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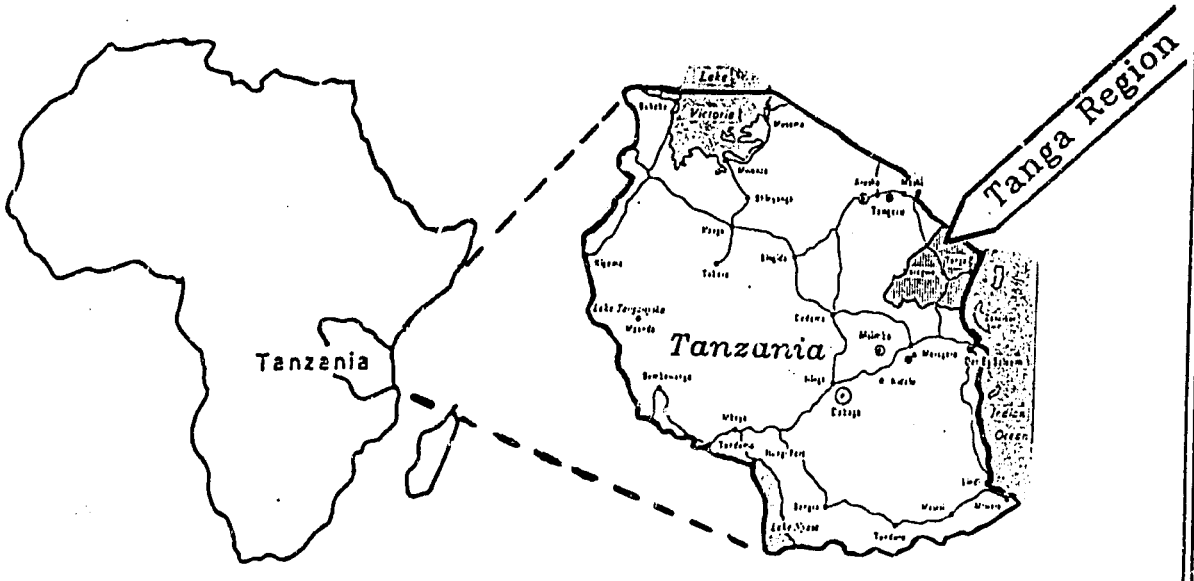
Beans (Phaseolus Vulgaris) in the Farming Systems in Tanga Region, *Tanzania, 1985*



by

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BEANS IN THE FARMING SYSTEMS IN TANGA REGION TANZANIA, 1985

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SUMMARY

As part of the Bean/Cowpea CRSP research in Tanzania, 78 smallholder farm families were interviewed in 1985 in Tanga region of Tanzania to collect information on their farming systems, the importance of beans in those systems, the varieties of beans grown, farmers' preferences for different varieties of beans for consumption, sale and storage, and the adequacy of the average family's diet. This report summarizes the results of data gathered from smallholder farm households in two major bean growing areas of Tanga region.

The study was undertaken jointly by faculty from Sokoine University of Agriculture, Morogoro, and the University of Illinois, USA as the Bean/Cowpea CRSP (Collaborative Research Support Program) encourages jointly funded research between US and host country scientists. The goal of this CRSP is the generation of increased food production and income for smallholder families in Tanzania. One of the priorities of this goal is the development of high yielding varieties of beans which are disease, insect and drought resistant. These new varieties must be complementary to the present smallholders' farming systems, smallholder families' tastes and preferences, and produce well in the agro-ecological zones in which they are introduced. This is the fourth area of Tanzania in which studies of this kind have been undertaken (Due et al., 1984(1),(2),and(3), 1985, and 1986).

Tanga region is in the northeast corner of Tanzania with Kenya and the Indian Ocean as borders (see Figure 1). What kind of a farming system and

level of income did these smallholder families, farming 25 acres or less, have?

Before responding to this question, it must be pointed out that the research was undertaken during a period when the economy of Tanzania was very depressed; foreign exchange was in extremely short supply, spare parts and imports had been pared to the bone. Most farm households did not use fertilizer, although it was recommended by the extension service. Fertilizer and other chemical inputs were largely unavailable. Most of the bean seed used was saved by the families themselves and the varieties were traditional varieties, often with local names. Bwanashamba was the variety most preferred in Lushoto for yield, consumption, storage and sale. This is the name by which the extension agent is called; thus this was a variety originally recommended by an extension agent. In Korogwe, Kilombero and Mwarusha were the two varieties most preferred. Kilombero is a variety originally from Kilimanjaro region and Mwarusha a variety from Arusha region of Tanzania.

All of the families but one reported consuming dried beans. They were consumed four times per week, on average, in Lushoto and three in Korogwe. Few of the families consumed bean leaves or green beans in the pod. Most of the dried beans were home produced, supplemented by purchases. The average family consumed 127 kg. per year in Lushoto in 1985 and 189 kg. in Korogwe. Families washed their beans before cooking; 77% soaked their beans before cooking. On average families cooked their beans two hours whether soaked or not.

Sixty-one percent of the families reported that bean seeds were chosen by husband and wife jointly. Families responded that they liked to grow the local varieties best as they were readily available in the markets, well adapted to the area, high yielding and insect resistent. However, families reported that too little early rain, diseases and insects affected bean yields adversely. This response emphasizes the need for high yielding, insect, disease and drought resistent varieties as yields in the two districts were very low (63 kg/acre in Lushoto and 251 kg/acre in Korogwe).

On average families planted 6.2 acres in Lushoto in maize, beans, maize/beans, potatoes, bananas, cassava, onions, and other vegetables and fruits; 2.1 acres of beans were planted after the maize had been harvested. In Korogwe the average family had 9.8 acres in crops of maize, beans, cassava, potatoes, bananas, and other vegetables and fruits. Almost two acres of maize, but no beans, were planted as a second crop after the first maize and maize/beans were harvested. In Lushoto families consumed 58% of their total production, sold 37% and saved 5% for seed. Cash income from crop sales amounted to 2,407 Tsh. for a household of 4.8 persons. In Korogwe 62% of the crop production was consumed, 35% sold, and 3% saved for seed. Cash income from crop sales amounted to 8,420 Tsh. for an average household of 4.9 persons in 1985. Bean sales contributed 34% of total crop sales on average.

Fifty-one percent of the household labor for farming was contributed by females in Lushoto and 55% in Korogwe. Females contributed more labor than

malas for all of the major crops produced. Small amounts of hired labor were utilized--an average of 13 days per household in Lushoto and 25 days in Korogwe. Only 28% of this labor was female. Most families were using very traditional tools in farming but 4 families in Korogwe hired mechanized farm machinery.

Considerable non-crop income was generated from employment off the farm, selling beer, and small quantities of fruits and vegetables. For the average household this non-crop income averaged 5,512 Tsh. In Lushoto 1,195 Tsh. was generated from livestock sales. These sales averaged only 191 Tsh. per household in Korogwe. Thus, on average, smallholder households in the two districts generated 6,257 Tsh. from crop and livestock sales and 5,512 Tsh. from non-crop income for a total of 11,769 Tsh. When farm operating expenses and family living expenses were subtracted, the average household had a balance of 4,833 Tsh. for savings or investment.

The acreages planted by the 78 smallholder families varied from 1.5 to 25. In order to contrast characteristics and earnings of small and large farms in the sample, the farms were divided into two groups--small farms of less than 8 acres and large farms of 8 acres or more. The average household size on the small farms was 4.4 and on the large 5.6; average acreage in crops was 4.8 and 14.1, respectively. Per capita consumption of the small household members from their own production was only 70% of the households on the large farms. Crop sales of the large farms were three times higher than for the small farms. Livestock sales were quite comparable for the two groups as was non-crop income per household. As was expected, farm

operating expenses (including hired labor) were significantly higher for the large farms. As a result, cash income per household was almost twice as high for the large than the small farms. These data are shown in more detail in Table 15.

In Lushoto the average family was consuming only 75% of recommended minimum levels of calories and protein from home produced foods. When a linear programming (LP) model was run to ascertain if the family could use the same acreage, labor, prices, and other constraints to generate sufficient crop production to provide minimum recommended levels of calories (2,350 per person per day) and protein (46 gms. per person per day) and generate a higher cash crop income it was found that, due to the relative prices of crops, the LP would optimize net revenue by having the families consume all bananas and some maize and sell all the beans and other crops (Solution 3) unless the LP was programmed to allow households to consume some of every crop (Solution 4). In Solutions 3 and 4 labor was binding in the month of September. However, if the labor was reallocated so that 10 more days were available in September, October and November (the periods of highest demand for labor), the minimum recommended levels of calories and protein could be met and an net cash income of 3,942 Tsh. generated per smallholder family. This is 1,235 Tsh. above current average family net income in 1985. These LP analyses indicate that families could allocate their time and land in a manner to provide the kinds and varieties of foods preferred and generate a higher net cash income to provide for farm operating and family living expenses, given present prices and assumptions made.

In Korogwe the average household had much higher crop production and net cash income. Here the average family was consuming 23% above minimum recommended levels of calories and protein and had a net cash crop income of 8,420 Tsh. In Korogwe the reported labor needed for crop production was much lower than in Lushoto; when a similarly constructed LP was programmed, labor was not a constraint in any month. In Solution 2 (Table 20) net income generated per household was above that earned by the sampled households (10,741 Tsh.) but households were consuming all maize and beans and other crops were being sold.

When the LP was reprogrammed in Solution 3 to have the average household consume some of all crops in approximately the same proportion as these sampled households in Korogwe, the net revenue rose to 10,465 Tsh. This optimal solution generated only 2,045 Tsh. more than the average for the sampled households. One must conclude that Tanga smallholder families were allocating their available resources in an manner to provide food for the family and a cash income for farming and other family living expenses, given prices, data available, and other assumptions.

Farmer reported that they would increase bean acreage if prices of beans were improved. Drought, insects and diseases were reported as the major factors affecting bean yields; thus, if bean breeders developed varieties which were drought, insect and disease resistant, farmers would experience improved yields, income, and nutrition. In addition to improved maize and bean varieties, sampled farmers were requesting fertilizer, increased visits by extension agents, and additional credit for input purchases.

BEANS IN THE FARMING SYSTEMS IN TANGA REGION TANZANIA, 1985

Jean M. Due, Jeremiah Rugambisa, Renee Schwartz and Negussie Tilahun*

In December, 1985, 78 smallholder farm families were interviewed in Korogwe and Lushoto districts, Tanga Region, Tanzania (Figures 1 and 2) to ascertain their farming systems and the importance of beans in those systems. This was the fourth area of Tanzania in which these data have been obtained as part of the Bean/Cowpea CRSP research (Due et al., 1984, 1985, and 1986). This report summarizes the sampling and data gathering methodologies and the results of the study.

This study was undertaken at a time when the economy of Tanzania was severely depressed. There was a severe balance of payments crisis and imports of all commodities, including agricultural inputs, were severely constrained. Thus, most farmers in the region and the nation could not obtain fertilizer and other insecticides or imported agricultural machinery if desired. High petroleum prices and shortages of petroleum and all kinds of spare parts affected all sectors of the economy but especially the transport and agricultural sectors, including extension services.

