mbuga soils.

3.5.2 Credit facilities

No farmer had difficulty in obtaining short-term credits for seasonal inputs for cotton but they seemed to be ignorant of facilities for acquiring seasonal inputs for other crops and for other types of credits.

The crop financing is presently the prerogative of the various crop authorities such as TCA in Shinyanga Region, although the responsibility for providing agricultural credit lies with TRDB. TRDB was established in 1971 as a successor of the National Development Credit Agency. TRDB's lending operations include credit for seasonal inputs, agricultural equipment, rural transport, storage facilities, fisheries and livestock development. Co-operative Societies and Unions represented TRDB's most important borrowings until 1974 when villages and District Development Corporations (DDC's) assumed ever-increasing importance. About 70 percent of the lending has been for seasonal inputs to support coffee, tea, cotton, and tobacco development. TRDB's lending terms include interest rates of 8.5 percent for short-term, 8 percent for medium-term, and 7.5 percent for long-term credits/loans per annum. Regional loan committees are empowered to sanction uncollateralized loans up to Sh 50,000, and collateralized loans up to Sh 200,000, above which the central office must issue its approval.

Short-term loans for seasonal inputs are for repayment within 12 months from the date of disbursement. Midium-term loans are repayable over a period of 5 years and are mainly for farm implements and machinery, including ox-ploughs and carts, trucks and poultry farms.

Long-term loans with a maturity up to 15 years cover more basic improvements such as produce godowns, buildings, and ranches.[3.9/] As a matter of policy, TRDB does not finance more than 75 percent of total loanable cost. Eligible borrowers are mainly the registered villages and the DDC's. It is the responsibility of TRDB upon receiving the village application for credit to assess the technical, economic and financial feasibility of the proposed use of inputs. Applications for financing a fertilizer package with a cost/benefit ratio of less than 1.33 in economic terms would be rejected. Now that each village has a technical "Manager", he should educate farmers of the existence of these credits and their terms and help them to apply for credits. A logical line of credit would include medium-term loans in respect of farm equipment, particularly ox-ploughs, and farm transport equipment such as ox-carts and wheel-barrows. These would be used for a variety of purposes on the farm such as carrying inputs to and crops from the fields. For example farmers know the value of manures in restoring soil fertility but they are put off by the drudgery of carrying it to their fields by use of say "debes" on the head in required quantities of 5 tons per ha every three years. On the other hand, TCA should advise TRDB on what types of credits it should extend to farmers whilst the former continues to offer short-term credits for all crops.

3.9/ Personal communication with TRDB Regional Representative.

3.6. Subsistence Requirements

This section describes the important food items commonly grown and used by the people in the area of study and the Region, their merits and de-merits. It also involves the determination of quantities of foods needed to meet daily nutrition requirements for an active male-equivalent, which forms the basis for determination of family food requirements based on average family sizes by system. Other food items which are not shown may also be used for food and require land and labour but to simplify the analysis, all nutrient requirements are assumed to be obtained from the foods shown.

3.6.1 Food items and their suitability

Cereals include maize as the main staple and sorghum as the second staple, roots include mainly cassava and to a minor extent sweet potatoes, and legumes include mainly groundnuts. Millets are also grown.

Maize - The popularity of maize is due to the fact that it gives more palatable meals, and it is resistant to bird damage. The maize grown contains quantities of protein similar to other cereals, much of which is in the form of lysine and tryptophan. All farmers surveyed grew maize for food, 92 percent used local varieties for seed and only 8 percent used Katumani as an improved maize variety. Local maize varieties are collectively called "mholoshi" which flower in about 73 days. They stay in the field for about 135 days, including a drying-off period. The improved Katumani variety flowers in about 65 days and stays in the field for about 120 days. Maize is usually

planted with the first rains in order to ensure early food supply for the family. Katumani is early maturing and gives good yields where the long rains seldom last for longer than two months, and therefore is more ideal for the area than the local varieties.

Sorghum - Sorghum requires less moisture than maize and some varieties are a good food with higher protein content than most cereals. Local varieties are collectively called "ukura". These are very tall, late maturing, and red and unpalatable. Improved varieties include the short types, mainly Serena (brown) and Lulu (white). These are quick maturing and more palatable than the local sorghums but are more susceptible to bird and insect damage. However Serena is becoming more popular in the Region. Of the surveyed farmers, 44 percent used Serena for seed. If grown by all farmers, it could ensure a quicker supply of food for the family than maize.

Cassava/sweet potatoes - These form an important part of the diet of many people in the area. These foods are easily cultivated, give the highest output of calories per ha, and require relatively little labour. They are however inferior to any cereal because they contain little protein and few minerals and vitamins. Thus they cannot be allowed to replace basic cereals. They should be planted in addition to, rather than instead of, the cereals as the reserve supply of food.

Groundnuts - All families grew groundnuts and used local varieties of either "manyema" or "mwarabu". Groundnuts are grown in mixture with either maize or sorghum. Groundnuts, like other legumes, have the advantage of being able to take nitrogen from the air and fix

it in the soil. All farmers indicated that groundnuts and maize or sorghum grow well together. These intercrops are planted with the first rains so that they can mature and ripen during the short dry spell of February. Groundnuts are important nutritionally, containing large quantities of fat, protein and Vitamin B. They supplement well the predominantly carbohydrate diet of cereals or roots eaten by many families, especially when animal protein is not readily available. When groundnuts and cereals are taken together at one meal, they supply protein containing fairly good quantities of all amino acids, and hence a high quality meal similar to casscin, the protein from milk. Thus groundnuts should be maintained in the diet.

Millets - These are also commonly grown in the eastern part of the Region. They survive drought conditions better than maize and other cereals, and so are commonly grown with advantage where rainfall is low or unpredictable. Millets form valuable foods because they are more palatable than sorghum and contain a higher percent of protein than maize, and they are rich in iron and calcium. Many millets however have the disadvantage of being subject to attack by small birds and also of having a tendency to dehisce their seeds into the ground. The most common variety of millet grown in the Region is Bulrush (uwele, Pennisetum typhoidum).

Milk - Many families with cows drink the milk sour rather than fresh. Although the souring process does not affect the nutritive value, it often substantially reduces the number of pathogenic organisms present. Thus it is safer to drink sour milk than fresh in peasant households because under peasant conditions milking is not

hygienically performed and containers into which milk goes are likely to be contaminated.

Overall - The described food items together with green leaves form the popular food combinations for many families in the Region. A family who has included good quantities of groundnuts and/or milk with the cereals or root staples should have satisfied their requirements for calories, protein and vitamins. Other protein, minerals, and vitamins are obtained from green leaves, mainly amaranthus spp (mchicha) and cassava leaves (kisanvu).

3.6.2 Quantities of foods needed to meet daily nutrition requirements for families with and without cows

The daily nutrition requirements for an active man based on standards for East Africa are 3,000 K - calories and 70 gm of protein (FAO, 1973). Table 3.9 shows a set of food items that meet full calories and protein requirements for an active man and average families with and without cows to supply milk. These relative quantities of foods were arrived at by knowing that 0.1 kg of each food item contains amounts of nutrients shown in table 3.10. In determining the amounts of cereals required, average value of nutrients for maize and sorghum was taken because farmers may use maize or sorghum "ugali" on the same day.

Milk yield for indigenous cows in Tanzania was estimated by FAO (1976) to be 352 kg per lactation. This figure however seems to be too large for dry areas such as Shinyanga Region, where cattle :

Table 3.9. Shinyanga Region: Foods that meet average daily consumption requirements of calories and protein by an active man-equivalent and average sample families with and without cows

Food items	Daily consumption by — Active man			Average family for each type of farm		
	Quantity	Nutrient		Quantity	Nutrient	
		Calories	Protein		Calories	Protein
	Kg	1000 K.-cal	Gm	Kg	1000 K.-cal	Gm
With cows:						
Milk[1]	0.44	0.62	31	2.62	3.60	189
Cereals[2]	.40	1.45	40	2.33	8.44	244
Cassava (flour)	.26	.88	4	1.51	5.12	24
Groundnuts	.01	.06	3	.06	.35	18
Total	-	3.01	78	-	17.51	475
Without cows:						
Cereals[2]	.59	2.05	59	3.24	11.07	333
Cassava (flour)	.20	.68	3	1.08	3.67	17
Groundnuts	.05	.29	13	.27	1.57	73
Total	-	3.02	75	-	16.31	423

Source: Survey data.
1/ Whole milk (yoghourt). Milk figures are based on assumed actual consumption.
2/ Maize, sorghum, or millets.

Table 3.10, East Africa: Nutrients per 0.1 kg of edible portion for foods commonly used by sample farmers

Food	Calories	Protein (Gm)
Maize (96-percent extraction)	362	10.0
Sorghum (whole grain)	335	10.4
Cassava (flour)	342	1.5
Groundnuts (dry)	580	27.0
Millets (whole grain)	362	11.0
Milk (whole)	140	7.0

Source: FAO (1973), table 2, pp. 249-259.

management is poor, there is not enough drinking water in yards and grazing areas, and there is no supplementary feeding of any kind. For these reasons a lower average milk yield of 0.8 kg per cow per day for

a lactation period of 7 months (or a total per lactation of 170 kg) was thought reasonable for the area of study. The latter figure is based on a study in Mara Region by Chikaka and Foote (1979), an area adjacent to Shinyanaga Region characterized by minimal rainfall and long dry seasons. Their system of cattle management is also similar. Thus, based on this milk yield, the family-consumption availability for milk was 1,000 kg per annum. This was obtained from 6 milking cows, on average, as reflected by the number of calves at the time of survey. 1000 kg per family per annum is equal to 175 kg per protein-consuming man-unit, or 0.48 kg per day. However farmers normally give some milk to pet animals like cats and dogs and to relatives without cows. Thus the daily per capita availability of milk was reduced to 0.44 kg per active man or 2.62 kg per family to allow for this.

