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Beans in the Farming Systems in Two Regions of Tanzania, 1980-82

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BEANS IN THE FARMING SYSTEMS IN TWO REGIONS OF TANZANIA, 1980-82

Jean M. Due, Marcia White and Timothy Rocke*

Many expatriates working in tropical Africa in the early 1960's assumed that successful North American and European agricultural technologies could be transferred to Africa to achieve rapid agricultural development. Mechanized machinery, fertilizer, insecticides, herbicides, monocropping, large concrete silos and other technologies familiar in the western world were transferred at very high cost but without success. Now it is realized that new technologies must be adapted to local situations and that those conditions vary significantly within a given country let alone within the continent, due to differences in altitude, rainfall patterns, climatic conditions, soil types, and other factors. Currently, research is focused on the present farming system to ascertain current practices before new technologies are recommended.

Not only must the current farming systems be understood, but the political-economic system into which crops and livestock are sold and from which credit, inputs, and wage goods are obtained must be known as lack of inputs, credit, markets, and wage goods may be more of a constraint on increased agricultural production than new technologies.

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*Jean M. Due is Professor of Agricultural Economics, University of Illinois at Urbana-Champaign; Marcia White and Timothy Rocke are graduate students at the same institution who have been working as Research Assistants on the Bean/Cowpea CRSP. Funding for the Bean/Cowpea CRSP is supported by USAID.

One of the objectives of the Bean/Cowpea CRSP in Tanzania was the development of high yielding varieties of Phaseolus vulgaris beans which would be drought, insect and disease resistant and acceptable to consumers within the country. Naively, it was assumed initially that one new "super" variety could be developed for the country which would increase incomes of small farm families and nutrition generally. Five years later it has been realized that several different varieties will be needed for different climatic conditions. It has also become apparent that consumer preferences for beans vary within the country.

If new varieties of beans are developed and adopted by small farm families, they must fit viably into the present farming system and must be acceptable to consumers. In order to provide information on the present farming systems for the breeders, data were gathered in three major bean growing areas of Tanzania on the importance of beans for consumption and income, the importance of beans relative to other crops produced, labor inputs applied, quantities of crops and livestock produced and consumed, other data relevant to the farming systems, and socio-economic characteristics of the families.

Significant differences were found in the importance of beans in the farming systems in areas of the country sampled. There were important differences in the traditional varieties of beans utilized, in varieties planted during the short and long rains, in varieties preferred for immediate consumption compared with storage and later consumption, and so forth. This study summarizes the data from the farming systems studies undertaken in two regions of Tanzania from 1980 to 1982.

Families are economic decision makers and their choice of crops depends on relative prices and availability of markets and wage goods as well as availability of inputs, labor, soil, climatic conditions, among other factors. Thus, it is important to understand aspects of the general economy of Tanzania during the period of these inquiries.

The Tanzania Economy

Tanzania is a predominantly agricultural country with a population of 20 million in 1982 and an annual per capita Gross Domestic Product (GDP) of $280; 83% of the labor force is engaged in agriculture (1, p. 254, 218, 258). Agriculture, including livestock and fishing, contributed 52% of GDP in 1982 and 74% of Tanzania's export earnings from coffee, tea, tobacco, sisal, cashew nuts, cloves, salt and cotton (2, p. 152, 166).

The period of the 1980's has been a very difficult one economically for many of the countries of sub-Saharan Africa. Not only were there adverse external factors such as the high oil prices since the mid 1970's (Tanzania was allocating 50% of her foreign exchange earnings to oil imports), the recession in the western world (which translated into decreased exports and lower foreign exchange earnings), and the three year drought; there were also important internal factors which affected the economies--overvalued exchange rates, increasing debt and debt servicing, low prices in the agricultural sector to favor urban consumers, inefficient and high cost agricultural marketing boards, state farms, and industries (both public and private) operating at low capacity and high cost (3).

Tanzania shared many of these economic and climatic problems. Although drought had not been nearly as severe or widespread as in the Sahel and

Ethiopia, Tanzania has been affected and food imports have soared. Real farm prices of most of the export crops were less than at independence; exports decreased in volume and in earnings. The reduced foreign exchange earnings and the increased cost of oil and other imports meant that foreign exchange was scarce and little could be used to import new agricultural implements, transport vehicles, fertilizer and other items needed for agricultural development. Spare parts for the agricultural and industrial sector became extremely scarce; industries operated at increasingly lower capacities; farmers, unable to find adequate markets, transport or prices, reduced production for sale. Smuggling of agricultural commodities across international borders was widespread as the real value of the Tanzania shilling decreased at home and hard currency markets were available in neighboring countries.

These adverse economic conditions can be shown in several ways--in changes in export volume and export earnings, in GDP per capita, in agricultural production and agriculture's contribution to GDP. These adverse economic conditions were occuring at a time when the population of Tanzania was increasing at 3.4% per annum (3, p. 82). With agricultural production increasing at 2.1% per annum from 1970 to 1982 (3, p. 77), the index of food production per capita fell from 100 in 1969-71 to 88 in 1980-82 (3, p. 57).

(a) Gross Domestic Product

As noted in Table 1, GDP per capita increased slightly in real terms from $260 in 1979 to $280 in 1980 where it has since remained constant. However, the average annual growth of GDP per capita has fallen from 2.3%

per annum from 1960 to 1979 to 1.9% from 1960 to 1980. Also agriculture's contribution to GDP has fallen from 54% to 52% during this same period.

Table 1. Per Capita GDP, Average Annual Growth Rate of GDP Per Capita, and Percentage of GDP from Agriculture, Tanzania, 1979 to 1982*

Year	GDP/capita	Average annual growth rate GDP/capita		% of GDP from agriculture
	$	%	years	%
1979	260	2.3	1960-79	54
1980	280	1.9	1960-80	54
1981	280	1.9	1960-81	52
1982	280	1.9	1960-82	52

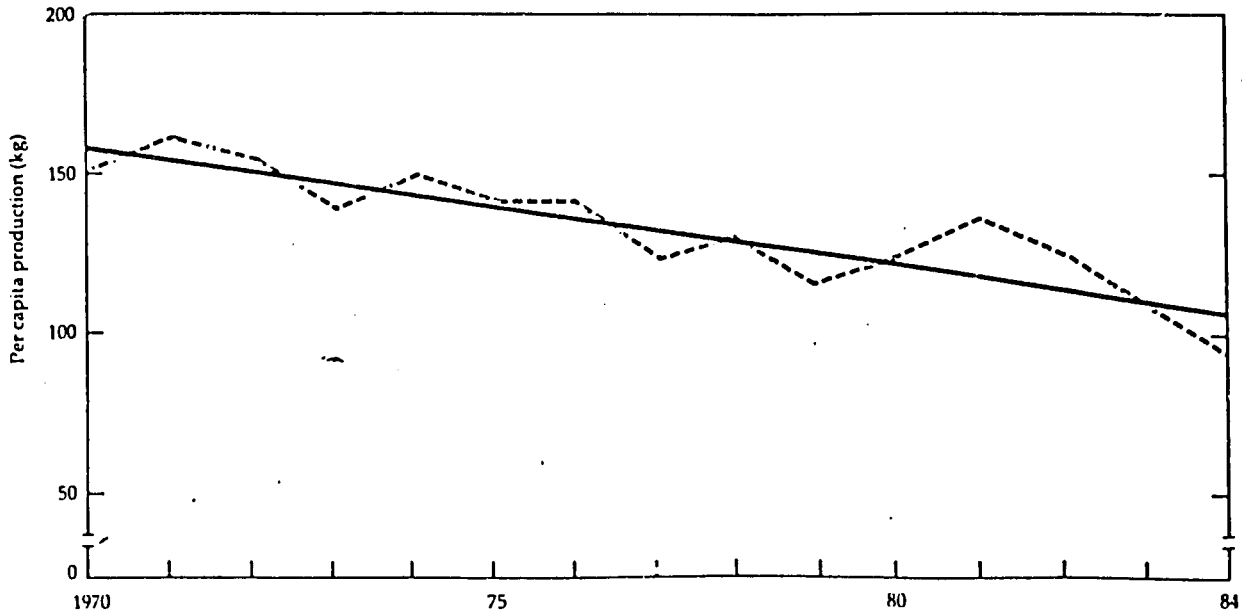
*Source: World Bank (1), various years.

(b) Agriculture

While Tanzania's total agricultural production increased from an index of 100 in 1969-71 to 123 in 1980 and 127 in 1983 (4, p. 155), population was growing at 3.4% a year and the index of food production per capita fell from 100 in 1969-71 to 93 in 1983 (4, p. 155), according to USDA estimates. The World Bank estimate of the index of food production per capita (with 1969-71 equal to 100) was 88 in 1980-82 (3, p. 57).