Agricultural surpluses can be sold either through the government marketing organizations or through small open markets. Prices in the latter are several times higher than through official channels as shown in Table 7.

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Figure I. Map of Tanzania Showing the Study Area - Tanga Region

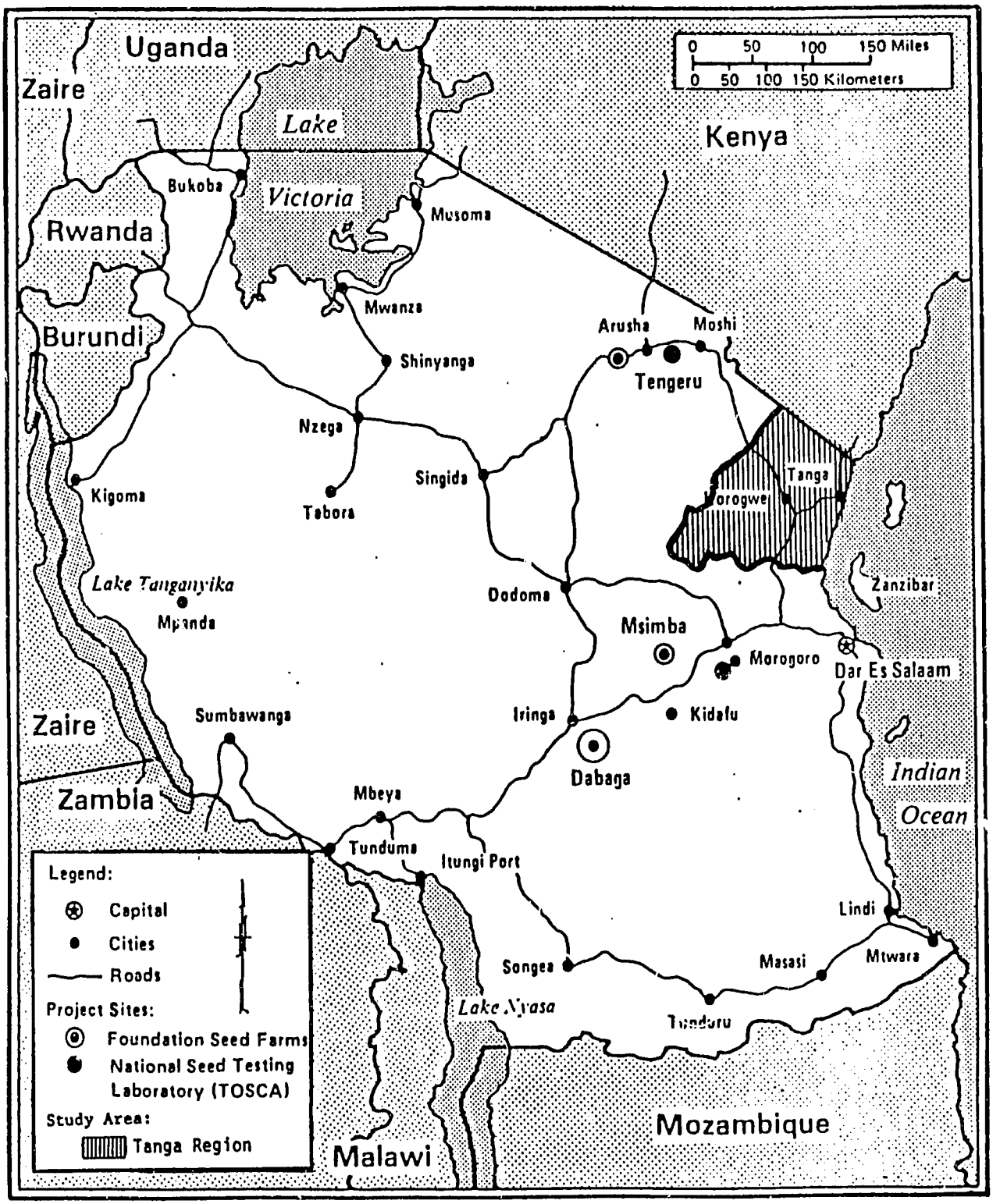
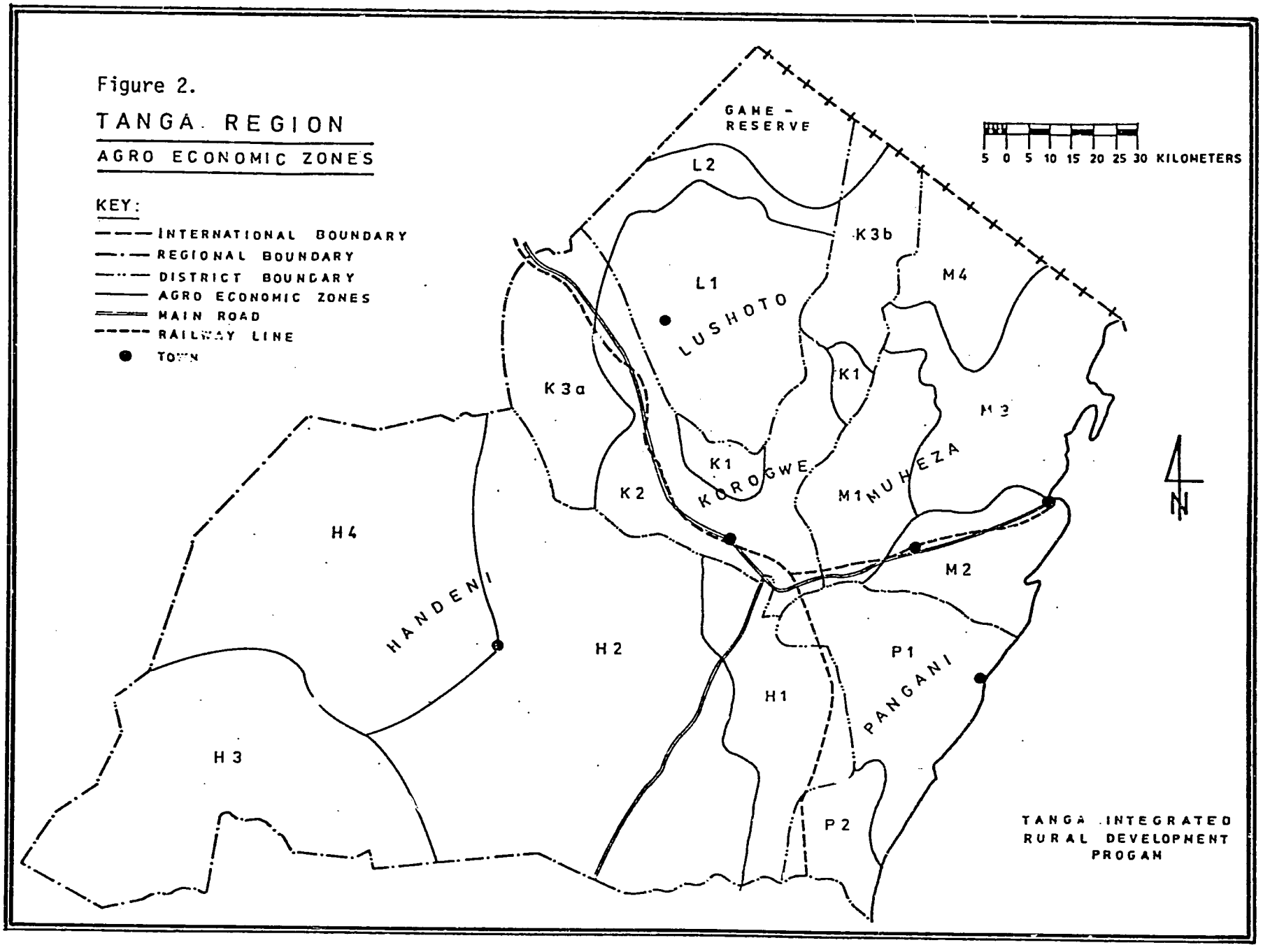


Figure 2.

TANGA REGION

AGRO ECONOMIC ZONES



The marketing boards have been inefficient and high cost. Like many other countries in tropical Africa, food production has not kept up with population growth, and the index of food production per capita in Tanzania in 1982-84 was 100, the same as the base year 1974-76, which was a drought period (World Bank, 1986, p. 190). In addition, the average daily calory supply per capita was 98% of the recommended FAO/WHO minimum requirements (Ibid, p. 234).

One of the reasons agricultural production has failed to increase as rapidly as population growth is the government policy of paying low prices to farmers to placate urban consumers. In recent years, however, official prices have increased, but open market prices continue to reflect shortages. Tanzanian government officials are attempting to stimulate agricultural production. Understanding the farming systems, farmers' perceptions of their circumstances, and the role of women in the farming systems are crucial factors in accelerating agricultural production.

Some General Characteristics of Tanga Region

Most soils in Tanga region along the coast and over the Usambara mountains are sandy loams. Deep red loams are found in the north and south of the Usambara mountains while black clay soils are found in the topographic depressions. The dark reddish-brown or dark clay soils have formed immediately to the south-west of the Usambaras, along the northern trunk road. While the sandy loams are largely either ferruginous or ferrisoils, those of the Usambaras are ferrallitic or ferrisoils in the high rainfall elevations and ferruginous lower down where the rain fall is lower (TIRDEP, 1975).

Primary school enrollment has increased rapidly in the region from 184,948 pupils in 1978 to 214,000 in 1984. This annual average rate of increase (2.6%) is lower than the national average of 2.7%. Lushoto had more classrooms per school (4.2) than any other district, followed by Korogwe with 3.9 in 1973/74. Also in 1974 Tanga region was better served with teachers than most other regions and had a pupil/teacher ratio of 43:1 compared with the national average of 46:1. By 1978 the pupil/teacher ratio in Tanga had risen to 47:1 while the adult literacy rate for the same year was 74 for males and 48 for females compared to the national rates of 65 and 39, respectively (Bureau of Statistics, 1984).

There are six secondary schools in the region, one private and five government operated; two of the schools are co-educational, one is for girls, and 3 for boys only. Three of the secondary schools teach to Form VI and the other three to Form IV. All secondary day schools are located in Tanga city which means that Tanga city students have a better chance of going to secondary school than rural students.

The quantity of health services in Tanga region is higher than the national average, with only 6.7% of the population not living within 10 km. of a stationary health facility compared with 21.8% for the country as a whole. Korogwe and Lushoto have two hospitals each with a total of 459 beds.

General Description of Lushoto District

The Lushoto district physical features are characterized by the Umba plains and the Usambara highlands. The Usambaras rise up to 2,400 meters(m) above sea level. The mountain soils have abrupt variations within short

ranges. The top is mainly forested, with soils that are laterite red; the slopes have non-laterite red and grey loamy mineral soils; and the lowlands have alluvial soils that are very fertile.

The vegetation in the highlands is mainly forest, degenerating into Acacia bushland and tropical forests, with grazing in higher regions. In the lowlands the vegetation is mainly grerovia conocarpoides bushland and Acacia with extensive seasonal grassland (TIRDEP, 1975-80).