In determining the food consumption requirements for families with cows and those without cows, respective average family sizes were determined first. Relative requirements for calories and protein for East African families by sex, age, and activity combinations were taken from FAO (1973).[3.10] Details are shown in table 3.11, using an active man as the basic unit. Nutrients required per family, as shown in table 3.9, were obtained by converting the family size figures to man-equivalents for calories and protein, as shown in tables 3.14 and 3.15, then multiplying by the 3,000 K - calories and 70 gm of protein required daily by an active man.

[3.10] The recommended intakes of nutrients given meet average human requirements based on current knowledge of deficiency states and allow for existing conditions in East Africa. These allowances in normal circumstances provide sufficient nutrients to prevent deficiency diseases and to allow growth and health maintenance of the body at optimum weight and activity.

Table 3.11. East Africa: Calories and protein requirements for specified groups in relation to those for an active man

Group	Calories	Protein (Gm)
	Ratio	
Children:		
Under 10 years	0.57	0.71
10-15 years:		
Girls	.94	.96
Boys	1.00	1.03
Adults:		
Active:		
Women	.86	.87
Men	1.00	1.00
Sedentary:		
Women	.72	.78
Men	.86	.87

Source: FAO, 1973.

In order to determine the source of nutrient requirements in table 3.9, it was assumed that farmers with cows would obtain much of their protein from milk and thus require fewer groundnuts. Families without cows require larger amounts of groundnuts. But for families with cows to have enough calories, they had to use more cassava while families without cows used more cereals.

3.7. Comparison of Actual Farming Systems With and Without Livestock

This section describes characteristics of the existing farming systems. The comparison is based on survey sample farms and identifies differences that exist between farms with livestock and those without livestock.

3.7.1 Crop acreage and yields

Farms which combined livestock and crop production had a total area of 6.8 ha per farm in crops as compared to 3.4 ha per farm for crops - only farms (table 3.12), but the former had somewhat larger families (tables 3.14 and 3.15). Distribution between cotton and other crops was about the same for the two farming systems. Three-fourths of the farmers owning livestock used ox-teams to prepare their land. This explains at least in part why they cultivated larger areas. Cotton for farms with livestock yielded better than that of farms with crops only. They likely benefited from the first rains through early land preparation by means of own ox-ploughs. Since farmers without livestock had smaller cash incomes (due to less land in cash crops and lower yields) and thus likely lacked money to purchase foods if needed, they apparently took better care of their subsistence crops, since yields of maize and sorghum were higher than on the farms with livestock. As shown in table 3.18, family labour availability was only 11 percent larger for livestock than for non-livestock farms. Thus most of the increased production on livestock farms is due to the use of oxen to replace hand labour, and possibly to harder work by the livestock farmers and their families (see section 3.8.2).

3.7.2 Non-cotton farming techniques

Details by system for crops other than cotton are shown in table 3.13 in percentages out of all farmers in each group. There were 21 farmers who kept livestock and grew crops, and 29 farmers who grew crops only.

Table 3.12. Sample farms: Area, production and yield per ha by major crops for families with and without livestock, 1977/78

Crop	With livestock			Without livestock		
	Area	Production	Yield per ha	Area	Production	Yield per ha
	Ha	1000 kg		Ha	1,000 kg	
Cash crops:						
Cotton	2.4	1.28	0.53	1.3	0.47	0.36
Paddy	.3	.48	1.60	.1	.16	1.60
Food crops:						
Maize	2.3	1.03	.45	1.1	.67	.59
Sorghum	1.3	.63	.48	.5	.29	.58
Groundnuts 1/	-	.15	.20	-	.07	.20
Cassava	.5	.68	(1.38) 2/	.4	.58	(1.38) 2/
Total	6.8	-	-	3.4	-	-

Source: Survey data.
1/ Intercropped with cereals.
2/ From MNDEP based on 1966/67 - 1976/77 average.

Table 3.13. Sample farms: Farming techniques used by farming systems for crops other than cotton

Technique used	Farmers	
	With livestock	Without livestock
	Percent	
Land preparation:		
Tractor	14	17
Ox-plough	76	4
Hand hoe	10	79
Planting:		
In rows	33	38
In ridges	0	7
Broadcasting	67	55
Intercropping	100	100
Rotation:		
One year	0	10
Two or more years	9	7
Use of improved seeds:		
Maize (Katumani)	9	7
Sorghum (Serena)	43	38
Paddy (Thaiwan 14)	0	0
Groundnuts (Mwitunde)	0	0
Use of insecticides	5	3

Source: Survey data.

Land preparation starts with the first rains and is the only farm operation which is mechanized. Fallowing of fields is done incidentally by all farmers whereas rotation seems to be of little importance. A seventh of the total farmers surveyed reported carrying out a 1 or 2 year rotation. The general tendency however was to use a rotation in which land under sweet potatoes or cassava is put back to cotton after two or more years. A seventh (14 percent) of the livestock owners hired tractors from TCA at a weighted cost of Sh 20/- per ha whereas 17 percent of the non-stock owners hired tractor services at the same terms. The majority of livestock-owners used ox-ploughs. Those using hand-hoes kept goats and sheep rather than cattle. Most non-stock owners used hand hoes for land preparation and the remaining hired ox-plough services at a cost of Sh 152 per ha. Livestock-owning farmers mainly were able to mechanize the land-preparation operation because of possessing ox-ploughs and this explains why they managed to prepare larger areas of land. Other operations are about the same on both types of farms and have been discussed in prior sections.

3.7.3 Food availability relative to needs

Family food needs vary according to age, sex, body weight, activity and climate as noted previously. Thus in planning to feed the family, these differences have to be considered. All family members eating at home were identified by age, sex, and activity combinations. For each type of farm, the average family members by age groups were obtained by taking the total for each group for the sample and dividing this number by the farmers in that type in the

sample, thus giving an average for a typical family. Based on the requirements of nutrients as shown in table 3.11, the food consumption equivalents in tables 3.14 and 3.15 were obtained. Families with livestock had somewhat larger families and thus required more food per family.

Table 3.14. Sample farms with livestock: Average family size by active male-consumption units

Group	Average 1/	Active male-consumption units of 2/	
		Calories	Protein
		No.	
Children:			
Under 10 years:			
Girls	0.95	0.54	0.67
Boys	.90	.51	.64
10-15 years:			
Girls	.48	.45	.46
Boys	1.19	1.19	1.19
Adults:			
Active:			
Women	1.33	1.14	1.16
Men	1.00	1.00	.93
Sedentary:			
Women	.80	.58	.62
Men	.48	.41	.42
Total	7.13	5.82	6.09

1/ Source: Survey data.
2/ Source: Figures in column 1 times respective columns in table 3.11.

The relative amounts of food needs for an active man (table 3.9) were compared with production for each system from table 3.12, converted to available nutrients (calories and protein only) and then put on a per-active-man basis in table 3.16 to see how each compares with total needs. Table 3.16 shows that families with livestock produce about twice the food nutrients actually required while smaller families without livestock produce moderately less food nutrients than

Table 3.15. Sample farms without livestock: Average family size by active male-consumption units

Group	Average[1]	Active male-consumption units of [2]	
		Calories	Protein
		No.	
Children:			
Under 10 years:			
Girls	0.79	0.45	0.56
Boys	.86	.49	.61
10-15 years:			
Girls	.90	.85	.86
Boys	.62	.62	.62
Adults:			
Active:			
Women	1.17	1.00	1.02
Men	1.00	1.00	.93
Sedentary:			
Women	.83	.60	.65
Men	.45	.39	.39
Total	6.62	5.40	5.64

1/ Source: Survey data.
2/ Source: Figures in column 1 times respective columns in table 3.11.

required based on FAO specifications. The families with livestock thus likely sold some food crops for cash or exchanged the surplus for cows. Table 3.12 omits some crops used for food, such as vegetables, leaves and fruits, and possibly some livestock products, and these could account for the 4-percent calorie and 14-percent protein deficit for the non-livestock farms.

Throughout this section it should be noted that these are based on averages for all farmers within each type of farm. Surpluses and deficits for individual farm families within each group would differ from the averages as shown and discussed here.

Table 3.16. Sample farms: Nutrients available and needs by farming system per active man-equivalent, 1977/78

System	Nutrients					
	Available		Needed		Balance	
	Calories	Protein	Calories	Protein	Calories	Protein
	1000 K-Cal	Gm	1000 K-Cal	Gm	1000 K-Cal	Gm
With livestock:						
Crops	5.59	97	2.34	32	3.25	65
Milk[1/]	.66	38	.66	38	0	0
Total	6.25	135	3.00	70	3.25	65
Without livestock:						
Crops	2.89	60	3.00	70	-.11	-10

Source: Based on survey data. See text for method of derivation.
1/ Milk use was based on availability, and crops were adjusted in the "need" columns to meet the total requirement.

3.7.4 Potential sources for family food needs

In order to determine needed production to meet family food needs for a typical farm, amounts of the common food items that can be produced from one ha of land and one lactating cow were determined (Table 3.17). Yields are taken at 80 percent of the RIDEP average to make sure that food requirements are met in most years. Yields for cereals and groundnuts are on an intercrop basis.

Cassava yields the highest calories per ha while groundnuts yield the highest protein per ha. However farmers normally are interested in maize because of its palatability, and thus they will always cultivate larger acreages of this crop. Groundnuts form the major source of protein, particularly when milk cannot be obtained, and normally are intercropped with maize or sorghum. Based on these yields and nutrient values, the crops to be grown in order to meet nutrient requirements for subsistence are determined in tables 4.4 and 4.5.