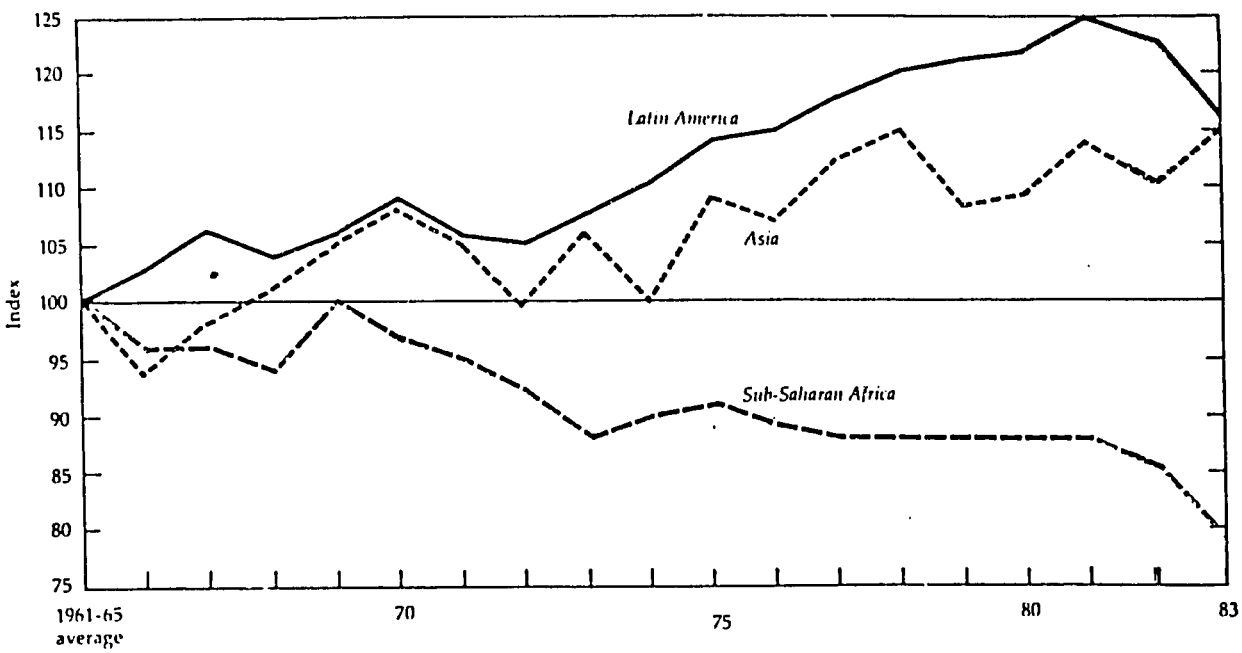
Tanzania was not the only African country with similar problems of agricultural production and production per capita. As shown in Figure 1.2, while the index of per capita food production in Asian and Latin American countries increased from 100 in 1961-65 to 115 in 1983, the index in sub-Saharan Africa fell from 100 to 80 in the same period. Similarly the index of per capita grain production in the 24 African countries affected by drought fell from 150 in 1970 to less than 100 in 1984--a decrease of more than 50% (Figure 1.1).

Figure 1.1. *Per Capita Grain Production in Twenty-four African Countries Affected by Drought, 1970–84*



Source: Based on Food and Agriculture Organization (FAO) data, except that the 1984 figure is a projection using data from FAO, the U.S. Agency for International Development, and the U.S. Department of Agriculture.

Figure 1.2. *Index of Per Capita Food Production, 1961–65 to 1983*
(1961-65 average = 100)



Source: Based on data provided by the U.S. Department of Agriculture.

The importance of smallholders in total marketed agricultural production can be seen from the fact that 85% of the maize (the major food staple), 50% of the rice, 95% of the drought staples and cotton, 15% of the sugar, 90% of the legumes, 85% of the coffee, 100% of the cashews and pyrethrum, 90% of the tobacco and 25% of the tea is produced by this sector (5, p. 162). The public estate sector produces 50% of the rice, 95% of the wheat, 85% of the sugar, 50% of the sisal, and 5% of the pyrethrum and cotton. The private estates (which decreased markedly after the Arusha Declaration of 1967) produce 10% of the coffee, 50% of the sisal and 70% of the tea. Thus the small farm sector produces most of the food crops and a major share of the export crops except for tea and sisal.

The volume and value of production of the major agricultural crops and livestock from 1974 to 1983 are shown in Table 2 from Tanzanian government statistics. It will be noted that the volume and value of crops (in constant prices) each increased approximately 20% during this period. However, the volume of bean production decreased from 255,000 metric tons in 1974 to a low of 134,000 in 1975 and has continued at 150,000 metric tons through the balance of the 1970s and early 1980s. Indices of total and per capita production can be found at the bottom of the table.

(c) Balance of Payments

Tanzania has experienced large trade deficits since 1975, a deficit which narrowed only during the boom in coffee prices in 1976 and 1977. The trade deficit had reached 5.3 billion Tanzania shillings in 1980 and 6.3 billion in 1982 (Table 3).

Table 2.

PRODUCTION BY COMMODITY, VALUE AND INDICES OF AGRICULTURE AND FOOD PRODUCTION

COMMODITY	PRICE WEIGHT	AVERAGE 1969-71	1974	1975	1976	1977	1978	1979	1980	1981	1982	PRELIM. 1983
	DOLLARS	1,000 METRIC TONS										
WHEAT	75	61	46	56	58	62	55	76	68	77	90	80
RICE, PADDY	83	173	134	150	172	194	260	220	215	200	200	210
CORN	35	626	550	825	897	968	1,041	1,000	1,000	1,430	1,432	1,300
MILLET	66	129	88	160	130	150	160	160	155	150	150	150
SORGHUM	66	127	230	330	260	240	250	220	215	230	220	220
BEANS, DRY	84	282	255	134	146	150	150	149	160	150	152	154
POTATOES	34	48	84	84	84	84	85	140	140	140	145	150
CASSAVA	9	2,075	2,516	3,800	3,900	4,250	4,300	4,550	4,000	4,800	4,900	4,900
SWEETPOTATOES	27	297	300	320	330	335	330	330	332	330	332	340
TOBACCO	583	12	18	14	19	18	17	17	17	17	16	15
COTTON	350	66	66	45	69	50	56	60	54	48	45	45
COTTONSEED	56	135	135	92	141	102	114	120	168	96	90	90
SOYBEANS	71	4	4	1	1	1	1	1	1	1	1	1
PEANUTS, IN SHELL	138	29	62	62	74	74	70	52	54	56	58	60
SESAME SEED	151	10	10	10	6	10	15	18	15	17	18	19
SUNFLOWER SEED	53	10	10	15	20	25	59	31	40	40	43	44
CASTOR BEANS	76	12	8	8	8	8	6	8	8	5	5	6
PYRETHRUM FLOWERS, DRIED	539	3	3	5	4	4	3	2	2	2	2	2
ORANGES AND TANGERINES	85	22	22	22	23	25	22	24	25	27	29	31
CASHEWS, IN SHELL	80	106	143	117	97	68	58	41	61	57	40	32
BANANAS	38	539	434	456	718	746	733	750	780	790	800	815
CLOVES	590	6	5	8	6	5	5	6	7	7	8	7
COFFEE	765	51	45	58	48	50	51	48	58	67	55	54
TEA	816	9	13	14	14	17	17	18	17	16	16	18
SISAL	115	197	135	123	119	105	92	81	115	61	60	50
SUGAR, RAW	61	91	110	96	102	101	101	129	120	122	115	105
COPRA	142	28	25	27	27	27	26	27	29	30	32	33
MEATS	357	173	175	180	182	188	196	185	179	189	200	203
MILK	73	368	370	650	683	700	716	732	732	740	764	781
HIDES AND SKINS	302	23	28	30	32	34	35	33	32	34	35	36
AGGREGATES OF PRODUCTION		MILLION DOLLARS AT CONSTANT PRICES										
CROPS		269.6	267.8	291.4	305.8	305.9	316.3	311.9	323.0	339.6	327.8	324.6
LIVESTOCK		97.1	98.0	120.9	124.6	128.5	132.9	129.4	127.0	131.8	137.8	140.4
TOTAL AGRICULTURE		366.7	365.8	412.3	430.4	434.4	449.2	441.3	450.0	471.4	465.6	465.0
TOTAL FOOD		254.1	258.0	301.3	317.3	326.0	340.5	334.5	334.2	355.1	361.6	362.1
INDICES OF PRODUCTION		(1969-71 = 100)										
CROPS		100	99	108	113	113	117	116	120	126	122	120
TOTAL AGRICULTURE		100	100	112	117	118	122	120	123	129	127	127
TOTAL FOOD		100	102	119	125	128	134	132	132	140	142	143
PER CAPITA AGRICULTURE		100	87	95	97	94	94	90	89	90	86	83
PER CAPITA FOOD		100	89	101	103	102	103	98	95	98	96	93
INDEX OF POPULATION 1969-71 POPULATION= 13,450,000		100.0	114.1	117.8	120.8	125.5	129.7	134.0	138.4	143.0	147.7	152.6

Source: (4, p. 155)

The importance of agriculture in generating Tanzania's exports earnings is demonstrated in Table 3. Except for 1976 and 1977 when world coffee prices were good, Tanzania's agricultural exports have been less and less able to pay for the country's imports. Several factors are responsible in addition to a doubling of imports over the period; when farm families were

Table 3. Imports, Exports, and Balance of Payments, Tanzania, 1975-81

	Tanzania Shillings Millions						
Year	Imports	Exports					Balance of payments
		Agriculture	%	Others	%	Total	
1975	5,694	1,866	68	899	32	2,765	-2,829
1976	5,421	2,963	72	1,146	28	4,109	-1,312
1977	6,199	3,452	76	1,084	24	4,536	-1,663
1978	8,798	3,042	83	629	17	3,671	-5,127
1979	8,885	3,120	72	1,223	28	4,343	-4,542
1980	10,047	3,342	71	1,358	29	4,700	-5,347
1981	9,739	3,378	72	1,328	28	4,706	-5,033
1982	10,519	n.a.	n.a.	n.a.	n.a.	4,230	-6,289

*Source: The Economic Survey, (6) 1981, p. 19 to 1980; 1981 & 1982, Foreign Trade Statistics (7) 1982, p. 21.
n.a. not available

moved from scattered holdings into ujamma villages in late 1975, several of the export crops like cashew were left behind and cashew production has fallen markedly (Table 2). Also the government's pricing and input policy favored domestic rather than export producers to deliberately equalize incomes in the agricultural sector. Prices, however, have fallen so much in real terms (to favor urban consumers) that real incomes in the rural sector have fallen by more than 23% since 1969/70 (Table 4). In addition subsistence production has increased since 1975 in both current and real terms (8, p. 28).