The rainfall in Lushoto ranges from 800 - 2000 millimeters (mm.) in the highlands and from 500-600 mm. in the lowlands with three main peaks; the long rains fall from March to May and the short rains from October to December; July and August are shower months.

The population in Lushoto district was estimated at 248,000 people (1978). The population density in the Usambaras is about 175 persons per square kilometer (Km^2), while the density in the Umba plains is about 31 persons/Km^2. About 1,000 Km^2 of Umba plains is occupied by game reserves. The District of Lushoto has about 139 villages with 8 administrative divisions. Mlalo Division is the most populous with 74,899 people and 32 villages.

The major crops grown are maize, beans, Irish potatoes, cassava, bananas, coffee, and other vegetables and fruits.

General Description of Korogwe District

Korogwe district covers an area of 3,758 sq. km. The district lies to the south of the Usambara Mountains. Of the four divisions of Korogwe District, only Bungo division is dissected by steep slopes while the other three divisions are generally even plains with a few gently sloping hills.

The wetter plains of Korogwe Division have acacia bushland type of vegetation with seasonal extensions of grassland. The western and eastern drier plains of Korogwe District have predominantly acacia-cammiphora bushland as their natural vegetation.

The Korogwe highlands receive between 1,000 and 2,000 mm of rainfall per annum while the wetter plains receive between 800 and 1,000 mm and the drier plains an average of 600 and 800 mm per annum.

The crops grown include maize, pulses, bananas, cassava, sweet potatoes, vegetables, tea and coffee.

Sample Selection

A multi-stage sampling technique was utilized to select the farm families included in the survey. At the first stage it was ascertained that Korogwe and Lushoto districts were the major bean producing districts in Tanga region. The second stage involved the choice of major bean producing divisions within Korogwe and Lushoto districts; the divisions chosen were Korogwe and Magoma in Korogwe district and Mlalo in Lushoto district. From the three divisions, a total of four important bean growing villages were chosen--Kwasemangube in Korogwe division, Kerenge in Magoma and Maringo and Hemtoye villages in Mlalo division. The data on divisions and villages were obtained from the respective District Agricultural Development Officers (DADOs). Finally the families to be included in the sample were randomly selected from lists in each village, provided by the respective village chairpersons. A total of 20 households was randomly selected in each of the four villages; the completed sample was 39 in each district or 78 total

smallholder farm households (farming 10 ha. or less). The interviews were carried out in December 1985.

Family Characteristics

The sample of 78 families was drawn from two districts, Korogwe and Lushoto; the average household size was 4.8 persons in Lushoto and 4.9 in Korogwe in 1985. Although some families had no living spouse, the average number of wives was 1.23 in Lushoto and 1.17 in Korogwe.

Table 1. Characteristics of the Average Farm Family Sampled, Lushoto and Korogwe Districts, Tanga Region, Tanzania, 1985

Characteristics	Lushoto	Korogwe	Average for Sample
Number of families	39	39	78
Age of head	41	48	44
Age of spouse	33	40	36
Number of wives	1.2	1.2	1.2
Household size	4.8	4.9	4.8
Adults equivalents farming[1] - male	0.9	0.8	0.9
female	1.2	1.3	1.2
other adult	0.6	0.4	0.5
children	0.2	0.2	0.2
total	2.9	2.7	2.8
Years of formal schooling - head	4.8	5.7	5.2
Years of formal schooling - spouse	4.3	5.3	4.8
Percentage attending literacy classes	28	18	23
Years farming - head	20	23	22
Number of shambas operated	3.4	4.4	3.9
Food most preferred	maize & potatoes	maize & cassava	

[1]Adult equivalents in full-time farming were calculated as follows: adult male and female 18 years and over 1; males and females aged 12 to 17, 0.5; and males and females 8 to 11, 0.3. If persons were farming less than 12 months, the percentage of the year was used; e.g. nine months was 0.75 rounded to the nearest decimal of 0.8.

The average smallholder farmer sampled (of whom 7 were female) was 41 and 48 years of age, respectively in Lushoto and Korogwe, with the spouses aged 33 and 40. The number of adult equivalents farming[1] per household in each sampled district were 2.9 and 2.7, respectively, as shown in Table 1. This total was made up of 0.9 males and 1.2 females, 0.6 other adults (sex not identified) and 0.2 children in Lushoto and 0.8 males, 1.3 females, 0.4 other adults and 0.2 children in Korogwe.

The farmers had an average of 4.8 years of formal schooling in Lushoto compared to 5.7 years in Korogwe; spouses had an average of 4.3 and 5.3 years of formal schooling respectively; 28 and 18%, respectively, of the farmers had attended literacy classes.

Objectives in Farming

Sampled families were asked their primary objectives in farming; all of the families responding stated that their primary objective was to provide food for the family, followed by income needed to make farm and family purchases.

Food Preferences

Maize is the major staple food in most of Tanzania; the foods most preferred in Lushoto district were maize and potatoes although cassava, bananas and beans were also mentioned by a number of families. In Korogwe district the foods most preferred were maize and cassava with potatoes, bananas, rice and beans also mentioned.

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[1] See conversions bottom of Table 1.

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Number of Fields Operated

Most smallholder families operated a number of fields widely scattered. The average number of fields operated was 3.4 in Lushoto and 4.4 in Korogwe; fields varied from being close to the house to 13 km. distant; the average distances from the house were 1.6 km in each district.

Decisions as to Which Crops Are Planted

Who in these sampled families made the decisions as to which crops were planted in 1985? In Lushoto the decisions were made by the husband and wife jointly in 85% of the families; in the remaining cases the decision was reportedly made by the husband. In Korogwe district, husbands and wives made the decisions jointly in 62% of the reporting families, the husband made the decisions in 20% and the wives in 18% of the families.

Acreage in Crops

Maize and beans were the predominant crops planted in the Lushoto and Korogwe districts by smallholder families. Maize and beans were both intercropped and monocropped during the first and second planting; however, it was more common to monocrop during the second planting. For the total sample, average acreage planted per family was 8.0 with maize making up 3.1 acres (39% of the total acreage) and beans accounting for 2.7 acres (or 34% of the total acreage planted). As there is significant intercropping, it is not easy to estimate maize and bean acreages separately. Our crude method used was, if a field of 2 acres was 50% maize and 50% beans, that field was estimated as 1 acre of maize and 1 of beans. The next most important crops

planted were cassava and potatoes with smaller quantities of cabbage, bananas, rice, coconut, coffee, sugarcane, and other fruits and vegetables (Table 2). Average acreages planted per family were higher in Korogwe district villages than in Lushoto as seen in Table 2; these were 9.8 and 6.2, respectively.

Table 2. Average Acreage of Crops Planted Per Sampled Farm Family in Lushoto and Korogwe Districts, Tanga Region, Tanzania, 1985

Crops	Lushoto	Korogwe	Tanga Sample
Maize(1)	1.7	2.5	2.1
Maize(2)	0	1.9	1.0
Beans(1)	1.4	1.9	1.6
Beans(2)	2.1	0	1.1
Cassava	.1	1.7	.9
Potatoes	.5	.1	.3
Cabbage	.0	.0	.0
Bananas	.1	.4	.2
Other	.3	1.3	.8
Total	6.2	9.8	8.0

Maize (1) and beans (1) were planted during the first planting season; maize (2) and beans (2) were planted during the second planting season after the first crop had been harvested.

The average acreage which families had in crops varied when second plantings were included; families, on average, cultivate the same land but part of the farm is planted twice so that acreage in crops per family is higher when second plantings are included. When only first plantings were included the mean acreage per family was 4.1 in Lushoto and 7.9 in Korogwe;

when second plantings were included the mean per family was 6.2 in Lushoto and 9.8 in Korogwe.

Distribution of Farms by Size

Similarly, the distribution of farms by size differs depending on whether only first or first and second plantings are included; the size of farm does not vary but the size of crop acreage varies. These distributions are shown in Table 3.

Table 3. Distribution of Acreage in Crops With and Without Second Plantings, Sampled Farm Families, Tanga, Tanzania, 1985

Acres	Number of Farms					
	Lushoto		Korogwe		Tanga Sample	
	1*	1 & 2*	1*	1 & 2*	1*	1 & 2*
0 - 2.9	11	4	3	3	14	7
3.0 - 5.9	22	20	14	10	36	30
6.0 - 8.9	4	8	8	8	12	16
9.0 - 11.9	0	3	7	6	7	9
12 & over	2	4	7	12	9	16
Mean acreage	4.1	6.2	7.9	9.8	6.0	8.0

*1 means first planting only; 1 & 2 means first and second planting.

It is apparent from Table 3 that, on average, farm acreages in Korogwe were larger than in Lushoto (9.8 compared to 6.2 acres) while in each district families planted an average of 2 acres in second plantings. A much higher percentage of farm families sampled in Lushoto had farms under 3 acres (28%) in the first planting than in Korogwe (8%); in Lushoto small farm households planted the most second plantings; in Korogwe these were

more common across class sizes. Korogwe also had a larger percentage of families with large farms of 12 acres and over.

When frequencies of farmers planting each crop were developed it was seen that all farm families planted maize and 75 of the 78 families sampled planted beans as a first crop with only 31 (40%) planting beans and 24 (31%) planting maize as a second crop. Of those families with second crops of beans, 98% were Lushoto farmers, whereas second plantings of maize took place solely in Korogwe.

In Lushoto, only 3 of the 39 families had beans monocropped during the first planting season while 83 fields (shambas) were intercropped; all of the intercropped fields planted beans with maize and sometimes with maize and other crops (potatoes, bananas, sugarcane and cassava); only 1 of the fields intercropped beans without maize and that field had beans with potatoes. During the second season in Lushoto 49 fields were monocropped with only 3 intercropped, all with potatoes. In Korogwe, farming practices were quite different; 27 fields of beans were monocropped during the first planting season while only 18 were intercropped; much more of the intercropping was done with cassava, but also with maize and other crops. In the second planting season only 1 of these families planted beans and that family intercropped with maize.

Seven families in Lushoto and 26 in Korogwe planted cassava; 23 families in Lushoto and 5 in Korogwe planted potatoes, with 9 and 15, respectively planting bananas. All of the rice reported was in Korogwe district.

Labor Utilization

Labor is believed to be one of the major constraints to increasing agricultural production in Tanzania, given current technology. Labor is needed not only to expand acreage in crops but also in better weeding and

land preparation which would increase yields. In the Tanga districts sampled, most of the labor used is family labor; 11 families in Lushoto district (28%) and 21 families in Korogwe districts (54%) hired labor with an average cost per family of 520 Tsh. (Table 11). Thus hired labor costs are important in these areas. Of the labor hired, 9 were males and 4 females in Lushoto and 19 males and 6 females in Korogwe.

Family households averaged 4.8 persons in Lushoto and 4.9 persons in Korogwe (Table 1). These households included persons of all ages, with relatives as well as family members. Families were asked how many members were available for farming and for what periods of time. From this information the adult equivalents in farming were calculated on the basis of male and female adults 18 years and over being equal to 1, children aged 12 to 17 to 0.5, and children 8 to 11 to 0.3 adults. If a person worked in farming only 8 months of the year, the equivalency was calculated by multiplying by 8/12th or 0.67. When these calculations were completed, adult equivalencies in farming of all sampled household members can be summed; these amount to 2.9 in Lushoto and 2.7 in Korogwe of which 31% were males and 41% females in Lushoto and 30% males and 48% females in Korogwe (see Table 1). In the latter calculations, children and "other" household members were excluded because of insufficient gender information.