Table 3.17. Typical survey farm: Estimated production of foods per ha and per lactating cow based on below-normal yields

Source	Assumed yield[1]	Nutrient	
		Calories	Protein
	Kg	Mill. K-calories	Kg
Crops per ha:			
Cassava	1,104	3.77	16
Sorghum	490	1.64	51
Maize	420	1.52	42
Millets	400	1.45	44
Groundnuts	260	1.51	70
Milk from one lactating cow	168[2]	.23	12

1/ For crops, based on 80 percent of RIDEP average yields from table 3.3.
2/ Based on milk yield of 0.8 kg per day for a 7-month lactation.

3.8. Labour Use by Enterprises by Months

Family labour is the core of labour supply for peasant production in Tanzania and obviously is a function of family size. Thus the family sex, age and activity combinations for all members staying at home are converted to man-days of farm labour actually used on farm operations for each farming system. This labour is then allocated to different farm enterprises depending on farm operations by months. Where there is sufficient land to extend cultivation, the real constraint is not the total supply of labour but the amount available at peak periods. Thus, in this section, assumptions about labour availability are reviewed and the available labour is compared with requirements by system by months in order to make sound recommendations for efficient labour use.

3.8.1 Initial assumptions about family labour availability

Sukuma women are more efficient in cotton picking and grading than men. However, for heavier tasks, such as land preparation, ridging and weeding, women are less efficient. During critical tasks of land preparation and weeding, women are usually allowed some time to fetch water and fire wood for cooking. For these reasons, they have been assumed to be two-thirds as efficient as active men in terms of farm operations. Children 10-15 years old are assumed to be one-third as efficient as active men if they actually do farm work (Upton, 1973). The family labour used is obtained by omitting labour for off-farm activities, such as schooling for children, and that of old parents who are assumed to be seated for most of their time except to help with postponable activities such as cotton grading, groundnut shelling, etc. Labour was hired only for land preparation, while other farm operations depended entirely on family labour. Thus the number of active members in the family is likely to dictate what and how much to produce.

The man-equivalents in terms of man-days of farm labour were obtained by multiplying the number of wives per family times two-thirds and the number of children 10-15 years old who do not go to school times one-third. These were then added to the number of active men per family (which was one) to obtain the man-equivalents available by system (Table 3.18). Larger families with livestock had more wives than smaller families without livestock but all children 10-15 years old of smaller families went to primary school while 0.08 man-equivalent of boys of the same age group for livestock farms remained

at home to help with farm work. These may have been nearly grown-up sons or children used to tend livestock herds.

Table 3.18. Sample farms with and without livestock: Initial assumptions about family labour availability per family.

Group	With livestock		Without livestock	
	Family members	Man-equivalent available	Family members	Man-equivalents available
	No.			
Active adults:				
Women	1.33	0.89	1.17	0.78
Men	1.00	1.00	1.00	1.00
Children 10-15 years old:				
Girls	.48	0	.90	0
Boys	1.19	.08 1/	.62	0
Total	-	1.97	-	1.78

Source: Survey data.
1/ Represents 0.24 boys on average who do not go to school.

The permanent family labour available per month was obtained by taking the number of man-equivalents in terms of man-days of farm labour actually available from table 3.18 times 26 days of the month excluding four Sundays. Families with livestock had 51 man-days and those without livestock had 46 man-days per month respectively.

3.8.2 Labour requirements and availability by months

Although it was not possible to record details of labour use, the available information on family labour was obtained by asking farmers what were the busiest periods in the season and what they did to supplement their resources during these periods. Farmers were asked to enumerate from memory what month and how many days were spent on each farm operation (Appendix tables A-1 and A-2). These

findings are consolidated in table 3.19 and form the basis for labour disposition by enterprise by operation by month. One active member of the family was required to look after livestock every day for half a day. Thus on average 15 man-days per month were required for the livestock enterprise. Table 3.19, derived from tables A-1 and A-2, shows labour requirements by crops on a per ha basis. It can be seen that cereals except paddy require about half the man-days needed for cotton. Paddy needs the largest amounts of labour per ha. Cassava also needs relatively large amounts of labour because it is usually planted on ridges.

Table 3.19. Sample farms: Total labour requirements by crops per ha based on land preparation by hoes

Crop	Requirement
	Man-days
Paddy	147
Cotton by type of inputs used:	
Fertilizers and insecticides	141
Insecticides only	136
Neither	134
Cassava	105
Cereal/groundnuts intercrop 1/	67

Source: Survey data.
1/ Maize, sorghum, or millets.

Labour requirements, disposition by month and crop, and labour available based on initial assumptions and required addition are shown in table 3.20 for farms without livestock. The small labour shortage in December could be off-set by men working 10 hours instead of 7½ hours a day, adding 9 man-days. Surplus labour appeared to be available in all other months.

Table 3.20. Sample farms without livestock: Labour requirements and availability by enterprise based on 1977/78 cropping pattern

Enterprise	Level of activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
	No	Man-days											
Labour requirements for crops, based on land preparation with hoes:													
Cotton	1.3	6	7	20	12	20	19	28	13	10	0	9	28
Paddy	.1	3	0	3	0	5	0	0	4	0	0	0	0
Food crops[1/]	2.0	10	34	21	10	10	10	6	0	0	0	22	26
Total	3.4	19	41	44	22	35	29	34	17	10	0	31	54
Labour available:[2/]													
Initial assumptions	-	46	46	46	46	46	46	46	46	46	46	46	46
Required addition	-	0	0	0	0	0	0	0	0	0	0	0	8

Source: Survey data.
1/ Maize, sorghum, groundnuts, and cassava.
2/ See text.

In order for the farms without livestock to be self sufficient in food needs, they need to increase their hours of labour. This would be through adult family members extending their working hours during the work peaks. However, subsequent analysis suggested that land-preparation with hand hoes for these heavy mbuga soils likely was the critical problem. Thus, ways to increase efficiency in this area were explored.

Farmers with livestock had serious labour shortages and manoeuvred their working hours and days and apparently included old parents and older children in school but staying at home on Sundays to even out labour shortages. Labour disposition for livestock farms is shown in table 3.21. Weeding was done in February through April and men, together with children 10-15 years old who did not go to school, were assumed to work 10 hours instead of 7½ hours a day, thus adding 9 man-days per average month for the period of weeding. Likewise, by

letting old people relieve women of household chores, they could add 15 man-days per month by working 10 hours instead of 6½ hours a day. Adults plus children not in school by working normal days on Sundays could add 10 man-days. However more was needed, so school children were assumed to work on Sundays, adding 2 man-days per month. In total families could add 37 man-days when this was required without keeping children home from school, making a total of 88 man-days available.[3.11]

Family labour available per month therefore appeared to depend on the task to be done within the season. Weeding and cotton picking were the most critical tasks, requiring lots of labour. It appears that families with ox-teams tended to prepare too much land,

overlooking other related operations of production such as weeding and cotton picking that would later cause labour problems.

3.11/ Note that in table 3.21, labour requirements based on land preparation with hoes is estimated first based on Appendix tables A-1 and A-2. Adjustment then is made for land preparation by ox-ploughs.

Table 3.21. Sample farms with livestock: Labour requirements and availability by enterprise based on 1977/78 cropping pattern

Enterprise	Level of activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
	Ha	Man-days											
Labour requirements for crops, based on land preparation with hoes:													
Cotton	2.4	12	13	38	35	38	35	53	24	20	0	18	53
Paddy	.3	10	0	8	0	14	0	0	12	0	0	0	0
Food crops 1/	4.1	21	68	41	21	21	21	11	0	0	0	45	51
Total	6.8	43	81	87	56	63	56	64	36	20	0	63	104
Less land preparation with ox-ploughs	-	23	0	0	0	0	0	0	0	0	0	50	67
Net total	-	20	81	87	56	63	56	64	36	20	0	13	37
	L.U.												
Livestock	23.3	15	15	15	15	15	15	15	15	15	15	15	15
Grand total	-	35	96	102	71	78	71	79	51	35	15	28	52
Labour available: 2/													
Initial assumptions	-	51	51	51	51	51	51	51	51	51	51	51	51
Potential addition 3/	-	0	37	37	20	27	20	28	0	0	0	0	1
Remaining deficit 4/	-	0	8	14	0	0	0	0	0	0	0	0	0

Source: Survey data.

1/ and 2/ same as on table 3.20.

3/ See text. Assumes maximum use of family labour when required without keeping children home from school.

4/ If school children work on week days as well as Sundays, this adds 12 man-days per month. The remaining small deficit in March likely was met by inadequate weeding of cotton. It is possible that other labour deficits were met in part in the same way.

CHAPTER IV

ALTERNATIVE FEASIBLE FARMING SYSTEMS

The subsistence crops discussed in Chapter III covered all the family nutrition requirements for the farm families with livestock and a substantial part for those without livestock. Farms with livestock seemed to have serious labour shortages. They had a monthly labour supply based on normal working hours of 51 man-days which was apparently increased for some operations with much difficulty through an assumed extension of working hours, working on Sundays, and even involving school children on week-ends and old members of the family. Non-livestock farms had few apparent labour problems except during land preparation in December because they cultivated small acreages of crops with hand hoes.

Alternative feasible farming systems for each type of farm are discussed fully in this chapter which make use of family labour more efficiently to meet family food needs and possibly to increase cotton production. Different cotton production systems are analysed, based on different yields, reflecting use of full-package adoption, partial adoption, and no use of the recommended package.