Table 4. Changes in Price Terms of Trade for Smallholders, Tanzania*

Time period	Percent change Export crops	Food crops	All crops
1969/70-1973/74	-24.0	-23.9	-23.9
1973/74-1978/79	-11.3	+29.0	- 2.1
1969/70-1978/79	-32.6	- 1.8	-23.2

*Source: USAID, Tanzania Development Strategy Statement, (8) Washington, D.C.: January 1981, p. 28.

Due to the shortages of trucks, petroleum, spare parts and to government marketing policies, marketing of both export and domestic crops has become increasingly inefficient. Marketing boards have increased employment and costs, thus reducing farmer prices; transport is often unavailable to pick up crops from the villages or transport inputs out. Wage goods are often unavailable; farm families cannot purchase needed wage goods even when money is available. Therefore it is not surprising that subsistence production has increased relative to marketed production.

Many persons blame world prices for the decline in Tanzania's exports but an examination of IMF data show that the index of Tanzania's major export crop prices (based on 1975 equal to 100) rose from 46 in 1970 to 248 in 1980 while the real value of export earnings (in 1975 prices) fell from 515 to 206 (5, pp. 193). Lele argues:

> "By 1980 export volumes were less than half those of 1970. There was also a substantial deterioration in the quality of agricultural exports with coffee, tobacco and cotton receiving between 10 to 30% quality discounts in the late 1970s, compared to the earlier period. If export volumes had been maintained at the peaks reached in the 1970s, the balance of payments crisis clearly would not have reached current proportions. A 2 to 4% rate of growth in exports similar to that existing since the 1930s - and far lower than that in the 1960s - would have averted the current crisis altogether". (5, p. 166)

If Tanzania is to feed its rapidly increasing population and generate more foreign exchange, some changes in structure and performance of the agricultural sector are imperative.[1]

Objectives of the Farming System Studies

These farming systems studies were undertaken to provide baseline data for the breeders and other researchers in order to better understand the present farming systems and the socio-economic characteristics of the farm families for whom they were providing the improved varieties. Were farm families homogeneous? Were the farming systems homogeneous? What varieties of crops are presently being grown? What varieties of beans were being produced and consumed? Were they similar among regions? Who chose the beans seeds for planting? (If new varieties were developed, it was important to transmit information to the persons choosing the seeds). Were beans more important for consumption or income generation? What were the major characteristics desired by consumers? These and a variety of other questions were asked of small farm [10 hectares (ha) or less] families in two bean growing regions of Tanzania - Morogoro and Arusha.

In Morogoro region samples of small farmers families were drawn from two very different districts. Mgeta, in the Uluguru Mountains at altitudes between 1,200 and 1,800 meters, has rainfall levels of 760 to 1,600 millimeters (mm) per annum. The higher elevation and rainfall allows two or three crops to be grown annually. Kilosa, at altitudes between 500 and 1,000 meters, with rainfall averaging less than one thousand mms. per annum,

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[1]In 1985, for the first time, some farm families refused to cooperate in data collection. They challenged, "Why should we give information when the government does nothing for us?"

allows only one cropping season per year; sometimes a second crop is planted after a first crop is harvested (beans after maize or sorghum, for example). Families in these two districts were interviewed in the 1980 and 1981 crop years, with different villages chosen each year. Major crops grown in Mgeta are maize, beans, cabbage, cauliflower, lettuce and pigeon peas; in Kilosa major crops are maize (the major food staple), sorghum, rice, cotton, beans and other vegetables.

In Arusha region in Northern Tanzania, there are two rainfall patterns, one mono- and one bimodal. The southern part of the region has rainfall of 500 to 1,000 mms. per annum from November to April with dry periods from mid-January to mid-February; important crops are maize, beans, sorghum, millet, cassava, cotton and oil seed plants and vegetables. Hanang district was chosen to represent districts in this part of the region. In the bimodal rainfall areas with ranges of 1,000 to 1,600 mms., the short rains fall between September and November and the long rains from mid-February to May. The important crops are maize, wheat, coffee, bananas, vegetables, fruits, pyrethreum, beans and peas. Good pastures provide for dairy and beef herds. Arumeru district was chosen from this region. Data covered the 1982 crop year.

Sample Selection

Under the ujamaa and villagization policies of the Tanzania government, farm families were moved from scattered holdings to ujamaa villages from 1970 to 1976. Each village chairperson has a list of all families in the village and their occupations. When non-farm families and families farming more than 10 ha. were excluded, every nth family was drawn at random from the list to give the desired sample size in each village. Samples varied

from 58 in Kilosa and 59 in Mgeta in 1980 to 60 in two villages in Mgeta area in 1981 and 43 in Hanang and 42 in Arumeru in Arusha region in 1982.

The sample size was constrained due to limited transportation and funds available. Transportation was a greater constraint than funding since roads are often impassible during certain periods of the year and the distance from the university had to be limited for multiple student visits. The questionnaires covered one crop year. Districts sampled were in major bean growing areas.

Questionnaires were administered to heads of households by university students from Sokoine University of Agriculture. This enabled the training of undergraduate students in research methodology and provided data which were used by the students for their Bachelor's theses. Students lived in the villages about one week to obtain a greater understanding of the farming systems before the questionnaire was developed. Farmers were invited to attend a meeting in each village to learn and discuss the purpose of the study and its objectives; at the same time the students and faculty learned more of the farming systems, major crops grown, sizes of farms, facilities in the villages and services available to the farm families. Male heads of households were generally interviewed unless the head was a female, but some questions were administered to spouses. For a detailed report of this study see Due, et al (9), (13), and (14).

Land Availability

These families were farming on average 8.4 acres in Kilosa and Mgeta districts, Morogoro region in 1980, 5.4 acres in Mgeta in 1981 and 7.8 acres in Arusha region in 1982. In each of the districts families were

farming between 4 and 6 separate plots of land some of which were intercropped. Sample farms ranged in size from 1 to 25 acres; distribution for each region is shown in Table 5. Unfortunately data were analyzed year by year and size units varied each year. Note that the highest frequency of small farms was in Arusha region where 23.5% were less than 3.5 acres.

Table 5. Size of Sampled Farms by District, Tanzania, 1980-1982

Kilosa (1980)		Mgeta (1981)		Arusha (1982)	
Size (acres)	%	Size (acres)	%	Size (acres)	%
0- 4.9	13.3	0-2.2	7.0	0-3.5	23.5
5.0- 9.9	73.3	2.3-4.8	43.0	3.6-5.5	16.5
10.0-14.9	6.7	4.9-7.2	35.0	5.6-8.0	30.6
15.0 & over	6.7	7.3-9.8	12.0	8.1-9.9	9.4
		9.9 & over	3.0	10 & over	20.0
Mean	8.4	Mean	5.5	Mean	7.8
Minimum	3.8	Minimum	1.8	Minimum	0.8
Maximum	25.0	Maximum	11.8	Maximum	25.0

In Mgeta district in the Uluguru Mountains and in Arumeru, land is a major factor limiting agricultural production. Land is intensively cultivated even up the steep mountainsides; shamba (plot) locations varied from being beside the house to being 11 kilometers (6.6 miles) away. In other areas, in general, land is not limiting although additional land may be some distance from the village; the villagization program resulted in farm families having to walk greater distances to their farms than when their houses were located on their holdings.

Decisions as to Crops Planted

Decisions as to which crops to plant in a given crop year were made by the husband and wife jointly in over 85% of the sampled families in Kilosa, 85% in Mgeta and 77% in Arusha. Husbands alone made the decisions in 20% of the cases in Arusha but less than 10% in Mgeta and Kilosa.

Crops Grown

The major crops produced in each area are shown in Table 6. It is difficult to obtain acres in each crop when crops are intercropped; sometimes four crops are intercropped in the same field. Mixtures vary, so it is not helpful to try to sum by mixtures. When the families were being interviewed, the number of crops and percentage of the acreage devoted to each crop was ascertained for each parcel of land. If one acre had 50% maize and 50% beans, then crop acreage was calculated as 0.5 maize and 0.5 acres of beans; then total acreages in each crop could be summed. In Mgeta, where there is multiple cropping each year, the averages represent the acreages for the entire year.

As noted in Table 6, maize is the predominant crop in each area. More than 80% of the families indicated that the primary objectives in farming was to provide food for the family; income was the second most important objective. Therefore maize, the major food staple, is the predominant crop. Families in Arusha region had larger maize acreages per farm than either of the other areas.

The second largest acreage in each of these districts was in beans with average acreage per sampled farm varying from 0.5 in Kilosa to 1.7 in Arusha. Families in Kilosa also grew rice, sorghum, cotton, sunflower, vegetables and fruits. Families in Mgeta grow vegetables (cabbage, green

beans, cauliflower, onions and cassava) for the Dar es Salaam market. Many Tanzanian families grow small amounts of bananas for family consumption; these are more important in Arusha region where some of the families also produced coffee and millet.

Table 6. Average Acreages of Major Crops Grown by Sampled Farm Families Tanzania, 1980-1982

Crop	1980 Mgeta	1980 Kilosa	1981 Mgeta	1982 Arusha
Maize	2.8	2.5	2.0	3.7
Sorghum	0	1.3	0.3	0.6
Beans	1.4	0.5	1.2	1.7
Rice	0	1.3	0	0
Cotton & sunflower	0	1.4	0	0
Cabbage	0.8	0	0.5	*
Cauliflower	0.6	0	*	*
Cassava	0.3	0.1	0.8	0.4**
Pigeon peas	0.7	0.1	*	0.2
Bananas	*	*	*	0.5
Coffee	0	0	0	0.4
Other	1.8	1.2	0.7	0.3
TOTAL	8.4	8.4	5.5	7.8

* Included with other
** Includes millet.

In each of the areas sampled, families grew beans in monoculture and intercropped with maize, sorghum, maize and peas, maize and bananas, and many other crops. In Hanang in the 1982 crop year 62% of the acreage in crops was intercropped; 27% of the total acres had beans in the intercropping mixtures. In other words, beans were in 44% of the intercropped acres in Hanang district. In Arumeru district 62% of the total acres were

intercropped with beans in 95% of the intercropped mixtures. In Hanang 14% of the total crop acreage was in beans in monoculture with only 6% in Arumeru.