Enumerators asked each sampled respondent the number of days household members worked on each crop and cropping practice. These data are summarized per farm in Tables 4 and 5. It is apparent from Tables 4 and 5 that enumerators did not obtain accurate data on the labor utilized in marketing the crops; this was a major oversight. Given that qualification, it is apparent that total labor allocated to major crops was 564 days in

Table 4. Mean Total Days Allocated to Crop Enterprises by Crop and Percentage of the Days Contributed by Females per Sample Family, Lushoto, Tanga Region, 1985

Enterprise	Maize		Beans		Potatoes		Cassava		Rice		Other		Total	
	Total	%F	Total	%F	Total	%F	Total	%F	Total	%F	Total	%F	Days	%F
Land preparation	74.2	50	94.9	50	15.2	50	0.8	50	---	---	8.2	52	193.3	50
Planting	17.7	52	51.2	49	5.1	51	0.7	50	---	---	4.0	52	78.7	50
Weeding	63.7	50	84.2	50	9.5	57	---	---	---	---	8.0	50	165.4	50
Fertilizer use	0.4	50	---	---	---	---	---	---	---	---	0.3	40	0.7	46
Harvesting	50.8	51	58.3	50	10.3	51	---	---	---	---	6.6	52	126.0	51
Marketing*	---	---	0.3	50	---	---	---	---	---	---	---	---	0.3	50
Total	206.8	51	288.9	50	40.1	52	1.5	50	---	---	27.1	51	564.4	51

*Only 1 farmer reported in Lushoto

Table 5. Mean Total Days Allocated to Crop Enterprises by Crop and Percentage of the Days Contributed by Females per Sample Family, Korogwe, Tanga Region, 1985

Enterprise	Maize		Beans		Potatoes		Cassava		Rice		Other		Total	
	Total	%F	Total	%F	Total	%F	Total	%F	Total	%F	Total	%F	Days	%F
Land preparation	77.8	53	33.5	54	1.4	44	7.0	53	5.9	60	5.2	50	130.8	53
Planting	13.7	55	24.6	54	0.4	50	2.8	52	1.9	41	1.2	50	44.6	54
Weeding	59.0	56	26.0	56	---	---	7.7	60	---	---	7.3	52	100.0	56
Fertilizer use	0.1	50	---	---	---	---	---	---	---	---	0.1	50	0.1	50
Harvesting	43.3	54	33.3	58	---	---	2.0	100	1.1	50	0.4	50	80.1	57
Marketing*	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Total	193.9	54	117.4	56	1.8	46	19.5	59	8.9	53	14.1	51	355.6	55

*No farmers reported in Korogwe

Lushoto and 356 days per farm in Korogwe; females contributed 51% of the labor on major crops in Lushoto and 55% in Korogwe. In Lushoto beans were reported to be the largest labor users whereas in Korogwe maize was the crop to which the highest percentage of labor was allocated. In Lushoto males and females contributed almost equal amounts of total labor requirements in crop and cropping practice. In Korogwe, on the other hand, females contributed 56% of the labor on beans, 54% on maize, 59% on cassava and 46% on potatoes for a total of 55%; females were particularly important in weeding and harvesting.

Land Availability

When respondents were asked if they could obtain more land if needed for farming 29 (38%) replied, "Yes", and 48 (62%) replied, "No". Of the 29 who replied in the affirmative, only 9 were in Lushoto and 20 in Korogwe; thus Korogwe has much less pressure on land expansion than Lushoto. How can these farmers obtain more land? Thirteen of the 29 stated that they could clear more land--that is, remove the bush from it; one family could rent at 600 Tsh. per acre and 11 stated that they could borrow the land (for the season) without cost. Four families stated they could purchase land at 2,000 Tsh. per acre.[2]

Average Total Production, Consumption, and Sales Per Family

The sampled farm families had much larger acreage and higher production of farm crops per family in Korogwe district than in Lushoto; in Korogwe total production per family averaged 3,514 kg. while in Lushoto the average was only 2,040 kg. (Table 6). Of this total, 62% was consumed, 35% sold and

[2]Purchase means acquisition of the right to use land rather than ownership in the western sense.

Table 6. Average Production, Consumption and Sales of Major Crops in Kg. per Sampled Family, Tanga Region, Tanzania, 1985

Crop	Lushoto	Korogwe	Tanga Sample
Maize-production (kg)	815	1,460	1,138
consumption	662	956	809
sales	99	458	279
seed	54	46	50
Sales value (Tsh)*	916	3,021	1,969
Beans-production (kg)	219	477	348
consumption	127	189	157
sales	46	233	140
seed	46	55	51
Sales value (Tsh)	567	3,215	1,891
Cassava-production (kg)	37	645	341
consumption	27	433	230
sales	10	212	111
seed	0	0	0
Sales value (Tsh)	66	897	481
Potatoes-production (kg)	303	75	189
consumption	151	44	97
sales	148	31	90
seed	4	0	2
Sales value (Tsh)	468	154	311
Cabbage-production (kg)	238	36	137
consumption	46	26	36
sales	192	10	101
Sales value (Tsh)	210	15	113
Bananas-production (kg)	229	590	409
consumption	121	434	277
sales	108	156	132
Sales value (Tsh)	58	259	158
Other-production (kg)	199	231	215
consumption	48	97	72
sales	151	133	142
seed	0	1	1
Sales value (Tsh)	422	859	640
Total-production (kg)	2,040	3,514	2,777
consumption	1,182	2,179	1,678
sales	754	1,233	995
seed	104	102	104
Sales value (Tsh)*	2,707	8,420	5,563

*Tsh is Tanzanian shilling; 17.5 Tsh were valued officially at U.S $1 at the time.

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3% saved for seed (by weight) in Korogwe compared to 58% consumed, 37% sold and 5% saved for seed in Lushoto. This means that in Lushoto, families consumed 1182 kg. of total produce per family while in Korogwe consumption averaged 2,179 kg. or almost twice as many kg. With households averaging about the same number of persons, Korogwe family members consumed nearly twice as much food produced on their farms as members in Lushoto. With price ranges similar in the two districts, farm families' average total value of production would also be almost twice as high in Korogwe as in Lushoto.

Because of the significantly higher production in Korogwe, families had higher consumption and still had a significantly larger amount of produce left over for sale; average value of sales per family was 8,420 Tsh. in Korogwe compared to 2,707 Tsh. in Lushoto; thus Korogwe families had 3.1 times as much sales revenue from crops as Lushoto families, on average.

Maize production was also much higher in Korogwe than Lushoto although yields per acre were similar; 65% of maize was consumed in Korogwe and 81% in Lushoto. Similarity, bean production was much higher in Korogwe with 40% consumed there and 58% consumed in Lushoto. Bean sales per family accounted for 23% of total value of sales in Lushoto and 38% in Korogwe (Table 6). Bean sales contributed 567 Tsh. to average family incomes in Lushoto and 3,215 Tsh. in Korogwe.

Where Do These Tanga Farmers Sell Their Crops?

There were major differences between districts in the manner in which crops were sold. In Lushoto only 1 farmer sold to NMC (the government operated National Milling Company); 14 sold some of their crop in local

markets, to businessmen, others, or at the farm. It is obvious that farmers sell parts of their crop in different markets. In Korogwe no farmers sold to NMC but 19 sold to TARECU (Tanga Region Cooperative Union) and 27 sold through businessmen, others, or at the farm.

What were the reasons for their choices? Farm families sold locally or through non-official channels because of higher prices received (Lushoto 18, Korogwe 11) or because of convenience (Lushoto 3, Korogwe 12). A comparison of official government producer prices and open market prices in 1985 are shown in Table 7. Eleven farmers in Korogwe reported that they were forced to sell to TARECU.

When asked what their major marketing problems were, two answers predominated: lack of transport and low prices. Twenty-four farmers in Lushoto and 5 in Korogwe thought transport was the major problem; 21 in Lushoto and 17 in Korogwe responded that low prices were major factors. Farmers who sold to TARECU also reported that TARECU was very late in paying farmers for their crops.

Respondent's View of Harvest in 1985

Respondents were asked if the harvest was good, bad or average this crop year; in Lushoto, the predominant reply was "bad" (23 farmers or 64%); 4 (11%) farmers believed their harvest was good and 9 (25%), that it was average. In Korogwe, 15 respondents out of 36 (42%) had a bad harvest, 15 (42%) had an average harvest and 6 (16%) had a good season.

Factors Affecting Bean Yields

Each respondent was asked to rate the three primary factors which seemed to most adversely affect bean yields in 1985. Responses varied by

Table 7. A Comparison of Official Government and Parallel Market Prices in Tsh. per kg., Tanga Region, Tanzania, 1985/86.

	Official	Parallel Market
Maize	5.25	9.00
Beans, dried	12.00	16.00
Cassava	3.00	6.60
Potatoes	none	6.00
Coffee-Arabica	28.20	none
-Robusta	16.10	none
Rice*	8.00	23.00
Cabbage	none	1.50
Bananas	none	0.50
Others	none	5.00

*Produced by only 5 farmers.

district (Table 8); in Lushoto 21 farmers believed that too little early rain was the major factor, 9 believed too little late rain was primary, 4 said too much rain, 3 insects, and 2 thought "other" factors were the primary causes. The "other" factors included poor soil, hot temperature, animals, and cold weather. Two farmers believed there were no problems. The second most important factor affecting yields in Lushoto in 1985 was often not specified; those specified were bean flies, aphids, bean mites, worms and bruchids. Diseases were not specified. Many respondents did not articulate a third factor; of those who did 5 reported diseases, 4 insects, 2 too much rain, and 2 unavailability of inputs (Table 8).

In Korogwe, too little late rain was the major factor of reduced yields for 11 respondents, too little early rain (8), too much rain (5), insects (4) and unavailability of inputs (4). The second most

Table 8. Farmers' Assessment of Major Factors Affecting Bean Yields, Tanga, Tanzania, 1985.

Factors	Lushoto			Korogwe		
	1	2	3	1	2	3
Too little early rain	21	0	0	8	1	0
Too little late rain	9	4	0	11	3	2
Too much rain	4	2	2	5	5	2
Insects	3	18	4	4	5	3
Diseases	0	1	5	1	9	3
Poor seeds	0	1	0	3	1	0
Unavailability of inputs	0	0	2	4	1	3
Other (poor soil, animals, heat, cool weather)	2	3	0	2	0	0

important factor there was disease, with 9 responses, followed by too much rain (5) and insects (5). Insects, diseases and unavailability of inputs were the most mentioned third factors. The other factors related to too high temperatures and animal destruction.

Thus, in the two Tanga districts sampled, it appears to farmers that drought, timing of rains, and excessive amounts of rain were the primary causes of reduced yields. This implies that breeders should put increased emphasis on drought resistant characteristics of beans to assist with yield improvement.

Do Farmers Choose Special Soils for Beans?