Land for grazing was not seen as a problem because of the management system of communal grazing, but actually farms with livestock appear to currently use all the land available for grazing and fallow. Further expansion of crop cultivation thus would need to be done at the expense of grazing and fallow land. Thus, with the livestock farms, land is likely to become a constraint. Thus farm

reorganization of crop-mixes and production patterns to be consistent with available family resources of land and labour is inevitable at some point in time, likely in the near future.

Because of the homogenous nature of the area selected for study, dominated by mbuga soils, the proposed systems are believed to be applicable to most parts of the Region with this soil type. The labour factor in peasant agriculture is the most important item in deciding the timing of cropping and the range of crops to be planted in farm holdings. Labour availability is closely related to the size of the family. Ideally alternative enterprises should be studied simultenecously in order to determine labour constraints and opportunity cost in terms of neglect of competing crops. Farm work does not occur evenly throughout the year. Busy periods or work peaks alternate with slack periods or work troughs. Work peaks occur because critical tasks such as planting, weeding and harvesting are closely related to the seasons and must be completed within a limited period of time. Delays generally cause loss of yield, so the man-days required to finish a given operation have to be compressed into a peak period. Grading, shelling or processing of some crops allow greater flexibility of timing. Livestock work however is usually spread fairly evenly throughout the year but must be performed daily. Thus the labour concept dominates analyses of peasant farming systems.

4.1. Farmer's Priorities and Production Decisions

Farmers have experienced over a number of years unfavourable weather patterns (table 1.1). They have tried to evade risks of crop failure through planting food crops first, intercropping legumes with cereals, and broadcasting seeds to wider spacing but have lacked the collateral benefits of using manures, improved seeds, and insecticides. Thus the long-term objective of feeding the family with enough quantity and good quality foods has been limited to at least some extent. Although the Government has at times increased producer prices well in advance of the cropping year, farmers naturally are influenced more by family food requirements, which depend on the number of people to be fed, yield expectations as guided by their knowledge of the land, capacity of their labour force, food stocks in hand from the previous harvests, and reserve crops they have in the ground. The balancing of these factors give farmers a cropping pattern which links preferred and reliable foods with their individual risk preference. For example low food stocks may mean a priority given to early food production for the family through planting short-term varieties such as "serena" sorghum. High food stocks may mean that preferred crops are planted first (planting maize using "katumani" for seed) and, as the season progresses, the farmer could then decide to include crops such as roots and millets depending on the availability of labour.

4.2. Crops to be Included in the Farming Systems

Three general criteria were used for selection of crops to be included in the cropping pattern of farmers in the area, that is (1) acceptability, (2) profitability, and (3) labour requirements by crops.

4.2.1 Acceptability

This includes farmers' goals and conditions under which they operate. As late as the 1940's, sorghum in the Region was the first preferred grain but the varieties grown were susceptible to bird damage. As the bird-damage problem grew, maize was interplanted with sorghum for, although less drought-resistant, maize was not attacked by birds. Tastes gradually changed and the balance altered (table 3.6). Sorghum by then was interplanted with maize as an insurance against rain failure. Since then intercropping has been widely used, particularly as an insurance technique. Crops which were more resistant to drought or local pests were planted together with preferred foods, the practice which also reaped benefits of efficient labour allocation in land preparation, and weeding. Much emphasis however has been placed through extension recommendations on pure stands, and "optimal" planting times, causing differences between technical (or recommended) and economic (or farmer-preferred) optima. Intercropping of legumes with cereals has thus remained. Staggered planting was practiced on a limited scale mainly as a means of flattening out seasonal labour bottlenecks. Thus, although yields per ha might be

reduced by delayed planting, total production might be increased by better use of off-peak resources. All farmers admitted intercropping groundnuts with maize or sorghum, and gave only one reason, namely, that they grew well together, reflecting the complementary benefit of using both water and nutrients in one space. Cassava and sweet potatoes were included on the farm as an insurance measure. Although cassava is not a preferred starch staple, its high productivity in terms of calories per ha and its capacity for storage in the ground make it an ideal famine reserve crop. Cassava requires little work after being weeded at the beginning of its second season and is usually planted when there are few demands of family labour (table A-2).

Although no farmer reported paddy as a food crop, farmers were likely to use it for food when food shortages occurred. Paddy seems to have little place in the cropping pattern of most farmers in this Region as reflected by the small areas cultivated, not being a traditional food and requiring large quantities of water. Millets could be an ideal substitute for paddy. Cattle hoarding is also a common feature of most livestock owners. This provides a measure of insurance and offers a potential supply of food, and cattle can be exchanged for cash as required with subsequent command over food stuffs for sale. However, these practices tend to reduce the efficiency of livestock production per se. Should the food crop position be improved by use of high yielding varieties, this could help to cut down the area planted with subsistence crops, thus releasing some land and labour and possibly some cash outlays to cotton and livestock

improvements. It is important to note that small but properly cultivated and managed areas are likely to yield higher returns per unit of land and labour than large neglected fields.

4.2.2 Labour requirements by crops

Table 4.1 shows total labour requirements in man-days by month for each crop considered in the alternative farming systems. The three alternatives for cotton production are shown, assuming land preparation with hand hoes in table 4.1 and land preparation with ox-ploughs in table 4.2. For the late-planted cotton, labour requirements are advanced one month, showing much of the work being done in January and August although some of the work starts in late December. Land preparation, planting, and weeding for the intercropped crops are done at the same time. The difference is during harvesting when the cereals are harvested through May and June, and groundnuts are uprooted later in August.

Paddy required large amounts of labour in January because farmers exercise the "low-land" type of paddy cultivation in which they make man-made basins (majaruba) to collect water during the long rains. Cassava also requires much labour in January because farmers make ridges for planting the cuttings.

Since the method of land preparation is associated with the time of planting and, since early-planted crops likely yield better than late-planted ones, when land preparation is mechanized crops may be early-planted and probably yield better. Labour requirements by months when land preparation is mechanized with ox-ploughs is shown in table 4.2.

Table 4.1. Typical farms: Labour requirements per ha by month and crop assuming land preparation with hand hoes

Crop	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
	Man-days											
Cash crops:												
Cotton 1/	5	6	12	15	16	15	22	10	8	0	12 5/	20
Cotton 2/	5	3	10	15	16	15	22	10	8	0	7	20
Cotton 3/	20	5	3	9	14	16	15	22	10	8	0	12
Paddy	33	0	27	0	47	0	0	40	0	0	0	0
Food crops:												
Cassava	53	18	0	34	0	0	0	0	0	0	0	0
Cereal/groundnuts intercrop 4/	0	17	12	0	5	5	0	3	0	0	11	14

Source: Survey data.
1/ Early-planted, fertilizers and insecticides applied.
2/ Early-planted, insecticides applied.
3/ Late-planted, neither input applied.
4/ Maize, sorghum, or millets.
5/ Including labour for applying phosphate fertilizers during land preparation.

Table 4.2. Typical farms: Labour requirements per ha by month and crop assuming land preparation with ox-ploughs

Crop	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
	Man-days											
Cash crops:												
Cotton 1/	5	6	12	15	16	15	22	10	8	0	7 5/	5
Cotton 2/	5	3	10	15	16	15	22	10	8	0	2	5
Cotton 3/	5	5	3	9	14	16	15	22	10	8	0	2
Paddy	13	0	27	0	47	0	0	40	0	0	0	0
Food crops:												
Cassava	33	18	0	34	0	0	0	0	0	0	0	0
Cereal/grounduts intercrop 4/	0	17	12	0	5	5	0	3	0	0	2	3

Source: Survey data.
1/, 2/, 3/, and 4/ same as table 4.1.
5/ Includes labour for applying phosphate fertilizers during land preparation.

4.2.3 Profitability

Existing crops are ranked according to their profitability per unit of land and per unit of labour used during the most limiting month of production, after meeting subsistence needs, based on averages for RIDEP (table 4.3).

Table 4.3. Typical farms: Production, gross values, cash input costs, and net cash returns per ha and per limiting-month man-day for specified crops based on 1977/78 prices

Crop	Production	Gross value 1/	Input cost 2/	Man-days			Net cash returns—		
				Overall	Limiting month with—		Per ha	Per man-day for limiting month with—	
					Hand hoes	Ox-ploughs		Hand hoes	Ox-ploughs
	Kg	Sh		No.			Sh		
Sorghum/ groundnuts:									
Sorghum	490	1,530	0	67	14	10	1,530	109	153
Groundnuts	260								
Millets/ groundnuts:									
Millets	400	1,520	0	67	14	10	1,520	108	152
Groundnuts	260								
Maize/ groundnuts:									
Maize	420	1,397	0	67	14	10	1,397	100	140
Groundnuts	260								
Cotton 3/	568	1,138	400	141	29	14	738	25	53
Cassava	1104	552	0	105	16	14	552	34	39
Cotton 4/	284	569	70	136	29	14	499	17	36
Paddy	760	912	0	147	16	31	912	57	29
Cotton 5/	208	417	0	134	16	32	417	26	13

Source: Computed from tables 3.3, 3.7, and 3.17.

1/ 80 percent of RIDEP yields per ha from table 3.3 for paddy, table 3.17 for crops other than cotton, and 80 percent of sample survey yields for 3 alternatives of cotton production from table 3.7, times official prices for 1977/78 from tables 1.3 and 3.4.

2/ Excludes land preparation. Use of purchased inputs on food crops and paddy were negligible, hence considered to be zero.

3/ Early-planted, fertilizers and insecticides used.

4/ Early-planted, insecticides used.

5/ Late-planted, neither input used.