In Mgeta in the Uluguru Mountains the first bean crop is intercropped with maize in November/December and the second crop is monocropped in April/May. In Kilosa district families grew beans both in monoculture and intercropped during the first season and in monoculture in the second season after maize had been harvested. In Kilosa, 90% of the families grew the large reddish brown type of beans, Canadian Wonder, locally called Kenya; other varieties were small red and small black. In Mgeta families preferred Kebwebwe for yield and Kenya for palatability, both for dried and green beans. In Arusha region families grew Canadian Wonder and Masai red beans primarily; families preferred the Masai red for palatability and storage; Masai red and Canadian Wonder were preferred equally for yield.

Capital Investment in Farming

For most of these sampled families, labor was the principal input in farming in addition to land. In most of tropical Africa, land is owned by the community or the ethnic group and allocated to individual families by the community leader or chief. When farm families were moved into ujamaa villages in Tanzania this land tenure policy did not change; presumably now the village chairman allocates the land to individual families. Land is not owned in the western sense in that it is not registered and titled; however, African families believe that they own their land, as western farm families do. In most of these areas shifting cultivation is still practiced; this is less true in Mgeta and Arumeru (Arusha) where population pressure on land is high and there is little land on which to shift cultiva-

tion from one year to another. Farms in these two areas practice permanent cultivation and use manure to maintain fertility. Given this typical land tenure pattern, farm families do not have a monetary investment in land.

The monetary investment in agricultural tools and equipment was very small indeed. The average value of capital equipment owned per sampled family varied from 170 Tanzanian shillings in Mgeta to 185 in Kilosa and 2,116 in Arusha.[2] Primary farming tools included hoes, axes, machettes, sickles, and hammers in Kilosa and Mgeta and these plus oxen and ploughs in Arusha. In Arusha, 1,600 shillings of the total investment of 2,116 shillings was in oxen and ploughs. These capital items and their estimated values per family are shown in Table 7.

Credit Availability

As noted in Table 7, capital equipment owned by the sampled families was very limited. Are credit opportunities available if farm families wish to borrow for new inputs? Tanzania established the Tanzanian Rural Development Bank (TRDB) in 1971 to provide capital to the rural sector. Government directives prioritize TRDB lending to ujamaa and other villages, district development corporations, cooperatives (until 1976 when they were dissolved), state farms, farmers associations (for tobacco) and a small number of individual borrowers (10 and 2). As a result of these policies individual farmers really cannot borrow from TRDB; the village borrows on their behalf and allocates to members; repayment is the responsibility of the village which is a registered cooperative and, therefore, legally liable. In practice in the early years of TRDB, villages were encouraged to borrow for

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[2]The official exchange rate of Tanzania shillings varied from 10 to U.S. $1 in 1980 to 17.5 to U.S. $1 in 1984.

communal rather than individual production. Repayment under this policy has been so low (11) that villages subsequently could borrow for private production.

Table 7. Average Capital Equipment Owned Per Sampled Family, Tanzania, 1980-1982

	1980		1981	1982
Equipment	Kilosa	Mgeta	Mgeta	Arusha
Hoes (no.)	3.7	3.5	3.4	4.4
" values (Tsh)	112.0	100.0	124.0	42.1
" life (yrs)	3.2	1.7	1.5	3.6
Axes (no.)	1.1	0.9	1.6	1.3
" value (Tsh)	18.0	19.0	13.0	31.2
" life (yrs)	6.0	6.6	5.2	7.4
Pangas (no.)	1.6	1.3	1.1	1.9
" value (Tsh)	23.0	19.0	19.0	22.4
" life (yrs)	2.1	4.2	4.7	5.4
Shovels (no.)	n.a.	n.a.	n.a.	0.4
" value (Tsh)	n.a.	n.a.	n.a.	17.4
" life (yrs)	n.a.	n.a.	n.a.	3.3
Hammer (no.)	n.a.	n.a.	n.a.	0.6
" value (Tsh)	n.a.	n.a.	n.a.	21.1
" life (yrs)	n.a.	n.a.	n.a.	6.2
Sickles (no.)	n.a.	n.a.	0.2	0.5
" value (Tsh)	n.a.	n.a.	1.0	7.7
" life (yrs)	n.a.	n.a.	3.1	3.0
Ox ploughs (no.)	0	0	0	0.6
" value (Tsh)	0	0	0	338.6
" life (yrs)	0	0	0	5.0
Oxen (no.)	0	0	0	1.8
" value (Tsh)	0	0	0	1,320.2
" life (yrs)	0	0	0	2.2
TOTAL VALUE (Tsh)	185.00	180.5	171.0	2,116.0

Many factors have contributed to the low repayment rate of TRDB which has fallen from 69% in 1974/75 to 33% in 1981 (10, p. 269). The depressed economic conditions in the country, the shortage of spare parts to keep

transport equipment running, the poor performance of the state enterprises which have not made repayment of loans a priority, and the changing regulations regarding village loans which were grants some years, loans some years, and part loans and part grants other years. Village members complain that the officials contract for the loans (delivered as inputs in kind) without consulting them and then expect them to repay when they have not been informed. TRDB was reorganized in 1985 to accept deposits and allocate credit; the name has been changed to the Cooperative Rural Development Bank.

Sampled families reported very little borrowing; when borrowing was done it was generally from friends and relatives at zero interest rate.

Labor

Labor is one of the major constraints to increased agricultural expansion in Tanzania, given current technology. In Morogoro region, most of the labor utilized is family labor while in Arusha region hired labor and ox-drawn and mechanized machinery is used to provide power for acreage expansion. Since family labor is the most important input in most areas, a brief description of the size and education of the family will be useful.

Families averaged 4.8 persons in Kilosa, 6.0 in Mgeta in 1980, 7.1 in Mgeta in 1981, and 6.8 in Arusha in 1982. These families, of course, included persons of all ages, with relatives as well as immediate family members. Average number of wives ranged from 1.0 to 1.3 (Table 8). The age of the male head of household averaged between 40 and 50 years with the spouse between 32 and 40 years old. Years of formal schooling of the male head varied between 2.7 and 3.9 years, with the highest average educational levels in Arusha. Heads of households had been farming on

average between 18 and 30 years and operated several different fields on the farm, many of which are separated by some distance from the house. Each family grew a variety of crops as seen in Table 6.

Table 8. Size and Characteristics of Sampled Farm Families, Tanzania, 1980-82

Characteristics	1980		1981	1982
Means of:	Kilosa	Mgeta	Mgeta	Arusha
Household size	4.8	6.0	7.1	6.8
Number of wives	1.2	1.0	0.8	1.3
Age of head	40.0	45.4	52.7	40.4
Age of spouse	33.3	35.4	40.7	32.5
Years of formal schooling (head)	3.3	3.0	2.7	3.9
Years of farming (head)	19.2	24.8	30.8	18.2
No. of fields operated	3.8	5.5	4.0	2.6
Male persons farming*	1.6	1.6	1.3	1.8
Female persons farming*	1.6	1.8	1.3	1.6
TOTAL PERSONS FARMING*	3.2	3.4	2.6	3.4

* Based on equivalencies described on p. 22.

It seemed important to ascertain the amount of labor utilized by crop and cropping practice in order to better understand the farming system. It is obvious that many members of the family provide labor for the enterprise especially during the agricultural season. If one wishes to sum amounts of labor contributed by family members, one must use a conversion of children's labor to adult day equivalents and of persons farming part of the year to annual equivalents. The latter is simple; one takes days working on the farm out of the total year or months out of 12, converts to a fraction of a year, and uses this percentage. However, in converting

children's and female contributions a more controversial subject arises as to the equivalents used. In East Africa the Collinson (1977) and Ruthenberg (1975) equivalents are the most commonly used; however, Morogoro colleagues have adjusted these as shown below:

	Sex	Age			
		7-16			16 & over
Collinson	M	.50			1.00
	F	.50			.75
		0-14	15-19	20-50	over 50
Ruthenberg	M	.25	.67	1.00	.67
	F	.25	.50	.67	.50
Morogoro	M	.25	.67	1.00	.67
	F	.25	.60	.90	.60
		8-11	12-17	18 & over	
Due	M	.30	.50	1.00	
	F	.30	.50	1.00	

Since average life expectancy is fifty-two years, Due did not include the over fifty adjustment. Conversations with Tanzanians and observation of work in the field convinced the senior author of the need for using equivalency of the work of males and females of the same age. It is acknowledged that in some operations (i.e. ploughing by hand) men, being stronger, may accomplish more; in other (e.g. harvesting) data support female superior accomplishments; thus the Due overall equivalencies. In this decision, she is in agreement with Christopher Delgado (12, p. 98) who writes:

> "The conclusion is that there is very little or no basis for estimating that a female worker is worth less than a male worker in the same age group.

Based on the Due equivalencies and the estimates of days each sex worked in the fields (given by male respondents), women contributed 48% of the total

labor, 46% of the land preparation, 55% of the planting, 52% of the weeding and 58% of the harvesting in Kilosa district as shown in Table 9.

Table 9. Percentage of Labor Days Contributed by Females by Operation by Crop, Sampled Families, Kilosa, Tanzania, 1980*

	Maize %	Sorghum %	Rice %	Cotton %	Beans %	Sunflower %	TOTAL %
Land preparation	44	37	61	39	55	34	46
Planting	52	41	77	48	60	40	55
Weeding/thinning	51	43	65	51	59	40	52
Spraying	0	0	0	0	0	0	0
Harvesting	54	46	71	51	69	43	58
Marketing	17	16	50	31	0	12	21
TOTAL	48	40	67	39	59	39	48

* Source: Due et al (13) p. 589

The percentage of labor contributed by females by crop and crop operation in Mgeta district are shown in Table 10. Here 49% of the total labor on major crops was contributed by females with males doing slightly over 50% of the land preparation, planting and weeding but females doing 60% of the harvesting and almost half of the marketing.