Farmers were asked if they have a special place to plant beans; 73% responded in the affirmative; of these 21 families were in Lushoto and 33 in Korogwe. On the 54 affirmative respondents, 24 mentioned black, moist soil;

some mentioned fertile soil, well drained, others mentioned valleys, and "as a rotation crop". Note that a higher percentage (89%) had a special place for beans in Korogwe than in Lushoto (57%).

Farmers' Responses if the Present Yield of Beans Doubled

If the present yield of beans doubled, all but one of the 78 farmer respondents said that they would grow more beans; the one exception said that their family would grow the same amount. Most of the respondents stated that they would grow two to three times as much; some would increase acreage two or three times; only 8 families stated that they would grow more beans and less of another crop; the reduced acreage would be in cabbage (2 families), vegetables (2), cassava (2) and maize (1 family).

Farmers' Responses if Bean Prices Changed

If the present price of beans doubled all but 2 farmers in Lushoto (95%) and in Korogwe (95%) would grow more beans; again respondents stated that they would grow 2 to 3 times more. Nineteen families (49%) in Lushoto and 21 (54%) in Korogwe would grow more beans and not reduce acreage of other crops. Other families in Korogwe would reduce acreages of potatoes (9 families), maize (7), cassava (1), cabbage (1) and sugarcane (1) in Lushoto and cassava (4), bananas (1), sugarcane (1), vegetables (1) and other crops (1) in Korogwe.

If the present price fell by one-half, all but 5 respondents in Lushoto and 17 in Korogwe stated that they would grow the same amount of beans for food and cash; more emphasis was placed on food than cash in the responses. It is apparent that farm respondents highly value beans for food

consumption. It is also apparent that if bean prices or yields increased, farm families would respond by growing more beans.

Consumption Characteristics Most Desired of Beans

(a) Yield:

In Tanga region many different types of beans were grown and preferences for yield varied markedly by district. In Lushoto a local variety was most preferred by 10 respondents followed by Bwanashamba (8), Kilombero (5), China (4) and hybrid (4) and other mixed varieties (6); one family did not grow beans. Second choices were China (4), Bwanashamba (3), local (3), Kilombero (1), and Kachina (1). In Korogwe the most preferred varieties for yield were Kilombero (17), Mwarusha (14), Canadian Wonder (6), Bwanashamba (2) and Msafiri (1). Second choices were Msafiri (5), Mwarasha (4), Kilombero (3), Bwanashamba (2), and China (1). Bwanashamba is the Kiswahili word for extension agent; presumably the bean variety received its name because it was recommended by an extension agent. Mwarusha means coming from Arusha and was probably a local name for Canadian Wonder.

(b) Palatability:

Respondents were asked their preferences of varieties of beans for palatability as leaves, green pods and dry beans. Most respondents answered only with regard to their preferences for dried beans. Again, there was as great number of varieties as listed above for yield. In Lushoto the local variety was most preferred by 15 families followed by Bwanashamba (9), China (5), Kilombero (3), Kachina (2) and 3 others preferred by 1 family each. Second most preferred for palatability were Kilombero (3), China (3), hybrid (3) and Bwanashamba (2). In Korogwe the most preferred varieties

were Mwarusha (18), and Kilombero (13) followed by small numbers preferring Canadian Wonder (4), China (1), and two other varieties (1 each). The second most preferred varieties were Bwanashamba (12), Kilombero (6), Msafiri (5), Mwarusha (2), and Masai red (1). Thus the local variety and Bwanashamba were most preferred in Lushoto and Mwarusha and Kilombero in Korogwe. Families stated that preferred varieties were tasty, available, a preferred color, and soft when cooked or cooked quickly.

(c) Storage:

Which varieties were most desired for storage? When respondents were asked which varieties of beans they preferred for storage, there were no responses from 11 in Lushoto and 5 in Korogwe, and several who said they had no preferences (3 in Lushoto and 11 in Korogwe). Of those respondents who mentioned a preference, 13 preferred the local variety, 8 Bwanashamba, 2 Kilombero and 1 each Mwarusha and China in Lushoto. Second preferences were few (4 for hybrid and 3 for China). In Korogwe varieties preferred for storage were Kilombero (17 respondents), Mwarusha (15), Bwanashamba (8), Msafiri (6), Canadian Wonder (4), and Khaki (1); second choices were few- Bwanashamba (3), Mwarusha (2), and Kilombero (1). Thus the local variety and Bwanashamba were most preferred for storage in Lushoto and Kilombero and Mwarusha in Korogwe.

(d) Sale

Which varieties do these sampled Tanga farm families prefer for sale? Again there were marked differences in preferences by district; the local variety was most preferred by 14 families in Lushoto followed by Bwanashamba (9), Kilombero (6), China (3) and four others with 1 choice each. Second choices were China and hybrid (4 each), Bwanashamba (3) and Kilombero and

Kachina 1 each. In Korogwe, the first choice was Mwarusha (17), Kilombero (16), Msafiri (5), Canadian Wonder (3), and Bwanashamba (2). Second choices were Bwanashamba (11), Msafiri (5), Mwarusha (3) and Kilombero (2).

In stating why they preferred certain varieties for sale, families in Lushoto said they preferred ones which were heavy (11), and available (8); in Korogwe 17 families mentioned heavy and others mentioned appearance, price and popularity.

Major preference for yield, consumption as dry beans, storage and sale can be summarized by district as follows:

	Lushoto		Korogwe	
	(1)	(2)	(1)	(2)
Yield	Local	Bwanashamba	Kilombero	Mwarusha
Consumption-dry beans	Local	Bwanashamba	Mwarusha	Kilombero
Storage	Local	Bwanashamba	Kilombero	Mwarusha
Sale	Local	Bwanashamba	Mwarusha	Kilombero

How Often Does Your Family Consume Beans?

Respondents were asked how often their family consumed bean leaves, green beans in the pod, mature green beans, and dry beans. None of the respondents said that they consumed bean leaves or green beans in the pod. Only three families (8%) in Lushoto and two (5%) in Korogwe reported consuming mature green beans; in both areas these beans were consumed three times per week for 8 weeks and were home produced.

All but one family reported consuming dried beans; times consumed per week varied from 1 to 7 with the average being 4 in Lushoto and 3 times in Korogwe. Forty percent of these families consumed beans 52 weeks a year

with some as infrequently as 12 weeks a year; the average weeks beans were consumed was 47 in each district. Most of the dried beans were home produced, supplemented by purchases. In Lushoto 16 families (41%) made some purchases during the year; in Korogwe 15 (38%) made some purchases and 4 families reported purchasing all their beans. The average family consumed 180 kg per year in Lushoto in 1985 and 155 kg. in Korogwe; average amounts consumed per serving were 1 kg in Lushoto and 1.3 kg in Korogwe.

Cooking Preparation of Dried Beans

All families reported that they washed their beans before cooking, 60 (77%) families soaked their beans before cooking and 8 families reported spicing their beans with coconut milk or okra. Families which did not soak their beans did not believe this required a longer period of cooking. Families cooked their beans an average of 2 hours.

Who Chooses the Bean Seeds for Planting?

Of the 70 families responding, 43 (61%) reported that bean seeds were chosen by husband and wife jointly, 16 reported the husband chose the seeds and in 7% of the cases the wife chose the seeds. In the remaining 16% of the families it was a family decision. In Lushoto, 68% of the choices were made by husband and wife jointly compared to 56% in Korogwe.

Families responded that they liked to grow the local varieties best because they were readily available, well adapted to the area, high yielding and insect resistant. The second most preferred varieties were Bwanashamba and Kilombero and the third choice Mwarusha. Families' preferred choice of varieties for the long rainy season were Kilombero (14), Mwarusha (10), and Canadian Wonder (4). Kilombero was first choice because it was well adapted to climatic conditions, was heavy, tasty and readily available.

Storage of Beans

Seventy-five (96%) of the farmers responded that they stored their dried beans in bags; 2 families store on the floor and 1 in tins. All of the beans were dried in the sun before storage. Do these families believe they have storage problems with their beans? Forty (56%) of those responding believed they had problems with boring insects or other pests. Other farmers believed the use of chemicals reduced germination and that there was a lack of sufficient chemicals to spray the beans.

Livestock Ownership

These Tanga sampled farm families did not own many livestock; the average number owned per family was 9 in Lushoto and 22 in Korogwe (Table 9). Average value of livestock owned per family was 4,732 Tsh. in

Table 9. Average Number and Value of Livestock Owned, Consumed and Sold per Sampled Farm Family, Tanga, Tanzania, 1985

	Owned		Consumed		Sales	
Lushoto	No.	Value (Tsh.)	No.	Value (Tsh.)	No.	Value (Tsh.)
Goats	0.7	560	<0.1	2	0.2	140
Poultry	5.4	253	2.2	153	0.4	27
Cattle	2.2	3,539	0.1	276	0.4	947
Sheep	0.7	367	0.1	74	0.1	73
Other	0.1	13	0	0	<0.1	8
Total	9.1	4,732	2.4	505	1.1	1,195
Korogwe						
Goats	1.2	725	0.3	228	0.2	134
Poultry	19.1	924	10.3	1,092	0.8	55
Cattle	0.9	1,477	0.1	338	0	0
Sheep	0	0	0	0	0	0
Other	0.6	60	0.2	14	<0.1	2
Total	21.8	3,186	10.9	1,672	1.0	191

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Lushoto and 3,186 in Korogwe; only 2 and 11, respectively, reported consuming poultry during 1985. Sales during the year were much higher in Lushoto where some of the cattle were sold; average livestock sales per family there were 1,195 Tsh. compared to only 191 Tsh. for Korogwe families.

Farm Capital Owned

These Tanga farm families did not own significant amounts of farm real capital in 1985; almost every family had hoes, pangas and axes and some had shovels, sprayers, hammers, and other items; none of the families owned oxen or ploughs. Average number of farm tools owned per family, their value,
estimated life and annual depreciation are shown in Table 10. The average value of farm implements owned per family was 438 Tsh. in Lushoto and 242 Tsh. in Korogwe and annual depreciation was 80 and 50 Tsh. in 1985, respectively.