The limiting month of production based on labour was determined by looking at requirements by crops in peak months in relation to labour available after meeting subsistence needs. A ratio between availability and requirements was computed for each month, and the limiting month for each crop is the one with the lowest ratio. Net cash returns per ha were divided by man-days of labour required per month for the limiting month for each crop and are shown in the last two columns of table 4.3. Net cash returns per limiting-month man-day was higher with use of ox-ploughs in production for most crops considered. No allowance has been made for the cost of ox-ploughs (or other land preparation) since this cost is assumed to be negligible for farmers with cattle (not strictly true) and, if hired, would reduce all crops per ha equally and so would not affect the rankings. Although cotton ranks low in relation to the cereals/groundnuts intercrops, farmers under present regulations have to grow at least the minimum recommended area of 0.8 ha. The most profitable crop per ha and per unit of limiting labour is the sorghum /groundnuts intercrop, closely followed by the millets/groundnuts intercrop regardless of how the land is prepared.

With regard to cotton, farmers would be better-off if they grew cotton as recommended but they do not do so because of (1) high cash outlays involved, (2) lack of equipment for early-land preparation, and the (3) priority placed on subsistence production.

4.3. Feasible Ways to Meet Subsistence Requirements

Based on daily consumption requirements of average sample families in table 3.9, put on an annual basis, families with cows to supply milk required 6.4 million K-calories and 191 kg of protein. About 1.4 million K-calories and 85 kg of protein came from milk. Families without livestock depended entirely on food crops to meet their nutrition requirements and required 6.0 million K-calories and 154 kg of protein, since families were somewhat smaller on average than were those of livestock owners. Total calories and protein requirements for each type of farm could be met by producing amounts of food crops from the area shown in tables 4.4 and 4.5, respectively.

The areas needed to meet subsistence requirements are based on the below-normal yields in table 3.17, which are likely to provide families with enough food even in most bad years. They have been determined deliberately taking into account farmers' likes and growing conditions in the area. The respective areas needed to produce these nutrients were obtained by dividing the nutrition equivalents of calories needed to meet subsistence requirements for each crop and intercrop by calories that can be obtained from that crop per ha based on below normal yields. Nearly half of the protein for farms with livestock comes from milk, and cassava would provide nearly half of the calories from crops for these farmers. For farms without livestock, much of the protein is assumed to come from groundnuts, thus the relatively larger areas for maize and sorghum/groundnuts intercrop.

Table 4.4. Typical sample farms without livestock: Required area for subsistence crops based on below-normal yields

Source	Area	Nutrition equivalent		Edible equivalent
		Calories	Protein	
	Ha	Mill. K-calories	Kg	Kg
Maize/groundnuts intercrop:				
Maize	0.60	0.91	25	252
Groundnuts		.91	42	120
Cassava	.56	2.11	9	773
Sorghum/groundnuts intercrop:				
Sorghum	.50	.82	25	245
Groundnuts		.75	35	100
Millets/groundnuts intercrop:				
Millets	.15	.25	8	73
Groundnuts		.23	10	30
Total	1.81	5.98	154	-

Source: Computed from tables 3.9 and 3.17.

Table 4.5. Typical sample farms with livestock: Required area for subsistence crops based on below-normal yields

Source	Area	Nutrition equivalent		Edible equivalent
		Calories	Protein	
	Ha	Mill. K-calories	Kg	Kg
Cassava	0.65	2.45	10	718
Maize/groundnuts intercrop:				
Maize	.50	.76	21	210
Groundnuts		.75	35	130
Sorghum/groundnuts intercrop:				
Sorghum	.20	.33	10	98
Groundnuts		.30	14	52
Millets/groundnuts intercrop:				
Millets	.13	.22	7	64
Groundnuts		.20	9	34
Total from crops	1.48	5.01	106	-
Milk[1/]	-	1.40	85	1,000
Grand total	-	6.41	191	-

Source: Computed from tables 3.9 and 3.17.
1/ Based on assumed availability.

Based on labour requirements in table 4.1 and 4.2, the total labour by months required to grow the minimum food crops specified by system are shown in table 4.6 for non-livestock farms and in table 4.7 for farms with livestock. The respective quantities of labour shown in tables 4.6 and 4.7 were obtained by multiplying the area required to meet subsistence requirements by system and crop times labour requirements by crop per ha in tables 4.1 and 4.2, in order to get the total requirements for subsistence. Total labour requirements were then subtracted from the total initial labour available and the remaining amounts in the last rows of tables 4.6 and 4.7 is then used to determine the feasible and optimum area that can be grown with cash crops. Modifications are then made to allow for possible increases in family labour or use of specified labour saving devices. These tables also were used in determining the limiting month for labour in connection with table 4.3.

Table 4.6. Typical sample farms without livestock: Labour required for food crops to meet subsistence requirements

Crop	Level of activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
	Ha	Man-days											
Labour requirements:													
Maize/groundnuts	0.60	0	10	7	0	3	3	0	2	0	0	7	8
Cassava	.56	30	10	0	19	0	0	0	0	0	0	0	0
Sorghum/groundnuts	.50	0	9	6	0	3	3	0	2	0	0	5	7
Millets/groundnuts	.15	0	3	2	0	1	1	0	1	0	0	2	2
Total	1.81	30	32	15	19	7	7	0	5	0	0	14	17
Labour available: 1/													
Total	-	46	46	46	46	46	46	46	46	46	46	46	46
For cash crops after subsistence needs	-	16	14	31	27	39	39	46	41	46	46	32	29

Source: Computed from tables 4.1 and 4.4.
1/ Based on initial assumptions in sub-section 3.8.2.

Table 4.7. Typical sample farms with livestock: Labour required for food crops to meet subsistence requirements

Crop	Level of activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
	Ha	Man-days											
Labour requirements:													
Cassava	0.55	21	12	0	22	0	0	0	0	0	0	0	0
Maize/groundnuts	.50	0	9	6	0	3	3	0	2	0	0	1	1
Sorghum/groundnuts	.20	0	3	2	0	1	1	0	1	0	0	1	1
Millets/groundnuts	.13	0	2	1	0	1	1	0	1	0	0	1	1
Total[1/]	1.48	21	26	9	22	5	5	0	4	0	0	2	2
	L.U.												
Livestock	25.3	15	15	15	15	15	15	15	15	15	15	15	15
Grand total	-	36	41	24	37	20	20	15	19	15	15	17	17
Labour available:[2/]													
Total	-	51	51	51	51	51	51	51	51	51	51	51	51
For cash crops after subsistence needs	-	15	10	27	14	31	31	36	32	36	36	34	34

Source: Computed from tables 4.2 and 4.5.
1/ Rounded up to nearest whole day.
2/ Same as note 1 in table 4.6.

4.4. Feasible Farming Systems for Typical Farms Without Livestock

This section indicates the maximum acreage and net cash returns for each type of crop and intercrop that can be grown using family labour after meeting subsistence requirements for farms without livestock. Three alternative ways of growing cotton are considered.

The main assumptions underlying this analysis are that (1) yields equal 80 percent of the RIDEP long-term average, (2) the price for each crop plus those for cash inputs equal those for the 1977/78 crop-year, and (3) since smaller farms' ability to prepare land tended to limit overall farming activities, so that surplus family

labour appeared to be available most of the year, ox-ploughing services would be hired while women work as hard as men.[4.1] If holiday schedules for school children living at home were made to coincide with the critical work peak of weeding and the most profitable crop was grown while expecting to hire ploughing services during December for land preparation, farmers' incomes would be increased substantially.

4.4.1 Optimum solution based on normal working periods

The maximum area for each crop including intercrops to generate cash are shown in table 4.8. These were arrived at by dividing the total man-days available for the critical month for a particular crop after meeting subsistence requirements by the labour requirements per ha corresponding to that critical month of production. The critical month for each crop was determined by looking at the month which had the lowest ratio between availability and requirements. For these farms the initial labour available is 46 man-days per month less needs for subsistence as shown in table 4.6.

The maximum net cash returns equal the net cash returns per ha from table 4.3 times the area in table 4.8. The largest of these maximums indicate the optimum sole enterprise which, in this case, is sorghum/groundnuts intercrop, giving farmers a net cash return of Sh 1,255 and an average return per total man-day of Sh 18.70, which

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4.1/ Smaller families without livestock had on the average 1.2 wives (table 3.18). By working as hard as men, they add 10 man-days per month.

is above the official wage for casual labour in the rural areas of Sh 14.60 for 1977/78. This would seem to be a desirable crop in the area and it conforms to the Government policy of sorghum growing specialization in semi-arid areas. However, because of another Government policy, farmers have to grow some cotton. Thus the following section discusses a cash crop combination that fulfills both these policies.

Table 4.8. Typical sample farms without livestock: Maximum area that can be grown and net cash returns from that area by enterprise, based on normal working periods

Enterprise	Labour			Maximum area	Net cash returns from that area
	Limiting month	Available	Required		
		Man-days		Ha	Sh
Sorghum/groundnuts	February	14	17	0.82	1,255
Millets/groundnuts	February	14	17	.82	1,246
Maize/groundnuts	February	14	17	.82	1,155
Cotton[1/]	December	29	20	1.45	1,060
Cotton[2/]	December	29	20	1.45	723
Paddy	January	16	33	.48	438
Cotton[3/]	January	16	20	.80	334
Cassava	January	16	53	.30	166

Source: Computed from tables 4.1, 4.3, and 4.6.
1/ Early-planted, fertilizers and insecticides used.
2/ Early-planted, insecticides used.
3/ Late-planted, neither input used.

4.4.2 Combining cash crops for increased returns

Smaller farms without livestock prepared their land using hand hoes and apparently had labour shortages during that work peak in December. Thus land preparation is the initial restraint and farmers should maximize returns to land. It is assumed that the maximum land that can be prepared by these farms is that prepared in the sample

year in table 3.1. Thus by deducting the land needed for subsistence in table 4.4, the remaining land can be allocated to cash crops. That is 1.59 ha (3.40 - 1.81 ha).