In Arusha where oxen, ox ploughs and hired mechanized machinery are commonly used, females still contributed 46% of the labor for major crops in Arumeru and 48% in Hanang district as shown in Table 11. In general females do little of the spraying and fertilizing but almost half of the other farming operations. Since the crops grown in Hanang and Arumeru differ and labor is, therefore, allocated differently, female allocations in both districts are shown in Table 11.

Table 10. Percentage of Labor Days Contributed by Females by Operation, by Crop, Sampled Families, Mgeta, Tanzania, 1981*

	Maize-Beans % F	Beans % F	Vegetables % F	Cassava % F	Other % F	TOTAL % F
Land preparation	47	48	28	51	63	46
Planting	53	59	22	50	63	47
Weeding/thinning	49	54	28	53	60	48
Harvesting	77	63	37	NA	74	61
Marketing	97	95	23	NA	100	47
TOTAL	58	52	28	52	64	49

* Source: Due et al (14), p. 28

Table 11. Percentage of Labor Days Contributed by Females, by Operation, by Crop, Sampled Families, (H) Hanang, and (A) Arumeru, Tanzania, 1982[1]

Crop	Maize		Beans		Coffee		Sorghum		Bananas		Millet		Other		Total	
	H	A	H	A	H	A	H	A	H	A	H	A	H	A	H	A
Land preparation	42	42	46	35	51	50	40	*	29	50	54	29	48	62	45	41
Planting	34	48	43	45	67	50	28	*	38	50	62	35	68	54	44	47
Weeding	41	46	44	42	48	59	35	*	53	50	75	38	65	50	46	46
Spray,fert.	38	3	81	0	50	14	**	*	**	*	*	*	*	*	41	12
Harvesting	40	48	48	51	88	50	42	*	49	63	60	38	54	62	57	49
Marketing	12	24	29	20	83	61	42	*	22	100	*	*	13	*	39	58
TOTAL	40	46	45	44	63	50	36	*	41	59	64	36	54	58	48	46

* none grown or marketed
** none applied
[1]Source: Due et al (9) p. 30

Value of total production

The calculation of the value of crop production introduced a dilemna as to the choice of prices to be used. A decision had to be made as to

whether government guaranteed prices or open market prices should be used in valuing crop production and sales. The Tanzania government has instituted a program of guaranteed prices for several products, among them being maize, cotton, sunflower, dried beans, coffee and sorghum.[3] Every effort is made by the government to ensure that those controlled products are marketed through the official marketing agencies established for that purpose. However, for all of the crops on the governmental control list (with the exception of cotton for which there is no real open market), the open market prices were several times higher than the established government prices. While the government prices remained constant for the entire country and crop year, open market prices were subject to wide fluctuations, as illustrated by bean prices in Mgeta which ranged from 3 to 10 Tsh per kg in 1981. A comparison of government and open market prices in 1980 is shown in Table 12.

Table 12. A Comparison of Government and Open Market Prices for Major Crops, Tanzania, 1980*

Major Crop	Government Price	Open Market Price
Maize	1.00	2.50
Sorghum	1.00	3.00
Rice	1.20	2.00
Cotton	3.25	0
Beans (dried)	3.50	5.00

* Source: Obtained in markets by Dr. P. Anandajayasekeram.

In reaching a final decision as to which price to use, the selling patterns of the surveyed farmers were reviewed. It was then realized that most of the farm families sold their crops on the open market and thus

[3]There were, however, no guaranteed prices for vegetables, including cabbage, cauliflower and green beans.

received the generally higher open market prices. Thus, these prices were used not only in the valuation of sales but also in valuing production and consumption. For those crops where there were no sales, such as maize in Mgeta and cassava, open market prices were also used. This was justified on the argument that purchases of these crops for consumption by the families were made on the open market and, as such, consumption from own production should also be so valued. Thus, in all cases, the value of production, consumption and sales was estimated using average open market prices in effect in a particular region.

Table 13 compares average volume and value of total production, consumption and sales, (given in both kilograms and shillings) per sampled family for the major regions surveyed. All regions produced maize and beans with maize production increasing in value over the period as one moves from the more traditional areas in Kilosa and Mgeta to the more commercialized farms in Arusha. Bean production was also highest in Arusha and lowest in Kilosa. Sorghum was only produced in Kilosa and Arusha, and although the volumes of production were similar, higher prices in Arusha resulted in a higher value of production. Rice, cotton and sunflower were produced only in the Kilosa district. Production of rice was moderately high and ranked second in value after maize, while production of cotton and sunflower together, ranked fourth. Pigeon peas were produced in all regions but production was generally small although prices were favorable. The largest amounts were produced in Mgeta district in 1980 both in terms of volume and value, with Kilosa reporting the lowest production. Mgeta was the only area reporting significant vegetable production which, after maize, were the most important crops produced.

Table 13. Average Value of Total Crop Production, Consumption and Sales per Sampled Family, Tanzania, 1980-82

	1980				1981		1982	
	Mgeta		Kilosa		Mgeta		Arusha	
	kg	Tsh	kg	Tsh	kg	Tsh	kg	Tsh
Maize								
Production	777	1,942	1,174	2,306	652	2,608	2,094	4,436
Consumption	768	1,920	611	1,263	652	2,608	1,154	2,437
Sales	-	-	563	1,043	-	-	870	1,865
Sorghum								
Production	-	-	369	1,082	-	-	285	704
Consumption	-	-	194	578	-	-	145	372
Sales	-	-	175	504	-	-	124	293
Rice								
Production	-	-	507	1,134	-	-	-	-
Consumption	-	-	213	483	-	-	-	-
Sales	-	-	294	651	-	-	-	-
Cotton/Sunflower								
Production	-	-	307	726	-	-	-	-
Consumption	-	-	30	52	-	-	-	-
Sales	-	-	277	674	-	-	-	-
Beans								
Production	209	997	110	490	167	836	454	2,125
Consumption	93	454	72	327	56	280	280	1,399
Sales	107	498	38	163	111	556	158	653
Pigeon Peas								
Production	163	547	30	106	-	-	35	157
Consumption	31	108	29	102	-	-	22	127
Sales	119	398	1	4	-	-	12	28
Vegetables								
Production	1,005	1,111	-	-	1,402	1,635	-	-
Consumption	199	214	-	-	87	95	-	-
Sales	679	783	-	-	1,315	1,540	-	-
Cauliflower								
Production	INCLUDED IN OTHER							
Consumption	INCLUDED IN OTHER							
Sales	INCLUDED IN OTHER							
Cassava								
Production	72	72	INCLUDED		209	209	74	187
Consumption	72	72	IN		209	209	70	176
Sales	-	-	OTHER		-	-	3	9

Table 13. Continued

Bananas								
Production	-	-	-	-	-	-	628	722
Consumption	-	-	-	-	-	-	389	464
Sales	-	-	-	-	-	-	236	254
Coffee								
Production	-	-	-	-	-	-	122	1,441
Consumption	-	-	-	-	-	-	-	-
Sales	-	-	-	-	-	-	121	1,440
Other								
Production	1,012	1,839	159	605	181	500	201	908
Consumption	134	319	109	395	134	320	55	243
Sales	715	1287	50	210	47	180	143	647
TOTAL								
Production	3,238	6,508	2,656	6,449	2,611	5,788	3,891	10,681
Consumption	1,297	3,087	1,258	3,200	1,138	3,512	2,114	5,218
Sales	1,620	2,966	1,398	3,249	1,473	2,276	1,668	5,190

Cassava was produced in all districts, although, as reported it is an insignificant component of the farming system both in terms of volume and value produced. Of the remaining major crops, bananas and coffee were not produced in large quantities except in Arusha. Production of 'other' crops (which included various items depending on the area) was not very large, except in Mgeta. Overall, the volume of crops produced was highest in the Arusha region, where generally higher crop prices meant significantly higher value of production when compared with the other regions.

The overall percentage of production consumed by the farm families themselves was remarkably similar in Mgeta (1980), Kilosa and Arusha but was substantially higher in Mgeta (1981) as shown in Table 14. In Mgeta, cassava and maize were generally produced for home consumption with a small percentage of maize production reserved each year to serve as the next year's seed. Cotton and sunflower (Kilosa), vegetables (Mgeta), and coffee

(Arusha) were produced mainly for sale with only small amounts used by the farm families. Most of the other major crops were divided approximately equally between consumption and sales in all areas. Pigeon peas offered a striking contrast among the villages surveyed constituting a major part of home-consumption in Kilosa and Arusha but only a small part of consumption in the early Mgeta study. However, maize production was fairly equally divided between consumption and sales in the other two regions.

Table 14. Average Values of Crop Production (in Tanzania shillings) and Percentage Consumed per Family, Tanzania, 1980 - 1982

	1980				1981		1982	
	Mgeta		Kilosa		Mgeta		Arusha	
Major Crops Produced	Val. Tsh	Con. %	Val. Tsh	Con. %	Val. Tsh	Con. %	Val. Tsh	Con. %
Maize	1,942	98.9	2,306	54.8	2,608	100.0	4,436	54.9
Sorghum	--	--	1,082	53.4	--	--	704	52.8
Rice	--	--	1,134	42.6	--	--	--	--
Cotton & sunflower	--	--	726	7.2	--	--	--	--
Beans	997	45.5	490	66.7	836	33.5	2,125	65.8
Pigeon peas	547	19.7	106	96.2	--	--	157	80.9
Vegetables	1,111	19.3	--	--	1635	5.8	--	--
Cassava	72	100.0	--	--	209	100.0	187	94.1
Bananas	--	--	--	--	--	--	722	64.3
Coffee	--	--	--	--	--	--	1,441	0
Other	1,839	17.3	605	65.3	500	64.0	908	26.8
TOTAL	6,508	47.4	6,449	49.6	5,788	60.7	10,681	48.9

Beans in the Farming Systems

It has been noted that bean acreages per family varied from 0.5 in Kilosa to 1.2 in Mgeta and 1.7 in Arusha; these acreages were 6, 45 and 22% respectively of total crop acreages. The contributions of beans to total

value of crop production, consumption, sales and net cash incomes in each sampled district are shown in Table 15. It can be seen that beans provide an important protein source and an important source of cash income; beans provided between 5 and 24% of total crop sales between 1980 and 1982 and between 8 and 19% of net family cash income.