Table 10. Average Number of Farming Tools Owned Per Sampled Farm Family, Value, Estimated Life, and Annual Depreciation, Tanga Region, Tanzania, 1985

Tools	Number		Value (Tsh.)		Est. Life (Years)		Depreciation (Tsh.)	
	Lushoto	Korogwe	Lushoto	Korogwe	Lushoto	Korogwe	Lushoto	Korogwe
Hoes	5.1	4.6	63.5	73.4	3.6	3.2	25.5	27.4
Pangas	2.0	2.4	52.2	52.3	8.0	7.1	10.9	9.2
Axe	1.4	1.3	58.9	51.6	16.0	14.4	4.7	4.7
Shovel	0.3	0.4	27.7	34.2	2.6	4.2	4.2	3.8
Hammer	0.2	0.3	13.5	18.6	3.2	4.2	0.8	1.6
Sprayer	0.3	0	222.3	0	2.4	0	33.5	0
Other	0	1.3	0	11.7	0	1.1	0	3.0
Total	9.3	10.3	438.1	241.8			79.6	49.7

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Farm Operating Costs

Average total farm operating costs per sampled family in each village are shown in Table 11. Hired labor was the most costly item in the farm

Table 11. Number Reporting and Mean Values of Farm Operating Costs and Depreciation per Sampled Farm Family, Tanga Region, Tanzania 1985

Purchased Inputs	Lushoto No. Reporting	Lushoto Mean (Tsh.)	Korogwe No. Reporting	Korogwe Mean (Tsh.)	Tanga Sample (Tsh.)
Hired labor					
-male	9	291	19	598	444
-female	4	93	6	59	76
-total	13	384	25	657	520
Seed	11	169	17	496	333
Fertilizer	14	211	1	2	106
Chemicals	3	49	1	4	26
Tools & equipment	0	0	3	29	15
Transport	3	150	3	76	113
Machinery for hire	0	0	4	146	73
Renting land	1	8	0	0	4
Depreciation		80		50	65
TOTAL (Tsh.)		1,051		1,460	1,255

operating costs followed by fertilizer (Lushoto only) and seed; transporting crops to market and hiring machinery were also important expenditures for some farmers; hired machinery costs were reported in Korogwe only by 4 farmers but costs were high. Only 11 farmers in Lushoto but 21 (54%) in Korogwe had hired farm laborers in 1985; of these more men were hired than women in each area. Fertilizer was available and utilized in Lushoto but was utilized by only 1 farmer in Korogwe. Although 14 families reported purchasing fertilizer or manure in Lushoto district, only 4 families

reported using fertilizer and most of this was used on cabbage, tomatoes, and potatoes; only 1 family reported using fertilizer on maize. In Korogwe, only 1 family reported using fertilizer and 1 manure; fertilizer was used on maize and manure on bananas. When interviewers asked how much fertilizer or manure was used per acre, responses varied so widely that it is obvious that the question was not being understood properly. Total average farm operating expenses per farm (including depreciation) were 1.051 Tsh. in Lushoto and 1.460 Tsh. in Korogwe.

Off-Farm Income and Gifts

On average sampled families earned significant amounts of income from employment off the farm, working as a secretary, tailor, teacher, driver, nurse, night watchman, shop owner, timber business person and house renter. These earnings varied widely by family from 0 to 50,000 Tsh; the average was 1,610 Tsh. per family in Lusotho and 5,073 Tsh. in Korogwe in 1985. Other significant amounts were earned by both males and females selling pombe (beer) and other small quantities of charcoal, vegetables,

Table 12. Average Off-Farm Income and Gifts Per Family Sampled Farm Family, Tanga Region, Tanzania, 1985.

	Lushoto			Korogwe			Tanga Sample		
Source	Male	Female	Total	Male	Female	Total	Male	Female	Total
Employment & Wages	1,606	4	1,610	4,770	303	5,073	3,188	154	3,342
Selling pombe (beer) etc.	1,544	295	1,839	1,940	415	2,355	1,742	355	2,097
Gifts	0	1	1	144	0	144	72	1	73
TOTAL	3,150	300	3,450	6,854	718	7,572	5,002	510	5,512

beverages, and so forth. These latter earnings averaged 1,839 Tsh. per family in Lushoto and 2,355 Tsh. in Korogwe; males earned much more than females in each of these endeavors (Table 12). Gifts were much less important as income sources to these families. Average total earnings from non-crop income and gifts averaged 3,450 Tsh. in Lushoto and 7,572 Tsh. in Korogwe (Table 12).

Family Living Expenditures

These families reported average family living expenditures of 4,799 Tsh. in Lushoto and 6,563 Tsh. in Korogwe in 1985 as shown in Table 13.

Table 13. Average Family Living Expenditures Per Sampled Farm Family, Lushoto and Korogwe Districts, Tanga Region, 1985.

Category	Lushoto		Korogwe		Tanga Sample	
	Tsh.	%	Tsh.	%	Tsh.	%
Food	1,259	26	1,886	29	1,572	28
Maize grinding	626	13	540	8	583	10
Clothing & footwear	1,052	22	1,760	27	1,406	25
Fuel, housewares, furniture, etc.	892	19	1,180	18	1,036	18
Transportation	237	5	316	5	277	5
Education & medicines	133	3	288	4	211	4
Fees & licenses	338	7	338	5	338	6
Development tax	262	5	255	4	258	4
TOTAL	4,799	100	6,563	100	5,681	100

Food expenditure was the largest single item accounting for 26% and 29% of total expenditures, respectively, in 1985; maize grinding added 13 and 8%,

respectively, thus food and maize grinding (for food) totalled 39% of family living expenditures in Lushoto and 37% in Korogwe. Clothing and footwear expenditures amounted to 22% and 27%, respectively, with fuels, furniture and other household costs 19% and 18% in 1985. Fees and licenses averaged 7% and 5%, respectively per village but these do not include the new development tax levied by the government for village development. The development taxes averaged 5% and 4% of total family expenditures and, when added to other fees and licenses, amounted to 12% and 9%, respectively per village.

Total and Net Cash Income

Total and net cash incomes generated from crop and non-crop sources are shown in Table 14.

Table 14. Average Total and Net Cash Income (in Tsh) per Sampled Family, Tanga Region, 1985.

Source	Lushoto	Korogwe	Average for Sample
Crop sales	2,707	8,420	5,564
Livestock sales	1,195	191	693
TOTAL FARM INCOME	3,902	8,611	6,257
Less farm operating expenses	1,051	1,460	1,255
Net farm income	2,851	7,151	5,002
Non-crop income	3,450	7,572	5,512
Sub-total net income	6,301	14,723	10,514
Family living expenditures	4,799	6,563	5,681
BALANCE	1,502	8,160	4,833

These sampled farm families had, on average 3,902 Tsh. cash income from crop and livestock sales and 3,450 non-farm income in Lushoto district and 8,611 and 7,572 Tsh., respectively from these sources in Korogwe district. Average farm income was greater than non-farm income in both districts, but only slightly greater. Seven families in Lushoto and 11 in Korogwe reported non-farm income. When farm operating expenses and family living expenditures were subtracted from cash income, Lushoto families had a balance of 1,502 Tsh. on average and Korogwe families had 8,160 Tsh. in 1985. Due to the non-farm incomes which these families were able to generate, the sampled smallholders in the Tanga region had significantly higher balances for investment, saving, or other expenditures than families sampled in Morogoro or Arusha regions in earlier years (Due et al., 1984, 1985, and 1986).

Borrowed Money

Several questions were asked as to whether or not families had borrowed money during the year and their repayment experience. Five of the 78 families sampled (6%) had borrowed; 2,000 Tsh., the largest amount, was borrowed from friends to rent a shamba (farm) and was repaid in full. Amounts of 1,500, 1,000, 800, 700 and 70 Tsh. were borrowed, all from friends or relatives for food, illness and general expenses; all but 1,100 Tsh. was repaid; no interest had been charged on any of the loans.

Was any money borrowed by the women for their activities? Seventy-five responded and all said, "No."

Bank Accounts and Postal Savings Accounts

Only 2 families in each district had bank accounts; in each case the account was in the husband's name. Post office savings accounts are often more widely used than banks in Africa as they are more numerous and at more favorable locations; in this sample, only 1 woman had a post office savings account.

Agricultural Extension

Farmers were asked if the agricultural extension agent had visited them during the past year; 10 farmers (26%) in both Lushoto and Korogwe had been visited during the year 1 to 4 times; the average was 1.8 times. Twenty-nine farm families (74%) in each district had not been visited. Advice given related primarily to planting and land preparation of maize and/or beans with 2 families reporting having received advice on coffee. Nine of the 10 farmers visited in each district believed that the agent's advice was helpful in increasing yields.

General Comments

Families were asked to make general comments about farming, government policy, the survey, and so forth. These comments varied by district; in Lushoto the need for better bean and maize varieties surfaced most frequently (20 responses), followed by the need for fertilizer or a fertilizer subsidy (5), more extension agent visits (4) and more credit for input purchases (3). In Korogwe comments centered on the need for tractors for hire (10), better bean or maize varieties (9), credit for inputs (8),

more extension agent visits (6), better prices (5) and more fertilizer available or fertilizer subsidies (2).

Comparison of Large and Small Farms

The acreage planted among the 78 farms sampled varied from 1.5 to 25 acres. In order to contrast characteristics and earnings of small and large farms in the sample, the farms were divided into small farms of less than 8 cres and large farms of 8 acres or more planted in crops. The average household size of the small farms was 4.4 and of the large farms 5.6, as shown in Table 14. Average acreage in crops was 4.8 for the small group of 51 farms and 14.1 for the large group of 27 farms. Total crop production average 1,761 kg for the small farmers and 4,696 for the large group; of this total, the small farmers consumed 1,597 kg. (or 91%) while the large farm operators consumed 2,746 kg. (or 58%). Consumption per capita averaged 363 kg. for the small farm families and 490 kg. for the large households; per capita consumption of small household members was 70% of members of large farm households. Thus the small farmers had crop sales of only 3,029 Tsh. while the large farmers had crop sales of 10,349 Tsh. Livestock sales were more comparable for the two groups--averaging 651 Tsh. for the small and 772 Tsh. for the large farmers. Thus farm income from crops and livestock totalled 3,680 Tsh. for the small group compared with 11,121 for the large group. The largest contrast was, as expected, in farm operating expenses, which averaged 848 Tsh. for the first group and 1,837 Tsh. for the large farmers. Hired labor costs averaged 325 Tsh. for the small farmers and 889 Tsh. for the large. Seed purchases averaged 217 and 550 Tsh, respectively, for small and large farmers.

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Table 15. Comparison of Socio-Economic and Production Factors Between Small (< 8 acres) and Larger (8-25 acres) Smallholder Farm Households, Tanga Region, Tanzania, 1985.

	Tanga, 1985	
	Small	Large
Size of samples	51	27
Average household size	4.4	5.6
Average crop acreage	4.8	14.1
Total crop production		
-- quantity (Kg.)	1,761	4,696
-- value (Tsh.)		
Crop sales (Tsh.)	3,029	10,349
Livestock sales (Tsh.)	651	772
Farm income (Tsh.)	3,680	11,121
Farm operating expenses	848	1,837
Off-farm income	5,578	5,388
Total net cash income	8,410	14,672
Family living expenses	4,628	7,670
Balance	3,782	7,002
Percent production consumed	91%	58%
Labor --family % female	54%	50%
% male	46%	50%
--hired % female	20%	16%
% male	80%	84%
--total labor % F	54%	48%
% M	46%	52%
Labor -- family days F	226	270
M	192	268
-- hired days F	2	6
M	5	31
-- total labor days F	228	276
M	197	299

Labor use differed by size of farm; the small farms, 54% of the household labor was female and 46% male; on the large farms household labor was 50% female and 50% male. Hired labor was 20% female and 80% male on the small farms and 16% and 84%, respectively, on the large farms. Thus total labor was 54% female on the small farms and 48% on the large farms; total labor days averaged 425 and 575 days, respectively.