The land remaining after growing 0.82 ha of sorghum/groundnuts intercrop is 0.77 ha which is about the specified Government minimum area for cotton growing.

Cotton growers have been resisting adoption of all recommendations because (1) they find a better return to their labour from food crops than cotton, (2) it involves taking risks of cash outlays that many farmers may be unwilling to bear, and (3) they place a higher value on assuring a certain minimum yield than on achieving a high yield in a given year. Thus for these reasons growing late-planted cotton without cash outlays is more acceptable, unless the recommended package is made very profitable.

Four-fifth ha of late-planted cotton uses all the available labour in January and requires 4 man-days in February (table 4.9). Since labour in February is exhausted by 0.82 ha of sorghum/groundnuts intercrop, cotton requirements could be supplied by women working as hard as men. Thus this system would give these farms a total net family income of Sh 1,589. This income is equal to a per capita income of Sh 240 which is about one-third larger than that found for the sample survey farms.

4.4.3 Increasing the sorghum/groundnuts area based on hired ox-ploughing services and changing vacation periods for school children

From the system in sub-section 4.4.2, of the 10 man-days supplied by women working as hard as men, 4 man-days would be used to grow 0.77 ha of late-planted cotton and the remaining 6 man-days would be supplemented with 13 man-days by school children staying at home in that month. Thus a total of 19 man-days would grow 19/17 = 1.11 ha of sorghum/groundnuts intercrop and give farmers an extra net cash return of Sh 1,528.

4.4.4 Final optimum solution

The optimum solution for smaller farms without livestock seems to be 1.93 ha of sorghum/groundnuts intercrop and 0.77 ha of late-planted cotton. This system would give farmers a total net family income of Sh 3,117 and a per capita income of Sh 470, using the labour disposition in table 4.9. This income is about 3 times bigger than that obtained for the sample survey farms.

4.5. Feasible Farming Systems for Typical Farms With Livestock

In this section farms with livestock are allowed a fairly reasonable work schedule in order to reduce their serious labour shortages while using the available family labour more efficiently to optimize incomes, after meeting subsistence requirements. Based on net cash returns per ha and limiting-month man-day concepts, the most profitable crop for these farms is determined. Because of Government

Table 4.9. Typical sample farms without livestock: Labour disposition for the systems and the final optimum solution

Solution	Level of activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
	Ha	Man-days											
Labour available[1/]	-	16	14	31	27	39	39	46	41	46	46	32	29
Required addition (from women)	-	0	10	0	0	0	0	0	0	0	0	0	0
Total	-	16	24	31	27	39	39	46	41	46	46	32	29
Labour required for sorghum/groundnuts[2/]	0.82	0	14	10	0	4	4	0	2	0	0	9	11
Labour remaining	-	16	10	21	27	35	35	46	39	46	46	23	18
Labour required for late cotton[2/]	.77	15	4	2	7	12	13	12	18	8	6	0	10
Labour remaining	-	1	6	19	20	23	22	34	21	38	40	23	8
Required addition from school children	-	0	13	0	0	0	0	0	0	0	0	0	0
Total available	-	1	19	19	20	23	22	34	21	38	40	23	8
Labour required for sorghum/groundnuts[3/]	1.11	0	19	13	0	5	5	0	3	0	0	2	3
Labour remaining	-	1	0	6	20	18	17	34	18	38	40	21	5

1/ Source: From table 4.6, last row.
2/ Source: Computed from table 4.1. Assumes land preparation by hand-hoes.
3/ Source: Computed from table 4.2. Assumes land preparation by ox-ploughs for this part.

policy with regard to cotton production, a certain area of cotton is retained to the extent that labour permits.

The price and yield assumptions developed in section 4.4 also apply here. Since these farmers possess their own oxen for land preparation, land that can be prepared is not a constraint. With regard to labour it is assumed that (1) farmers increase their labour efficiency through (a) women working as hard as men during the normal working periods, thus adding 11 man-days per month, (b) adults and children 10-15 years who do not go to school work 10 hours, thus

Table 4.10. Typical sample farms with livestock: Maximum area that can be grown and net cash returns from the area by enterprise based on normal working periods

Enterprise	Labour			Maximum area	Net cash return from that area
	Limiting month	Available	Required		
		Man-days		Ha	Sh
Sorghum/groundnuts	February	10	17	0.59	903
Millets/groundnuts	February	10	17	.59	897
Maize/groundnuts	February	10	17	.59	824
Cotton[1/]	April	14	15	.93	626
Cotton[3/]	August	32	22	1.45	605
Paddy	May	31	47	.66	602
Cotton[2/]	April	14	15	.93	464
Cassava	April	14	34	.41	226

Source: Computed from tables 4.2, 4.3, and 4.7.
1/, 2/, and 3/ same as in table 4.8.

adding 23 man-days during the critical work peaks, and (2) school holidays for children staying at home if made to coincide with the critical work peak of weeding in February would add 13 man-days in that month.

4.5.1 Optimum solution based on normal working periods

In determining the maximum area for each cash crop and the critical month of production, the same method was used as previously. Based on net cash returns per ha and limiting-month man-day, the most profitable crop again is sorghum/groundnuts intercrop (table 4.10). This explains at least in part why these farms cultivated large food-crop areas than they required for subsistence.

4.5.2 Combining cash crops for increased returns

Total family labour remaining after growing 0.59 ha of sorghum/groundnuts is first derived since it is based on normal working periods. Then the two labour assumptions are relaxed in turn. Labour disposition for the different iterations is shown in table 4.11.

Iteration 1. Adding 0.8 ha of late-planted cotton through women working as hard as men during normal working periods - With larger farms, late-planted cotton competes favourably with cotton grown as recommended (table 4.10). However farmers would be willing to grow the former. Since the crop is less profitable than others, the Government minimum area of 0.8 ha is all that is likely to be grown. If the 11 man-days added by women were in February (since February labour was completely exhausted by 0.59 ha of sorghum/groundnuts), 0.8 ha of late-planted cotton would use only 4 man-days of this labour. Thus farmers would realize Sh 334 from late-planted cotton, or a total family income of Sh 1,237 from this system.

Iteration 2. Adding paddy to 0.59 ha of sorghum/groundnuts and 0.8 ha of late-planted cotton - The limiting month for paddy for larger farms is May, and it is preferred to other cereals in this case because it does not require labour in February, and it has a higher net cash return per ha than cassava. The amount of family labour remaining in May is 28 man-days. Thus the maximum area that can be grown is 28/47 = 0.59 ha which gives a net cash return of Sh 538. This system would give farmers a total family income of Sh 1,775.

Iteraction 3. Increasing the sorghum/groundnuts area through increased family labour efficiency - If the increased family labour

through working
of 23 man-days/harder during the critical work peak of weeding sorghum/groundnuts was used on this crop, together with the remaining 7 man-days (11-4 man-days in iteration 1), 30/17 = 1.76 ha would be grown. This would give a net cash return of Sh 2,693. Thus, together with incomes from iterations 1 and 2, this system would give farmers a total family income of Sh 4,463. This income is still lower than that obtained for the sample survey farms. Then a fourth iteration that would
/ increase farmer's income was attempted.

Iteration 4. Increasing farmer's income by changing vacation dates to permit school children to stay home during weeding - By using school children to weed sorghum/groundnuts in February, 13/17 = 0.76 ha could be added. This area gives a net cash return of Sh 1,163. Thus, together with incomes from iteration 3, this system gives a total family income of Sh 5,631 and thus a per capita income of Sh 790 excluding that from livestock. This income is about 10 percent greaterthan that found for the sample survey farms.

4.5.3 Final /optimum cash crop combination

Based on iterations in sub-section 4.5.2, a combination of 3.11 ha of sorghum/groundnuts intercrop, 0.80 ha of late-planted cotton, and 0.59 ha of paddy is optimum. This gives a total net family income of Sh 5,631 and involves labour disposition, based on the previous two assumptions, as shown in table 4.11.

Another alternative would be to hire temporary labour during weeding but this is against the Party and Government policy of socialism and self-reliance.

Table 4.11. Typical sample farms with livestock: Labour disposition for iterations and optimum cash crop combination

Iteration	Level of activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
	Ha	Man-days											
Labour available 1/	-	15	10	27	14	31	31	36	32	36	36	34	34
Labour required for sorghum/groundnuts	0.59	0	10	7	0	3	3	0	2	0	0	1	2
Labour remaining	-	15	0	20	14	28	28	36	30	36	36	33	32
Required addition from women	-	0	11	11	0	11	0	0	11	0	0	0	0
Total available	-	15	11	31	14	39	28	36	41	36	36	33	32
Iteration 1: Late-planted cotton	.80	4	4	2	7	11	13	12	18	8	6	0	2
Labour remaining	-	11	7	29	7	28	15	24	23	28	30	33	30
Iteration 2: Paddy	.59	7	0	16	0	28	0	0	23	0	0	0	0
Labour remaining	-	4	7	13	7	0	15	24	0	28	30	33	30
Required addition through increased family labour efficiency	-	0	23	19	0	13	0	0	7	0	0	0	0
Total available	-	4	30	32	7	13	15	24	7	28	30	33	30
Iteration 3: Sorghum/groundnuts	1.76	0	30	21	0	9	9	0	5	0	0	3	5
Labour remaining	-	4	0	11	7	4	6	24	2	28	30	30	25
Required addition from school children	-	0	13	0	0	0	0	0	0	0	0	0	0
Total	-	4	13	11	7	4	6	24	2	28	30	30	25
Iteration 4: Sorghum/groundnuts	.76	0	13	11	0	4	4	0	2	0	0	1	2
Labour remaining	-	4	0	0	7	0	2	24	0	28	30	29	23

Source: Computed from tables 4.2 and 4.7.
1/ After meeting subsistence requirements.