Table 15. Beans in Specified Aspects of the Farming Systems by District, Tanzania, 1980-1982

	1980		1981	1982
	Kilosa	Mgeta	Mgeta	Arusha
% of total value of production	8	7	14	20
% consumed	65	50	33	66
% sold	35	50	67	34
Value of sales (Tsh)	422	498	556	653
% total sales	5	17	24	13
% net cash income	14	15	19	8

a) Selection of bean seeds

If new varieties of beans are to be introduced, it is important to know who chooses the bean seeds for planting so that pertinent information is conveyed to the appropriate persons.

In Mgeta, husband and wives together decided on choices of seeds to be planted in the majority (48%) of the cases, with parents and children making joint decisions in an additional 14% of the cases. Wives and children made the decision in 20% of the cases; wives alone made more of the decisions than did husbands alone (13% compared to 5% for the men).

In Arusha the wife (or women) made the majority of decisions as to beans selected for planting in 56% of the total number of families. This compares with only 13% for the husbands (or men). Joint decisions between

husband and wife were made in about 30% of the cases. Thus females are involved in choosing bean seeds in about 86% of those families surveyed.

b) Major factors affecting bean yields

The major problems associated with bean cultivation were drought and insect damage, with disease and too much rain reported in a number of cases. In Kilosa the major problems reported were drought caused by failure of early rains or adequate moisture for 31% of the farmers, insect damage for 22% and plant diseases for 12%. In Mgeta (1981), the major problems were insect damage (48%), drought (40%) and poor seeds (8%). The major problems reported in Arusha were drought in 27% of the cases, insect damage and disease in 39% of the cases, too much rain and poor seeds in 17 and 9% of the cases, respectively. Data were not provided to ascertain whether or not farmers could determine the kinds of insects and diseases affecting their yields.

c) Plantings if prices or yield changed

Farm families were asked what changes, if any, they would make in acreages if current bean prices doubled, fell by one-half and if bean yields doubled. In all cases families responded that if the prices of beans doubled they would grow more beans; some would grow less of other crops and some would increase total acreage planted. If the price of beans fell by one-half, families responses varied; some would grow the same quantity as currently for family consumption; others would reduce acreage; in general more families would plant about the same acreage than would reduce acreages significantly. If the yield doubled, more than three-quarters of the families in Arusha and two-thirds in Mgeta said that they would grow more beans; Kilosa families were not asked this question.

d) Varieties of beans most desired

Respondents were asked to rank the varieties of beans most desired for yield, palatability, storage and overall performance. The results are discussed below, first for the Mgeta region, followed by the results in the Arusha region.

i) Yield (Mgeta)

In Mgeta all 60 families ranked Kebwebwe as the type most preferred in terms of yield performance.

ii) Palatability (Mgeta)

The Kenya variety was generally prefered for consumption as green beans, followed by Kebwebwe for 58 of the 60 families. All 60 families preferred the Kenya variety for consumption as dried beans.

iii) Storage (Mgeta)

The Kebwebwe variety was preferred by 55% of the respondents, followed by Kenya with 10%; 35% of the families preferred both varieties equally.

iv) Overall Performance (Mgeta)

All 60 families preferred the Kenya variety for marketability. For the short rainy season 95% of the respondents preferred 'Kebwebwe" because of its short maturity period and only 5% chose the Kenya variety. During the long rainy season, 95% of the respondents would prefer the Kenya variety due to its longer maturity period, while the remaining 5% preferred Kebwebwe because of its moisture resistance characteristics.

v) Yield (Arusha)

Results for Arusha are summarized in Table 16. The red colored and Masai red were preferred by almost half of the respondents (46%) in terms of yield performance, followed by the Canadian Wonder variety which was preferred by 40% of the respondents. Other varieties mentioned included Selian Wonder, local and small varieties, mixed colored, and hybrid varieties.

vi) Palatability (Arusha)

The red colored varieties were most prefered for consumption as leaves and green and dry beans. Canadian Wonder was again second with the other varieties including Selian Wonder receiving a small share of the votes.

vii) Storage (Arusha)

Ranking of preference remained as before with the red colored and Masai red varieties first and Canadian Wonder second.

viii) Overall Performance (Arusha)

Preference with regards to overall performance reflected earlier choices with the red varieties (red colored and Masai red) first and Canadian Wonder second in Hanang. These two major varieties were preferred by an equal number of respondents in Arumeru. For the regiona as a whole, the red varieties were prefered by 46% of the respondents and Canadian Wonder by 35%. Other varieites were preferred by only a small number of the respondents (7%).

Table 16. Preferences of Varieties of Beans Most Desired by Sampled Farm Households, Arusha Region, Tanzania, 1982

Varieties	Hanang		Arumeru		Arusha	
Preferences	1	2	1	2	1	2
a) Yield						
Red colored and Masai red	17	13	19	9	36	22
Canadian Wonder	16	9	15	10	31	19
Other	4	10	5	10	9	20
Total responses	37	32	39	29	76	61
b) Palatability - leaves						
Red colored[1]	11	6	6	5	17	11
Canadian Wonder	7	11	6	1	13	12
Other	3	5	3	5	6	10
Total responses	21	22	15	11	36	33
c) Palatability - green beans						
Red colored[1]	15	8	12	7	27	15
Canadian Wonder	12	13	10	8	22	21
Other	3	6	2	2	5	8
Total responses	30	27	24	17	54	44
d) Palatability - dry beans						
Red colored[1]	20	4	8	13	28	17
Canadian Wonder	11	13	13	8	23	21
Other	2	9	6	5	8	14
Total responses	33	26	27	26	60	52
e) Storage						
Red colored[1]	23	4	16	8	39	12
Canadian Wonder	6	20	12	11	18	31
Other	3	5	7	3	10	8
Total responses	32	29	35	22	67	51
f) Varieties preferred to grow best overall						
Red colored	22		12		34	
Canadian Wonder	14		12		26	
Red and Canadian	4		5		9	
Other	2		3		5	
Total responses	42		32		74	

[1] Red colored and Masai red varieties.

In Hanang, Canadian Wonder was preferred over the red varieties in short rains because of its drought resistant and early maturity characteristics. However, the same reasons were given in Arumeru for choosing the red varieties over Canadian Wonder in short rains. For the long rainy season the red varieties were preferred in Hanang and the two varieties chosen equally in Arumeru. In both districts, the red varieties were deemed to be more moisture tolerant and high-yielding during long rainy seasons.

e) Consumption and Preparation of Beans

Families were asked about their consumption patterns of beans in the form of leaves, green beans and dried beans.

In Mgeta the majority of families (98%) did not report any consumption of bean leaves. Of those who did, consumption averaged about 3/4 kg. four times per week for a total of 3 kilograms per week. All families consumed green beans (in the pod) at least once a week, with a range of 1 to 6 times per week and a weighted average frequency of 3.2 times per week. The amount consumed varied between 1/2 and 8 kg. All but one family reported consumption of dried beans with a mode of twice a week. The weighted average frequency was C.8 kg. consumed 2.3 times per week.

Beans were generally boiled with a number of condiments including salt, onion, spices and tomatoes. Cooking time for dried beans varied from 1 to 2 hours, with an average of 1.7 hours. Hard seeds posed no serious problems in cooking for any of the families but 73% responded that improperly prepared beans created digestive problems and no family used beans as a weaning food.

In Arusha the consumption of bean leaves was not widespread with about 50% of the families reporting no consumption. Of these families in Arumeru who used bean leaves consumption was only once or twice a week for 2 weeks of the year. In Hanang, 15 families (35%) ate bean leaves 1-2 times per week for 4 weeks and 19% ate bean leaves 3-5 times per week for 13 weeks of the year. Amounts consumed were approximately 1 kg. per family per serving, all procured from own production. The modal frequency of consumption of green beans in the pod was 1-5 times per week of approximately 1 kg. per family, all of which were home produced for the 48 families (56%) who ate green beans. Consumption of mature green beans was more widespread, with 86% of the families consuming beans in this form. The modal frequency of consumption was 1-5 times per week of 1 kilogram per serving over a 13 to 20 week period. Only 3 families purchased beans in this form, the rest of consumption being home produced.

All families reported eating dried beans with a modal frequency of 1/2 to 5 times per week. Only 10% of the families purchased dried beans, with the remaining families using home produced beans only.

Beans were generally boiled with added oil, along with salt, onions, and vegetables for flavoring. In some cases the boiled beans were then fried with vegetables and bananas. Cooking time ranged from 1 to 2 1/2 hours.

f) Crop Losses and Storage of Beans

In Mgeta beans are harvested about 55 to 80 days after planting by uprooting the entire plant which is subsequently dried in the sun. The plants are then beaten with sticks to remove the dried pods which are then stored in tins, clay pots or sacks. Pest damage is reduced by sun-drying

the beans twice per month throughout the storage period. A few farm families dust the stored beans with DDT, but the high cost of this chemical limits the application of this storage method. Storage periods ranged from 1 to 12 months, with a weighted average of 7.3 months. A large percentage (82%) of the farmers reported crop losses during storage attributed to attacks by pests (57%) and insect damage (25%). Of those families who reported no storage problems, 9 (15%) used pesticides or other chemicals and 2 (3%) used other dehydration methods.