Income earned from non-crop sources--from selling small quantities of fruit and vegetables, making beer, and employment off the farm averaged more for the small (5,578 Tsh.) than the large farmers (5,388). Combined net cash income averaged 8,410 Tsh. for the small farmers compared with 14,672 Tsh. for the large farmers. If family living expenses of 4,628 Tsh. for the small farmers and 7,670 Tsh. for the large farmers are subtracted from net cash income, the small farmers had a net balance of 3,782 Tsh. for savings, investment, other expenses and the large farmers had an average net balance of 7,002 Tsh.

In summary, the large farms, averaging 14.1 acres in crops in 1985, had a balance of 7,002 Tsh. from their activities while the small farmers, with an average of 4.8 acres in crops, had a balance of 3,782 Tsh.; acreage in crops of the large farms was almost three times the crop acreage of the small farmers but net returns was only approximately twice as great since the small farm households generated relatively more income from non-farm sources.

Further Analyses

A linear programming (LP) model was developed to ascertain whether, with present prices, yields, labor, acreage, and other inputs the average farm household in each district could provide minimum calories and protein

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per person recommended by WHO/World Bank and, at the same time, provide a higher net return for the family. The model first developed showed that unless minimum acreages of several crops were programmed, the calorie and income requirements would be met by producing only one crop on the average cultivated acreage. Since these families' first priorities are to provide food for the family and since families desire a variety of foods, it was necessary to require the model to provide minimum amounts of the major crops grown--maize, beans, bananas, and other vegetables - cassava, onions, potatoes, and so forth.

Linear Programming

The objective of the Linear Programming model is to determine the optimal mix, consisting of eight crops, that produce the highest net returns subject to land, labor and nutritional (i.e., miminum recommended calorie and protein) requirements. The included crops were maize, beans, banana, cassava, potatoes, cabbage, onion and tomato. For convenience in specifying the model, these crops were classified into four major groups of maize, beans, banana and others.

The linear programming model was formulated as follows:

$$\text{Max } Z = \sum_{i=1}^{4} b_i X_i - \sum_{i=1}^{4} P_i C_i - \sum_{i=1}^{4} S_i$$

subject to:

1) $\sum_{i=1}^{4} X_i \leq L$

2) $\sum_{i=1}^{4} W_{mi} X_i \leq K_m \qquad m = 1, 2, \ldots\ldots\ldots\ldots\ldots 12$

3) $\sum_{i=1}^{4} l_i X_i \geq M$

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4) $\sum_{i=1}^{4} U_i X_i \geq Q$

5) $X_i l_i - C_i - S_i = 0$

6) $\sum_{i=1}^{4} C_i \geq M$

where:
- i - Crops - namely maize, beans, banana and others
- b_i - Value of production of crop i minus farm operating expenses
- X_i - Yield per acre of crop i
- P_i - Price of a Kcal of crop i
- C_i - Quantity Kcal of crop i consumed
- S_i - Quantity Kcal of crop i sold

1) L - Average acreage of land available (6.2 acres)

2) W_{mi} - Average number of days farm household worked with crop i per acre.
- m - Months, January through December
- K_m - Number of days available for work per month

3) l_i - Calorie yield (Kg) of crop i per acre
- M - amount of Kcals households must consume to meet minimum calorie requirement

4) U_i - Utilizable protein yield (Kg) of crop i per acre
- Q - Minimum Kg of crop household must consume to meet daily minimum protein requirement

<u>The Objective Function</u>

$$\text{Max } Z = \sum_{i=1}^{4} b_i X_i - \sum_{i=1}^{4} P_i C_i - \sum_{i=1}^{4} S_i$$

The objective function is to maximize the net return from crop production defined as total value of production less farm operating expenses and food cosumption. Farm operating costs for Lushoto and Korogwe districts are presented in Table 11. The farm operating costs for each crop/acre were deducted from its total value of production/acre. Since the importance of

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each crop in terms of land allocation varies, different weights were given to each crop in calculating operating costs per acre. Farm operating costs include expenses on hired labor, fertilizer, seed, transport, depreciation, chemicals and land renting.

A wide disparity was observed between official and parallel (unofficial) market prices (Table 7). Parallel market prices were used in this analysis because almost all farmers sold their crops in the parallel markets.

The objective function is maximized subject to a set of twenty-eight linear constraints. These consist of one land constraint, one labor constraint for each of the twelve months, a calorie constraint, a protein constraint and five consumption constraints.

The land constraint is:

$$\sum_{i=1}^{4} X_i \leq L$$

The average acreage of crops planted per sampled family is shown in Table 2. This was used in the LP and was constrained not to exceed the average farm size in the two districts (i.e., 6.2 acres for Lushoto and 9.8 acres for Korogwe respectively).

Labor Constraints:

$$\sum_{i=1}^{4} W_{mi}X_i \leq K_m \qquad m = 1, 2, \ldots\ldots\ldots\ldots 12$$

The family labor input for each of the farming activities--land preparation, planting, weeding, fertilizing, harvesting and marketing for the major crops during the crop year--were obtained from the survey. The average labor days expended on these activities per month per acre of each crop type multiplied by the average adult person equivalents working in

agriculture of each household was used for the LP. The total number of days available per month is calculated by subtracting a total of six days per month for such activities as religious and cultural ceremonies, illness and marketing. The remaining days in each month were multiplied by the average adult labor equivalents for each district.

Nutritional Constraint:

One interest of the present analysis is to ascertain if the current mode of production provides the minimum calorie and protein for the average household. Calorie and utilizable protein (protein completely utilizable for anabolic purposes) are therefore included in the model to capture the nutritional consideration of households in food production. The calorie and utilizable protein (UP) content of the different crops produced by the farm households are shown below (Latham, 1979, pp. 264-276):

Food	Kcal/kg	UP content per kg
Maize	3,620	46 gms.
Beans	3,360	163 gms.
Rice	3,640	8 gms.
Banana	880	46 gms.
Others*	1,910	24 gms.

*computed as average of cassava, potato, cabbage, onions and other fruits and vegetables

The calorie consumption of the four crops is computed as follows:

$$\sum_{i=1}^{4} l_i X_i \geq M$$

The right side of this equation must meet or exceed the minimum calorie (4,280 Kcal) per household recommended by FAO/World Bank, which in turn is computed as:

$$M = (H_i)\ (C_u)\ (D)$$

where: M = Amount of Kcals households must consume to meet minimum calorie requirement
H_i = Daily calorie requirement (2,350 Kcal) per person
C_u = Average number of consumer units per household
D = Days in year

The utilizable protein constraint was computed in a similar way from the following equation:

$$\sum_{i=1}^{4} U_i X_i \geq Q_i$$

$$Q_i = (T_i)\ (D)\ (C_u)$$

where: T_i = Daily protein requirement (41 gms.) per consumer unit

U_i, R_i, Q, D and C_u as defined in the foregoing

In the second stage of analysis the LP was constructed in a way to maximize net revenue after allocating a proportion of some of the crops for consumption. This was made possible by constraints:

$$X_i l_i - C_i - S_i = 0 \qquad \text{and}$$

$$\sum_{i=1}^{4} C_i \geq M$$

The LP was formulated to maximize net revenue from sale after fulfilling the minimum calorie and protein requirements. The model developed showed that unless minimum acreages of the major crops were included in the model, the nutrition and income requirement would be met by

producing only one crop type. Since the families desire variety of food (evidenced by their pattern of production and consumption), it becomes necessary to reformulate the LP to find the optimal crop mix. Eight additional constraints were then included that set the minimum and maximum bounds of land allocation for each of the major crop types.

The number of consumer units (Cu) per family were derived from the survey results that included 78 households in Lushoto and Karagwe districts. A consumer unit reflects different nutritional requirements based on the age and sex composition of each member. Different weights are allocated to household members in computing the Cu. The Cu weight allocations are shown below (from Latham, 1979, except for an adjustment to equate adult males and females in farming in Africa since women work longer hours than males.)

	Weight
Male and female (adult)	1.00
Male and female (age 10 - 18)	1.14
Male and female (age 7 - 9)	1.16
Male and female (age 4 - 6)	.97
Male and female (age 1 - 3)	.72
Male and female (age <1)	.44

Different assumptions on resource allocation were made and an LP solution was obtained for each of the assumptions. The coefficients for the LP in Lushoto are given in Table 16. The results in Table 17 show that required calorie and UP will be met and additional net income will be generated for all solutions except #2. However, net income will change as minimum and maximum land allocators change for each crop. This allows the model to be used as one tool in measuring the effects of varying the availability of resources to the farm households. The results of each modelling effort for Lushoto are discussed first.

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Table 16. Cooefficients of Linear Programming Model for Lushoto, Tanzania, 1985

	X_1	X_2	X_3	X_4	C_1	C_2	C_3	C_4	S_1	S_2	S_3	S_4	RHS
Z =	3,827	987	1,140	3,292	-2.5	-4.8	-.56	-2.6	1	1	1	1	
Land	1	1	1	1									≤ 6.20
Calorie	1,735	210	2,015	1,266									≥ 4,280
U.Protein	22.05	10.20	18.32	36									≥ 74.46
January	10.17	5.78		29.20									≤ 75
February	4.57	7.50		27.09									≤ 64
March	.70	10.20	4.10	13.21									≤ 75
April	7.10	5.97	3.59	18.21									≤ 70
May	8.10	4.58	3.59	6.32									≤ 75
June	6.47	4.57		6.67									≤ 70
July	6.33	2.85	19.40	15.21									≤ 75
August	14.78	7.94		11.79									≤ 75
Sept.	20.75	8.50	8.72	29.05									≤ 75
Oct.	19.27	8.50	14.40	16.84									≤ 75
Nov.	20.15	7.86		12.52									≤ 75
Dec.	14.12	6.20	2.56	12.01									≤ 75
MinMz	1												≥ .10
MinBns		1											≥ .05
MinBan			1										≥ .05
MinOth				1									≥ 1.00
MaxMz	1												≤ 5.50
MaxBns		1											≤ 5.50
MaxBan			1										≤ .10
MaxOth				1									≤ 1.50
CalMz	1,735				-1				-1				= 0
CalBns		210				-1				-1			= 0
CalBan			2,015				-1				-1		= 0
CalOth				1,266				-1				-1	= 0
CalConst					1	1	1	1					= 4,280

MinMz - Minimum land allocation to maize
MinBns - Minimum land allocation to beans
MinBan - Minimum land allocation to bananas
MinOth - Minimum land allocation to others
MaxMz - Maximum land allocation to maize
MaxBns - Maximum land allocation to beans
MaxBan - Maximum land allocation to bananas
MaxOth - Maximum land allocation to others
CalMz - Kcal content of maize/acre
CalBns - Kcal content of beans/acre
CalBan - Kcal content of bananas/acre
CalOth - Kcal content of others/acre
CalConst - Calorie constraint

Lushoto Results

Table 17. Optimal Solutions at Various Land and Labor Allocations, Lushoto, Tanzania, 1985

Solution No.	Acres in Crops					Net Income (Tsh)
	Maize	Beans	Bananas	Other	Total	
1	1.7	3.5	0.1	0.9	6.2	2,707
2	0.3	2.5	1.0	1.0	4.8	29
3	3.3	0.5	0.1	0.1	4.0	3,082
4	3.1	0.5	0.1	0.2	3.9	2,098
5	3.6	0.5	0.1	0.2	4.4	3,942
Returns/ acre (Tsh)	3,827	967	1,140	3,292		

Solution #1 (Table 17) reflects the production of the average sampled smallholder household in 1985. The allocation of labor and land produced 2,040 kg. of crops of which 1,182 kg. (58%) was consumed, 754 kg. (37%) sold for 2,707 Tsh. and 104 kg. (5%) saved for seed. Using the Kcal conversions on page 41, it was ascertained that the average Lushoto family produced 108% of minimum recommended calories (4,280 kcals.) on 6.2 acres

of land but consumed only 75% of the minimum recommended calories after 104 kg. were saved for seed and 754 kg. sold.