4.6. Increasing Farmers' Incentives

It is clear from this analysis that cotton is not as profitable a crop as several alternatives and it is grown because of Government

policy. Thus, in order to make this crop economically-viable, it is imperative to raise its price relative to those of other crops and to those for cash inputs. For example an increase of 35 percent in the cotton producer price for the 1977/78 crop-year would have increased the net cash return from late-planted cotton to Sh 563 and that from early-planted cotton to Sh 1,537; the latter then would compete favourably with the most profitable intercrop, sorghum/groundnuts (table 4.3).[4.2/]

It is postulated that farmers in developing countries like Tanzania need at least a 2.5:1 return on cash inputs to warrant the risk and costs of investing in fertilizers and insecticides although many Tanzania planners consider a 2:1 return as fully adequate. By increasing the cotton producer price from that in the 1977/78 crop-year by 35 percent, while keeping those for other crops and inputs unchanged, would improve this ratio as follows:

Fertilizers and insecticides over nothing $= \frac{1921 - 703}{400 - 0} = 3.0.$

Thus, at this higher price, farmers likely would tend to be stimulated to use cash inputs on cotton or expand cotton area provided adequate credit was available.

The long-term strategy however should be to constantly raise yields from food crops and livestock through improved husbandry and

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4.2/ Cotton prices were increased by 33 percent for AR cotton and by 25 percent for BR cotton in 1979/80 over the 1977/78 level prices used in the systems analyses on 6th October, 1979. However prices of maize, groundnuts and paddy were also raised, so that recalculations would be needed to see to what extent the optimum crop combinations would change. This is considered outside the scope of this thesis.

use of improved seeds. For example a reduction of subsistence area could be compensated by using high-yielding varieties of food crops and optimal weedings since small but properly managed areas likely yield higher returns per unit of input used than large but neglected fields. Once the subsistence production has been improved, more land and labour likely would be released for production of cotton or other cash crops.

CHAPTER 7

SUMMARY AND CONCLUSIONS

The study was designed to examine difficulties relating to increased production of cotton in Chinyanga Region. The problems studied include ones that are natural, physical, economic and technical. The main objectives of the study included identification and assessment of factors that motivate farmers to expand or reduce area and production of cotton, examination of the productive efficiency of the cotton producers and identification of a feasible plan for increasing aggregate output of the Field Unit in the area of study based on the characteristics found for the system.

The survey was conducted during July to September 1978 and sought information covering the 1976/77 and 1977/78 crop years. Primary data were collected from 50 randomly selected farmers based on a questionnaire which was revised following a pretest. The questionnaire contained both closed and open-ended questions and was designed to collect basic information on the farmers' activities, possessions, immediate goals and problems, and how they solve them. This was a single-visit survey. For secondary data, officers in the various agricultural offices in Chinyanga Region were contacted to make use of their annual reports and relevant files, supplemented with informal conversations.

Direct programme planning was used to determine optimum resource allocation. Relations between specified variables were tested by means of chi-square and correlation analyses.

The study was limited to a certain extent by the author's inability to speak the farmers' vernacular language. Secondary school leavers who

are known by tribe would be more appropriate in doing the direct interviewing. The precision of important items such as area, yields, livestock numbers and family incomes depended on the memory of the respondents but, because of the established rapport before interviewing, the collected answers are believed to be generally correct.

In running the correlation analyses, all cotton-growing recommendations were given equal weightings because it was difficult to decide which operation was most important. It would be better to give different weightings to different operations.

Changes in crop prices during the writing period were not taken into account. It would be desirable in future to test effects on the optimum farming systems of changes in crop prices, for example (a) before the sharp rise in prices of either cotton or its inputs, (b) after the rise in cotton price and (c) before and after the sharp rise in prices of competing crops.

This study confirms that farmers put first priority on production of food crops and, in order to evade risks of crop failures, they intercrop legumes with cereals, broadcast the seeds to wider spacings but lack the collateral benefits of using manures, improved seeds and insecticides. This limited, at least in part, their long-term objective of feeding the family with enough quantity and good quality foods, which in turn resulted in competition between subsistence crops and cotton production.

The importance of cotton in Tanzania and to the people who grow it cannot be overemphasized. A point of concern is that consumption of

lint by local mills is increasing rapidly, in addition to the great desire for foreign exchange. Thus, unless production is increased, the planned expansion of local mills is likely to limit exports in future. Cotton production in Tanzania reached a peak of just over 400 thousand bales in 1966. Since then, production has fluctuated between 350-400 thousand bales in most years but in the 1974/75 crop year it dropped to 250 thousand bales. The average production of AR (first grade) cotton in the period 1972/73 to 1977/78, excluding 1974/75, was 1 percent less than that during 1966/67 to 1971/72. But BR (second grade) cotton was 9 percent more over the same period, thus indicating a deterioration in cotton quality. Cotton production in Shinyanga Region, which contributes about one-third of the country's crop, has not shown desired increases. The average production of AR cotton for the period 1972/73 to 1977/78 was 5 percent less than that during 1966/67 to 1971/72, but the lower-quality BR cotton was about the same as in the earlier period.

The decline in cotton production and quality is due to a configuration of factors. These have been identified in this study based on an interview of 50 farmers in Kondo and Kindo Divisions of Shinyanga District covering the crop year 1977/78.

Kinyongo District was purposely selected for convenience of [illegible] for the first sampling stage. Because of the homogeneous nature of the area selected for study, dominated by ntugu soils, the [illegible] systems are believed to be applicable to most parts of the [illegible] with this soil type.

Farmers' goals, according to priority, include (1) a stable and [illegible] food supply throughout the year balanced between legumes and starch staples and green leaves, and (2) adequate cash income to purchase goods such as clothes, building material and farm equipment. Farmers with livestock also attempt to safeguard the future by accumulation of capital in the form of animals, the sign of social status.

The major resources identified in this study are family labour availability and utilization efficiency. This resource formed the basis for detailed calculations in Chapter VII relating to labour availability after meeting subsistence requirements and labour allocation to different crops and operations and, in Chapter IV, changes in the farming systems are developed that make optimum use of family labour in critical months. Land and capital were not considered as limiting because on the average farmers maintained a ratio of 1:1

between use of land for crops and grass fallow or communal grazing land, although land is likely to be a problem in future.

Farmers put first priority on subsistence crops. Although cotton planting does not require as much labour as land preparation, weeding or harvesting, it is during mid-November and mid-December, the time recommended for cotton sowing, that farmers are busy preparing land for their subsistence crops. Thus it is the priority placed on subsistence crops and labour bottlenecks at cotton planting time that account for late-planted cotton. It is thus difficult to comprehend how a farmer can manage all his subsistence crops and grow cotton as recommended at the same time. Thus the time of planting (which is of paramount importance in increasing yields) must be carefully looked into not only for cotton but also for all other crops in the system taking account of labour demands for the entire system.

Proper spacing and therefore thinning were practiced on a minor scale. By the time farmers are ready to plant cotton, they are already late and, in trying to catch up with the planting date, since total absconding from cotton growing is not allowed, they rush the operation by broadcasting the seeds on flat fields. Farmers are well aware of keeping weeds under control but are faced with a problem of organizing their family labour between crops and within crops. In order to spread the risks of total crop failures, they weed their cotton once or twice. Such practices plus late-planting and broadcasting the seeds, render other practices such as fertilizer and insecticides use uneconomic. It is recommended that, where possible, farmers should use ox-drawn equipment in weeding to save labour and

increase the frequency of weeding, but in the absence of this equipment, a reduced cotton area which can be commanded by family labour after meeting subsistence requirements would be of greater benefit than a large but neglected area. Although use of cash inputs on cotton proved not fully economic at 1977/78 prices, farmers who cultivated relatively small cotton areas, with all inputs, and who managed three or more weedings, got higher yields per ha than those who used insecticides only or who used neither input (Table 5.7).

Farmers are aware of the value of manures in restoring and maintaining soil fertility but are put off by the drudgery of carrying it to their fields on heads by use of tins or baskets in required quantities. On the other hand fertilizers were not fully economic probably because the rates were based on blanket recommendations at Ukiriguru Agricultural Research Institute, particularly when applied to the already fertile mbuga soils. Thus research relating to soil fertility should evaluate the variance in soil types, fertility and residual effects due to continuous fertilizer use on farmers' fields or based on village trials. Credit facilities for purchase of farm transport equipment such as ox-carts and wheelbarrows could be of much help to farmers. Farmers failed to benefit from use of insecticides either because they sprayed once or twice out of the four recommended spray regimes. This tended to be a waste of insecticides and has an indirect undesirable effect of increasing insect resistance to insecticides.

Farmer's age, education, wealth and contact with extension agents had no measurable influence on cotton yields per ha. This was likely

due to the high priority placed on subsistence crops while ignoring the recommended practices for cotton. It could also be either due to lack of a reliable husbandry package, such as inputs use which are attractive to farmers, or insufficient work programming for contact agents and poor supervision as a result of limited mobility.

Favourable producer prices for food crops have made these more profitable than cotton, particularly since cotton requires about twice as much labour per ha as maize or sorghum. The weather has been unfavourable in many years since 1973/74 and this, as well as low economic returns for cotton, is most likely why farmers tend to concentrate more on food crops at the expense of cotton production. The Government policy of "Kilimo cha kufa na kupona", meaning agriculture is a matter of life and death, probably favoured production of food crops, neglecting the contemporary importance of cotton.

From the foregoing review, farmers have been intentionally rational in organizing the farming operations to fulfill their objectives. They are ready to adopt any innovation to changing circumstances, provided the change is satisfactory in terms of the additional net benefits involved relative to the implied risks and costs.