In Arusha harvesting of beans follow methods described above in Mgeta. The dried beans are then stored in bags untreated, in bags after being treated with various chemicals or ash. The majority of farmers reported some storage problems with only 14% of the families reporting no storage problems. The biggest problems in storage were posed by pest damage (61%) and the unavailability and high cost of bags and pesticides (21%).

Respondents estimated that 4% of total bean production was lost or wasted, with loses ranging from 1 to 10% of production. A large part of field losses were attributed to too much rain (28%), pests and diseases (27%), delay of harvest (13%) and too litle rain (9%). Storage losses amounted to less than 90 kg. (1 bag) annually for about 64% of the families, due to pest damage from rats and insects. Twenty-five percent of the families reported having no storage losses; 76% of the families reported no losses due to transportation problems.

Farm operating expenses

The levels of farm operating expenses within districts varied according to their farming systems with the more traditional farmers of Kilosa and

Mgeta using significantly fewer purchased inputs than the more commercial farmers in Arusha, as illustrated in Table 17. In 1980 farm families in Kilosa used no purchased seed, fertilizer or chemicals and spent only 5 Tsh for hired labor; that same year Mgeta farm families purchased small amounts of seed, fertilizer and chemicals; average farm operating expenses per family were 174 Tsh ($17) in Mgeta and 276 ($28) in Kilosa including depreciation costs. Data for the 1981 Mgeta families showed greater use of fertilizer, seed and hired labor but the average expense per family was

Table 17. Average Farm Operating Costs, (in Tanzania Shillings) per Sampled Family, Tanzania, 1980-1982

	1980				1981		1982	
	Mgeta		Kilosa		Mgeta		Arusha	
	Amt.	Val.	Amt.	Val.	Amt.	Val.	Amt.	Val.
Hired male labor(d)	na	na	na	na	na	na	26	613
Hired female labor(d)	na	na	na	na	na	na	9	150
Total hired labor(d)	na	20	na	5	na	46	35	763
Seed (kg)	na	36	-	0	na	84	31	322
Fertilizer (kg)	na	24	-	0	na	123	1	4
Chemicals (kg)	na	6	-	0	na	22	11	260
Petroleum (gal)	-	-	-	0	-	-	10	126
Machinery hire (d)	na	6	na	215	-	-	na	884
Transport hire	na	4	-	0	na	49	na	224
Land rental	-	-	-	0	-	-	na	72
Depreciation of farm tools	na	78	na	56	na	95	na	794
TOTAL	na	174	na	276	na	419	na	3,449

na - not available
d - days
kg - kilograms
gal - gallons

only 419 Tsh ($42). However, Arusha farm families hired significantly more labor, used hired machinery and transport to market, and purchased much larger quantities of seed, chemicals and petroleum. Their average farm operating expenses were 3,449 Tsh ($197). Arusha farmers reported large numbers of livestock owned suggesting use of manure, which helps to explain the low use of chemical fertilizers. As noted in Table 13, Arusha families also had higher yields of staple crops than the other districts.

Income Generated From Small Sales, Off-Farm Employment & Gifts

Most economists working in Africa assume that off-farm employment opportunities for members of farm households are very limited as are incomes generated from sales of small quantities of fruits and vegetables, brewing of beer and gifts. In order to test this hypothesis data were gathered from the sampled families by sex to ascertain the amount of these types of income generated and sources.

It was found that these sources of income were more important than hypothesized and that females generate an important percentage of this type of income, as shown in Table 18. Data collection improved over time with the Arusha data being much more complete than earlier studies.

Off-farm earnings were the most important sources of this type of income generation; males and females were engaged in land clearning, cutting trees, carpentry, tailoring, hoeing, construction, butchering, road work, security, teaching and other business enterprises. Beer brewing and sales of small quantities of fruits and vegetables provided the major sources of income to the females. Gifts, including child support, were a small percentage of this category of income. On average, sampled families in

Kilosa district had 368 Tsh. ($37), in Mgeta, 978 Tsh. ($98) and in Arusha, 4,340 Tsh (approximately $248) from these income sources. However, this category of income represented 11, 43, and 84% of crop sales respectively in the areas sampled constituting an important addition to family cash income.

Table 18. Average Income Generated from Off-Farm Employment, Sampled Families, Tanzania, 1980-82

Source of Income	1980 Kilosa	1980 Mgeta	1981 Mgeta	1982 Arusha
Employment - males	244	141	436*	3,446
- females	n.a.	125		137
Vegetable, fruit & beer, etc. - males	n.a.	n.a.	134*	141
- females	81	n.a.		562
Gifts - males		0	408*	31
- females	43	0		23
Total - males	43	17	n.a.	3,618
- females	43			722
	368	283	978	4,340

n.a. - not available
* not separated by sex

Family Living Expenditures

Average family living expenditures for the surveyed families are reported in Table 19, with the exception of Mgeta 1980, for which itemized expenditures were not collected by the enumerator. Average families expenses ranged from 2,485 Tsh ($249) in Kilosa to 5,419 Tsh in Arusha. Generally, families spent the largest share of their budget on food and clothing . For the Kilosa area, these two items accounted for 64% of the total family budget, with expenditures for other items ranging from 2% for "other items", and fees and licenses, to 10% for maize grinding. If maize grinding is included with food expenditures, then food and clothing would

account for almost 75% of the average family's budget. For the Mgeta (1981) region, the budgetary allocation for food and clothing amounts to 81% excluding maize grinding, and 84% with maize grinding. In Arusha, the corresponding figures are 56% and 65%, respectively. Data in Table 19 support economic theory that raising a family's income generally results in smaller percentages being spent on food; as income increases the share of food expenditure in the total budgets decreased from 37% in Mgeta to 30% in Kilosa to 22% in Arusha. Expenditures for such items as medicine and education, fuel, entertainment, and furniture show a corresponding increase from Mgeta to Arusha.

Table 19. Average Family Living Expenditures Per Sampled Farm Family, Tanzania, 1980-1982

Items	1980 Mgeta		1980 Kilosa		1981 Mgeta		1982 Arusha	
	Amount	%	Amount	%	Amount	%	Amount	%
Purchased food	n.a.[1]		752	30	598	37	1195	22
Maize grinding	n.a.		259	10	48	3	490	9
Clothing & footwear	n.a.		848	34	712	44	1823	34
Kerosene, fuel, batteries & radio	n.a.		225	9	162	10	625	11
Pots, pans, furniture	n.a.		100	4	24	1	408	8
Medical & educational	n.a.		138	6	55	3	338	6
Fees & Licenses	n.a.		48	2	-	-	181	3
Transportation[2]	n.a.		78	3	30	2	326	6
Other	n.a.		37	2	-	-	33	0
Total	n.a.		3,205	100	2,485	100	5,419	100

[1] n.a. - not available
[2] excludes the cost of transporting farm products to market

Net Cash Income and Use of Cash Earnings

The income generated from farm operations showed noticable differences from one region to another as illustrated in Table 20. While gross farm cash income (defined as total crop and livestock sales) varied from 2,417 Tsh in Mgeta (1981) to 7,202 Tsh in Arusha, it is differences in farm operating costs which help to move net farm cash income closer together. Higher gross cash income in Arusha is matched by higher farm operating costs, resulting in a net farm cash income in line with those reported for the 1980 Mgeta and Kilosa areas. However, those farmers included in the 1981 Mgeta study reported significantly lower net farm cash income compared with the other three areas.

Average off-farm income and gifts per family were highest in Arusha district, amounting to 4,340 Tsh compared to 978 Tsh in Mgeta (1981) (the highest figure for the other 3 districts). Thus, total cash income was highest in Arusha (8,093 Tsh) and lowest in Mgeta (1981) (2,976 Tsh) with the corresponding figures for the other 2 areas showing much similarity (Table 20).

Family living expenses reflected fairly accurately the realized income levels, again being highest in Arusha and lowest in Mgeta (1981). Thus, families were, on average, able to tailor their family budgets to their incomes, and on average were able to meet their expenses from realized incomes. In all cases, therefore, the districts reported an income surplus from which they could save for future needs. Again, Arusha showed the most favorable balance, but lower family living expenses helped secure a larger surplus in Mgeta (1981) when compared with the 1980 survey results.

Table 20. Average Family Cash Earnings (in Tanzania Shillings) per Sampled Family, Tanzania, 1980-1982

	1980		1981	1982
	Mgeta	Kilosa	Mgeta	Arusha
Total value of crop production	6,508	6,449	5,788	10,681
Total value of crop sales	2,966	3,249	2,276	5,190
Total value of livestock sales	294	101	141	2,012
	3,260	3,349	2,417	7,202
Farm Operating Costs	174	276	419	3,449
Net farm cash income	3,086	3,074	1,998	3,753
Off-farm income & gifts	283	368	978	4,340
Total cash income	3,369	3,442	2,976	8,093
Family living expenses	3,205	2,485	1,629	5,419
Balance (saving potential)	164	957	1,347	2,674
Average acres in crops	8.4	8.4	5.4	7.8
Net value of crop production	6,334	6,173	5,369	7,232
Net returns/crop acre	754	735	994	927

Given average acres in crops and net value of crop production (defined as total value of crop production less farm operating costs) net returns per acre can be computed for these districts. Net value of crop production again followed previous rankings with Mgeta 1981 lowest and Arusha highest. However, the differences among these regions is less marked, ranging from 7,232 Tsh in Arusha to 5,369 Tsh in Mgeta (1981). On a per acre basis, lower acres in crops for Mgeta (1981) resulted in highest returns per acre for this area in comparison with the other three.

REGRESSION ANALYSIS

(a) Variation in Total Value of Production

Given the importance of agriculture in the economic structure and survival of these Tanzanian households, increase in family income will continue to come primarily from increases in production. In other words, the marketable surplus (after family consumption needs have been met) must be increased. It is therefore important to determine those factors likely to signficantly affect such increases in production throughout Tanzania.