Given the constraints, can the average household change the land and labor allocations to meet the minimum recommended caloric requirements and increase their net cash income? In these solutions, allocations for seed are omitted for ease of presentation.

Solution #2 met the exact minimum calorie and utilizable protein constraints, used relatively more land for beans (2.5 acres), little for maize (0.3 acres), 1 acre for bananas and 1 acre for other crops, but utilized only 4.8 of the 6.2 acres available. In this solution 47% of the family's calories are derived from bananas and 30% from other crops (vegetables). This allocation of land obviously does not meet the family's preference for maize as the staple crop. In addition, net revenue is only 29 Tsh; there were no labor constraints.

Since the average farm household planted only 0.1 acres of bananas and since few families planted or had a market for more than 0.1 acres of bananas, the decision was made to set maximum acreages for each crop, as well as the minimum acreages established earlier, to insure diversity in food production and reduce risk (when a large percentage of the acreage is planted to one crop). The limits, after doing sensitivity analysis, were 5.5 acres each for maize and beans, 0.1 acres for bananas and 1.5 acres for other crops.

Now, with these limits and minimum but not <u>exact</u> calorie and protein requirements, the results are as in Solution #3 in Table 17. The acreage allocated to crops falls to 4.0, of which 3.3 are in maize, 0.5 in beans and 0.1 each in bananas and other crops. Net revenue is 3,082 Tsh. and consumption is still primarily from maize and bananas with beans, some

maize and other crops for sale. Labor is binding in September. An additional day of labor in September would increase net revenue by 184 Tsh.

Bananas have such a high calorie content and low price per Kcal. that the LP will choose to have the family consume bananas and sell beans and other crops to maximize net revenue. Thus, the LP was programmed to provide calories in approximately the same proportion of maize (56%), beans (11%), bananas (10%) and other crops (23%) as the average family's consumption in 1985. Now the results appear as in Solution 4. Acreage of maize is 3.1, beans, 0.5, bananas, 0.1, and other crops, 0.2 for a total of 3.9 acres cropped. Net revenue is 2,098 Tsh. September labor is still binding in this solution.

Since in Solutions #3 and 4 labor was binding in September and in actuality the families planted beans as a second crop after the maize or beans were harvested, and it appeared that the labor for banana production in July, September and October was over-reported in Solution 5, a small amount of the labor (family and hired) was reallocated to September, October and November and to enable a second bean crop in February and March. When the LP was re-run in Solution 5 with consumption allocated as in Solution 4, the land allocations were 3.6 acres of maize, 0.5 of beans, 0.1 of bananas and 0.2 of other crops, giving a net return of 3,942 Tsh. September labor is still binding with the same value. It is obvious that to obtain a solution with consumption preferences more closely aligned with those of the families, the LP must be formulated to have consumption allocated in roughly the same proportions.

The results of the sensitivity analysis are presented in Table 18. It can be observed that the ranges for the limiting factors of production are fairly wide, except in Solution 2. This suggests that the optimal

allocation of resources (land, labor, and calories) is not very susceptible to changes in the addition or restricting of resources. It must be remembered, however, that the change which results may be in the quantities produced rather than in the pattern of production.

The limits may be interpreted in the following manner. When an activity is forced below its lower limit a change results which causes a reduction in the quantity of calories produced. The amount of the reduction is based on the marginal value product of that resource. For example, if labor in solution #3 is forced below 68.43 days there will be a corresponding decrease of 184 Tsh. of net return. The opposite is true for increasing supplies of binding resources. A marginal increase in one day of labor in September will result in an additional 184 Tsh. in net revenue.

Table 18. Sensitivity Limits for the Limiting Resources, Lushoto, 1985.

Resources	Available Resource	Marginal Value (Tsh.)	Sensitivity Limits Lower	Upper
Optimal Sol. 2				
Land (acres)				
Max. maize	0.30	7,817.50	0.30	0.60
Max. beans	2.30	987.00	2.30	3.60
Max. bananas	1.00	9,683.60	1.00	1.20
Max. other	1.00	6,077.20	1.00	1.30
Optimal Sol. 3				
Labor (Sept.)	75 days	184.43	68.43	79.10
Land (acres)				
Min. beans	0.50	-580.67	0	2.81
Max. bananas	0.10	3,440.84	0.05	0.90
Min. other	0.05	-2,065.80	0	0.73
Optimal Sol. 4				
Labor (Sept.)	75 days	184.43	68.23	80.76
Land (acres)				
Min. beans	0.50	-580.69	0.25	3.69
Min. bananas	0.05	-468.26	0.02	0.10
Optimal Sol. 5				
Labor (Sept.)	85 days	184.43	68.23	91.10
Land (acres)				
Min. beans	0.50	-580.69	0.25	3.64
Min. bananas	0.05	-468.26	0.02	0.10

Similarly an increase of one acre of maize in Solution 2 beyond the maximum acreage of 0.30, will result in an increase in net revenue of 7,817.50 Tsh. or a decrease of one acre of beans in Solution 4 will result in a loss in net revenue of 580.69 Tsh. The marginal values are shown in Table 18.

Korogwe Results

It will be remembered that in Korogwe, the average family farmed 9.8 acres with a slightly larger household than in Lushoto (4.9 compared with 4.8) but less adult equivalents in farming, Lushoto had 2.9 and Korogwe had 2.7 (Table 1). Also yields were much higher in Korogwe and the average household consumed 123% of the minimum recommended levels of calories per person. What is also strikingly different about Korogwe are the labor days reported for each crop. These are much lower than in Lushoto although acres farmed are higher (Tables 4 and 5). These differences are not easy to explain as the same enumerators with the same faculty advisor undertook the enumerating in each district. Apparently they recorded the amounts of labor which the farmers reported without questioning the discrepancies between districts and size of farms cultivated. Given these differences in labor requirements, labor was not binding in either of the solutions and the LP generated solutions which utilized all the land (9.8 acres), whereas in Lushoto, given available labor, all the land available could not be used in the LP solution.

Since the crop yields, average household size (which affects Kcal consumption requirements), farm operating costs and total value of production differed in Korogwe, the LP coefficients are shown in Table 19. Since families produced two major crops in Korogwe, maize and beans, and much smaller acreages of a number of other crops, cassava, potatoes,

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bananas, and other vegetables and fruits, the LP was formulated to include three crops--maize, beans, and other crops. Minimum and maximum acreages of maize were 0.1 and 6.5; of beans, 1.0 and 4.0; and of other crops, 1.5 and 5.0.

The first Solution is that of the average smallholder farmer in Korogwe who plants 4.4 acres of maize, 1.9 of beans, and 3.5 of other crops for a total sales income of 8,420 Tsh. (having saved 102 kg. for seed).

In Solution 2, the LP uses the same constraints but allocates 4.8 acres to maize, 3.5 to beans, and 1.5 to other crops for a net income of 12,151 Tsh. But without consumption constraints (that some of all crops are consumed), the LP has the household consuming all maize and selling beans and other crops.

In Solution 3, the LP was formulated to have the household consume some of all the crops to provide variety and better nutrition for the household; now the household produces 4.3 acres of maize, 3.5 of beans, 2.0 of other crops for a net income of 10,465 Tsh. In these Solutions 2 and 3 labor is not binding in any month. Gross returns per acre less farm operating expenses for each crop are shown at the bottom of Table 20. It is seen that Solution 3 is significantly better in generating net income than the solutions which the family made--net income has been increased 2,045 Tsh. But the family is now consuming the minimum recommended level of calories and protein rather than 23% above the minimum level as in Solution 1.

The sensitivity limits and marginal values are interpreted as in Table 18. Marginal values play an important role in planning. For example, if additional labor is to be hired or if additional land is to be leased, the farm households would benefit if they pay a wage or rent lower than the

Table 19. Coefficients of the Linear Programming Model for Korogwe, Tanzania, 1985

	Maize	Beans	Others	X_1	X_2	X_3	S_1	S_2	S_3	RHS
Z =	2,423	2,687	1,326	-2.5	-4.8	-2.6	1	1	1	
Land	1	1	1							≤ 9.80
Calorie	1,201	844	482							≥ 4,349
U.Protein	15	41	5.0							≥ 75.90
January	7.7	0.8	3.0							≤ 75
February	7.1	0	2.0							≤ 64
March	6.5	1.1	2.0							≤ 75
April	5.9	0.9	2.0							≤ 70
May	3.3	7.4	0.3							≤ 75
June	1.8	17.0	0.3							≤ 70
July	2.9	11.4	1.0							≤ 75
August	2.9	4.8	1.0							≤ 75
Sept.	3.1	11.2	1.0							≤ 75
Oct.	2.1	5.2	2.0							≤ 75
Nov.	1.7	0.7	1.0							≤ 75
Dec.	2.4	0.6	2.0							≤ 75
CalMz	1,201			-1			-1			= 0
CalBns		844			-1			-1		= 0
CalOth			482			-1			-1	= 0
Const				1	1	1				≥ 4,349
MinMz	1									≥ 0.1
MinBns		1								≥ 1.0
MinOth			1							≥ 1.5
MaxMz	1									≤ 6.5
MaxBns		1								≤ 3.5
MaxOth			1							≤ 5.0

X

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Table 20. Optimal Solutions at Various Land and Labor Allocations, Korogwe, Tanzania, 1985.

Solution No.	Acres in Crops				Net Income (Tsh)
	Maize	Beans	Other	Total	
1	4.4	1.9	3.5	9.8	8,420
2	4.8	3.5	1.5	9.8	12,151
3	4.3	3.5	2.0	9.8	10,465
Returns/ acre (Tsh)	2,423	2,687	1,326		

Table 21. Sensitivity Limits for the Limiting Resource, Korogwe, 1985

	Available Resource	Marginal Value (Tsh.)	Sensitivity Limit	
			Lower Limit	Upper Limit
Optimal Solution 2				
Land (acres)				
Max. Beans	3.5	264	1.8	3.6
Min. Other	1.5	-1,097	.6	4.7
Optimal Solution 3				
Land (acres)				
Max. Beans	3.5	264	1.3	3.6

marginal value. It also measures the opportunity cost that the households would forego if they desire to reallocated land or labor from one type of cropping activity to another.

In summary, given the assumptions made, the formulation of the LP, and data constraints, the average smallholder household could re-allocate land and increase net revenue the most by following Solution 5 in Lushoto and Solution 3 in Korogwe. A summary of the entire research results appears on pages vi to xi.

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