Before any suggestions for improvements are made in this thesis, the existing farming systems are examined and, based on these, feasible alternative farming systems are developed. Two major types of farming systems are identified based on family size, farm size, farming techniques and ownership of livestock. Fourty percent of the surveyed farmers owned livestock (23 livestock units per average family for those owning some) and had relatively larger farms and

slightly bigger families. They used ox-ploughs for land preparation. They had an average family size of 5.8 male-consumption equivalents of calories and 6.1 male-consumption equivalents of protein. Their average farm size was 6.8 ha of which 2.4 ha were for cotton, 0.3 ha for paddy, and the remaining 4.1 ha for food crops. They produced twice as much food as actually required for subsistence, and it is believed that the surplus was either sold or exchanged for cattle. They had a total family income of Shs 5,070, about half of which came from cotton sales and 9 percent from paddy sales. They also had a permanent labour supply of 51 man-days per month based on assumed normal working time (referred to as initial labour) which was not enough for the area they cultivated. It was assumed to be supplemented with much difficulty in various ways, through extending working hours, working on Sundays, and even involving school children and old members of the family at extremely busy periods. Hiring of casual labour was difficult because of the policy of socialism and self-reliance and children between 10-15 years who lived at home went to school following the Universal Primary Education policy.

Sixty percent of the surveyed farmers had slightly smaller family sizes and no livestock. Mostly they used hand hoes for land preparation. They had an average family size of 5.4 male-consumption equivalents of calories and 5.6 male-consumption equivalents of protein. Their average farm size was 3.4 ha of which 1.3 ha were for cotton, 0.1 ha for paddy and the remaining 2.0 ha for subsistence crops. Their family income was low, Sh 1,130, of which over eighty percent came from cotton sales. These farms had a permanent labour

supply of 46 man-days per month based on normal working hours and seemed to have little labour problems except during land preparation in December. However they apparently experienced some food shortages because they produced 4 percent less calories and 14 percent less protein than required for full subsistence, based on nutritional studies by FAO.

In general, the major food items were maize and sorghum, intercropped with groundnuts, and cassava. Of the intercropped area, maize and groundnuts occupied $\frac{2}{3}$ and $\frac{1}{3}$ respectively and sorghum and groundnuts occupied $\frac{3}{4}$ and $\frac{1}{4}$ respectively. Paddy was mainly grown for sale but could be used for food when there was shortage. Farmers with livestock supplement food crops with milk. Use of inputs on food crops was negligible and following of the fields was done incidentally whereas rotation seemed to be of little importance. Most farmers used local seed varieties for food crops. Yields of food crops for smaller farms were better than for the larger farms because they likely took better care of their subsistence crops. However, they failed to fully meet their subsistence requirements because of a poor combination of cereal crops. Use of a millets/groundnuts intercrop would stabilize their grain supply. On the other hand yields of cash crops for larger farms were better, likely benefiting from the first rains through early land preparation with own ox-ploughs. Farmers who used recommended inputs on cotton got relatively better yields per ha and per limiting-month man-day than those who used insecticides only or neither inputs, but the venture was not profitable enough despite large Government subsidies on fertilizers and insecticides to meet

what many economists believe is required to cover both the added cash outlays and the risk of complete loss in the case of crop failure.

In trying to suggest alternative feasible farming systems which are typical to the area, ensuring family food needs throughout the year, and possibly raising farmers' incomes; the following criteria are used. Farmers naturally are influenced more by family food requirements which depend on the number of people to be fed, yield expectations as guided by their knowledge of the land, capacity of their labour force, food stocks in hand from the previous harvests and reserve crops they have in the ground. Based on these, the ideal crops to be grown in the area would include sorghum as the major starch staple intercropped with groundnuts. Bird-damage which is a great threat to sorghum production is currently reduced by the national programme of aerial spraying with quolcator. Thus together with bird-scaring procedures by farmers likely a lot of produce can be saved. Maize, although more susceptible to drought, is liked by farmers because it is palatable and, as far as it is concerned, farmers will continue to play games with nature. Cassava is a good reserve crop and millets could replace paddy, which requires more water and labour, both constraints in this area.

In determining the subsistence requirements, the nutrient content of the common food items including milk were taken, based on standards by FAO (1973) for East African families. Based on daily requirements for an active man, annual requirements by system were determined. The yield of nutrients from the food items was based on 80 percent of the average yields per ha by crop as found in RIDEP

(1975) to provide adequate food in most years. From these, the area required to meet subsistence requirements by crop was determined, then allocated with family labour by months. Smaller farms without livestock should cultivate 1.8 ha and larger farms with livestock should cultivate 1.5 ha of subsistence crops, since, for the latter, milk meets part of their needs. If farmers used improved seeds, such as serena for sorghum and katumani for maize, plus insecticides to control crop pests both in the fields and stores, they presumably would get better yields and so could reduce land and labour required for subsistence.

In selecting crops considered to generate cash, existing crops and three ways of cotton farming were ranked according to their profitability in terms of net cash returns per unit of land and labour used during the most limiting month of production, after meeting subsistence requirements based on 80 percent of RIDEP yields and 1977/78 prices. The most profitable crop was sorghum intercropped with groundnuts. With regard to cotton, the most profitable type was that grown as recommended but, depending on farmers' operating situations, late-planted cotton would be more economic. These two formed the cash crop combinations for the systems analysis.

The limiting month for each crop considered was the one with the lowest ratio between labour availability and requirements after meeting needs for subsistence crops. The maximum possible area for each crop to be grown was then obtained by dividing the man-days available after meeting subsistence requirements for that critical month by the labour

requirements per ha corresponding to that critical month of production. The area obtained was then multiplied by the net cash returns per ha.

Optimum solution for smaller farms was 0.8 ha of sorghum/groundnuts intercrop, which would give these farms a net cash return of Sh 1,255, but a cash crop combination including 0.8 ha of late-planted cotton would increase their total net family income to Sh 1,589, which is about one-third higher than that obtained for the sample survey farms. However by hiring ox-ploughing services for land preparation while school holidays for children living at home were made to coincide with the critical work peak of weeding, smaller farmers could improve their farming system by growing 1.9 ha of sorghum/groundnuts and 0.8 ha of late-planted cotton. This system would triple their net family income to Sh 3,120 based on 1977/78 prices.

The optimum cash crop combination for larger farms include 3.1 ha of sorghum/groundnuts intercrop, 0.8 ha of late-planted cotton, and 0.6 ha of paddy, from which they realize a total net family income which is 10 percent larger than that found for the sample survey farms excluding that from livestock despite the use of yields that were only 80 percent of the RIDEP long-term average.

It is concluded therefore that if the aim is to increase farmer's income, the crop which gives the highest net cash returns per limiting month man-day after meeting subsistence requirements, sorghum/groundnuts intercrop, should be encouraged. From the Government's point of

view, cotton production likely could be stimulated by increasing its price relative to other crops and cash inputs. An increase by 35 percent over prices used in the systems analyses would give a benefit/cost ratio of 3:1 for cash inputs, enough to warrant the risk and costs of using fertilizers and insecticides. If producer prices of other crops and inputs increase simultaneously with those of cotton, farmers will always be tempted to grow the most profitable crop relative to cotton. If holiday schedules for school children living at home were made to coincide with the critical work peak of the most profitable crop, this would improve farmers' incomes. Research on cotton improvement should be considered not only for specified cotton operations but in relation to all crops of the system, given the resources on typical individual farm units.

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APPENDIX

Table A.1. Sample farms: Labour allocated to cotton operations per ha. as found for the sample based on land preparation with hand hoes

Operation		Month	Days spent	Man-days by operation	
				By month[1]	Total
				No.	
Land preparation		November	4	7	
		December	7	13	
					20
Planting		January	3	5	5
Thinning		February	2½	5	5
Fertilizer application		February	2½	5	5
Weeding	1st	March	8	15	
	2nd	April	8	15	
	3rd	May	8	15	
					45
Spraying	1st	March	½		
	2nd	April	½		
	3rd	April	½		
	4th-6th	May	2½		
					2[2]
Harvesting/picking		June	8½	16	
		July	8½	16	
		August (DR)	3	5	
					37
Grading		July	4	7	
		August	4	7	
					14
Cleaning		September	4½	8	8
Total[3]			76¾	-	141

Source: Survey data.

1/ Days spent times average adult equivalent of 1.86 workers.

2/ Labour based on maximum of 4 sprays.

3/ Days spent may not equal total man-days due to rounding.

Table A.2. Sample farms: Labour allocated to crops other than cotton per ha. as found for the sample based on land preparation with hand hoes

Operation and crop	Month	Days spent	Man-days by operation	
			By month 1/	Total
			No.	
Land preparation:				
Maize, sorghum/groundnuts	November	6	11	16
	December	3	5	
Cassava, sweet potatoes	January	29½	53	53
Paddy	January	18	33	33
Planting:				
Maize, sorghum/groundnuts	December	5	9	9
Cassava, sweet potatoes	February	9½	18	18
Paddy	March	14½	27	27
Weeding:				
Maize, sorghum/groundnuts				
1st	February	9	17	29
2nd	March	6½	12	
Cassava, sweet potatoes	April	18½	34	34
Paddy	May	25½	47	47
Harvesting:				
Maize, sorghum/groundnuts	May	3	5	10
	June	3	5	
Paddy	August	14	26	26
Processing: 2/				
Maize, sorghum/groundnuts	July	1½	3	3
Paddy	August	7½	14	14

Source: Survey data.

1/ Same as table A.1.

2/ This is a postponable operation in which every member staying at home was likely to participate. Days required as shown here are believed to be underestimated for cereals/groundnuts intercrop.