Multivariate and bivariate regressions were calculated to ascertain those factors accounting for the variation in gross value of production for those areas surveyed in Tanzania between 1980 and 1982. Several alternatives were tried in an effort to determine those variables most likely to affect production, given standard economic theory and production possibilities existing from one area to another, although the underlying theory was fairly homogeneous.

Results from the socio-economic studies showed that a large percentage of the surveyed farmers' first priority was to provide adequate food for the family; income was the second most important priority. Given that these two variables would likely increase with increasing family size, the affect of family size on total production was tested to determine whether families increased acreages planted to accomodate increases in family size. The tested equation was of the form:

(1) $$X_3 = a + b_4 X_4$$

where:

X_3 is acreage and X_4 is total family size

The explanatory power of this regression was extremely low, with reported R^2 as low as .0004 in the 1980 Mgeta study. A slightly higher R^2 of .25 was reported for Kilosa farmers in the same year, with the estimated coefficient of the independent variable significant at the 95% confident level(t=4.16). Only in this case would a unit increase in family size result in a corresponding increase in acreage planted; for the Mgeta region the corresponding figures is less than a 1/4 acre increase.

Given the lack of explanatory power of this regression, attempts were made to estimate the effect of total labor equivalents available on acreage planted and to determine whether this would be influenced by the amount of male or female labor available. The estimated equations were of the form:

(2) $$X_3 = a + b_7 X_7$$

(3) $$= a + b_5 X_5 + b_6 X_6$$

where:

X_5, X_6 and X_7 are male, female and total labor equivalents, respectively. For the Kilosa area, the explanatory power of the regression remained the same (R^2=.15) for both formulations but labor disaggregated by sex had statistically significant coefficients. The corresponding results for the Mgeta area (1980) was R^2 of .03 for the disaggreated equation and R^2 = .13 and .11 for the two villages in the 1981 Mgeta study. Thus, although families surveyed considered food to be an important influence on their farming needs, family size and labor supply did not significantly influence or explain variations in the acreages planted to crops, a situation which may be the result of deep-seated traditions as to cropping patterns, choice of crops and risks.

In order to be able to make recommendations as to improving the well-being of these farmers, the researchers sought therefore to determine

those factors most likely to influence the value of total crop production. This was done although realizing that other factors such as weather and government policies also affect yields and prices. The regressions took a number of forms depending on the included variations, among which were, value of consumption (proxy for food requirements), farm operating costs, male and female equivalents, education of the respondent and number of years farming.

Based on the theory of many Tanzanian agricultural economists that labor is the major constraint to increasing production in traditional agriculture, total labor equivalents (X_7) were used as the independent variable to account for variation in the value of total production (VTP). The estimated equation was:

$$VTP = a + b_7 X_7 \quad (4)$$

The resulting R^2 was .12 in Kilosa and .01 in Mgeta (1980). For Mgeta (1981) the results were R^2 of .14 and .01 for Kibaoni and Langali villages, respectively. The validity of the hypothesis was questioned by the results, since in only 50% of the cases was the labor coefficient statistically significant.

Given these low levels of explanatory power, alternative variables were sought to held explain the variations in VTP. Earlier studies by Kashuliza (15), Rashidi (16) and Mdoe (17) raised several possibilities, including farm size, age of farmer, years of education of the respondent, and farm operating costs in addition to labor available. The strength of these variables' influence on VTP was tested in an equation of the following form:

$$VTP = a + b_3 X_3 + b_7 X_7 + b_8 X_8 + b_9 X_9 + b_{10} X_{10} \quad (5)$$

where

VTP, X_3 and X_7 are as defined above,

X_8 is level of education of the respondent

X_9 is number of years the respondent has been farming

and X_{10} is total farm operating costs.

The results of this regression varied substantially from one area to another, with R^2 ranging from .88 to .31. The results for specific regions are as follows: (t values given in parentheses)

(6) VTP_k (Kilosa 1980)* $= 1{,}064 + 545.78X_3 + 90.03X_7 - 101.15X_8 + 3.60X_{10}$

$R^2 = .88$ (4.50) (0.25) (1.21) (5.23)

(7) VTP_m (Mgeta 1980)* $= 1{,}892 + 363.42X_3 + 366.61X_7 - 12.29X_8 + 1.72X_{10}$

$R^2 = .31$ (3.66) (0.86) (0.53) (1.38)

(8) VTP_{kb}(Kibaoni)** $=147.10 - 19.26X_3 + 235.47X_7 + 212.18X_8 + 44.88X_9 + 7.43X_{10}$

$R^2 = .68$ (-0.12) (0.49) (0.36) (1.65) (5.15)

(9) VTP_2(Langali)** $= -1088.64 + 1011.28X_3 - 138.34X_7 + 458.02X_8 - 8.86X_9 + 2.64X_{10}$

$R^2 = .47$ (3.20) (-0.18) (0.48) (-0.21) (1.03)

(10) VTP_a(Arusha '82)*** $=.3722 + 709.10X_3 - 43.60X_4 + 155.70X_8 + 4.00X_9 + 0.47X_{10}$

$R^2 = .53$ (4.37) (-0.13) (0.45) (0.04) (3.50)

* for these two regions, number of years farming (X_9) was negative and not statistically significant

** results are given for each district separately; a regression using aggregated regional data was not estimated for Mgeta 1981

*** In this regression, total labor equivalents (X_7) was replaced by family size (X_4)

This new formulation of the regression (equation 5) generally resulted in an increase in R^2. Farm operating costs exerted a significant influence on production in all regions except Langali. Acreage also had a significant effect on value of production except in Kibaoni where it was negative and insignificant. Neither total labor equivalents or family size had any

significant impact on the dependent variable. The number of years farming and education level of the respondent exerted little influence on the value of total production.

It can thus be concluded on the basis of these results that farm operating expense and the acreage in crops are the major determinants of the value of total crop production for these surveyed areas. Family size and supply of family labor as well as farming experience are much less influencial and constraining than may be theorized. It, therefore, becomes important in prescribing new techniques and inputs to be cognizant of the correlation between these variables. The more the farmers invest in improved technology in the form of improved seed, machinery and land preparation, the higher the corresponding level of production. However, one must not lose sight of the likely impact of rising farm costs on net returns per acre, even when total returns are rising.

NUTRITIONAL ADEQUACY

Further research was undertaken to ascertain if one could use the consumption data collected from a one-time questionnaire to determine if these families were receiving recommended levels of calories and utilizable protein (UP). Also, linear program (LP) models were developed to determine the acreage needed just to provide food for the average family and then to develop revenue maximizing cropping systems subject to various constraints including the restraint that the system provide adequate calories and UP based on average family size, labor, and available acreage.

The number of persons per family was converted into consumer units (CUs) which reflect differing nutritional requirements of persons of

different age and sex, according to FAO data and the work of Latham (18). The data related to the Arusha sample of 85 families from Hanang and Arumeru districts (for a more detailed description of the sample see Due et al (9). The consumer unit weights as determined by Latham are:

	Children
Adult Female = 1.00	Age 7-9 = 1.16
Adult Male = 1.34	4-6 = .97
Adolescent female(10-18) = 1.14	1-3 = .72
Adolescent male(10-18) = 1.35	less than 1 = .44

The linear program makes specific use of the average number of CUs per family in each district; the average number in Hanang was 7.0 and in Arumeru 7.1. The range of consumer units per family varied from 1.3 to 17.0.

Calories enter the LP in the form of the per kilogram calorie content of the foods produced on the farm as reported by farm families interviewed in the survey. The calories per kilogram figures are derived from the Food Composition Table for Use in Africa (19, 1968). In the LP the "average farm family" is constrained to produce recommended minimum calorie levels based on average consumer units per family. The relative proportions of each calorie source were also constrained to existing (1982/83) food consumption patterns.[4] For example, if maize represents 58% of the diet in weight, it is programmed to provide 58% of the calories. The figures for calorie content are as follows:

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[4]If this constraint had not been utilized, the system would provide only maize (due to calorie and protein content, relative price and yields); this is clearly unacceptable as families need a variety of foods and foods with differing nutritional components.

Food	Cal/KG	Food	Cal/KG	Food	Cal/KG
Maize	3,570	Green beans	430	Beef (lean)	1,220
Sorghum	3,450	Cassava	1,490	Sheep	2,650
Millet	3,490	Pigeon peas	3,450	Goat	1,790
Wheat	3,310	Cowpeas	3,380	Chicken	1,460
Dry beans	3,360	Bananas	880		

Although the method of calculation for the utilizable protein (i.e. - protein completely utilizable for anabolic purposes) is complex, utilizable protein (U.P.) is used in the LP in much the same way as calories are used. The relative proportions of UP sources are maintained at existing levels (e.g. 58% for maize) so that the cropping pattern must provide at a minimum a recommended level of U.P. for each of the foods in the current consumption pattern. The U.P. per kilogram contents for the major food crops used in this portion of the program are:

Maize	46	gms/kg
Sorghum	54	"
Dry beans	163	"
Pigeon Peas	88	"
Bananas	8	"
Cassava	7	"

The formula for the calculation of utilizable protein is (20, p. 87):

(11) $$UP_i = \frac{RP_i}{1 - (7.6\ CP_i/C_i)} - .08\ CP_i$$

with:

RP_i - Reference protein/kg of food i.

CP_i - Crude protein/kg of food i.

C_i - Calories per kilogram of food i.

The crude protein and calories for each food are found in the Food Composition Table for Use in Africa (19). The reference protein is a

function of the food's chemical score which may be found in standard nutritional references; further details concerning the UP calculation can be found in Gillard-Byers, (20, pp. 82-87).

Finally, the recommended levels of calories and utilizable protein have been set in the program at 2,295 cals/CU/day and 41 grams U.P./C.U./day. The source for both of these figures is Shimkin (22), FAO (19), and World Bank (1).

Calories Consumed

The average person (consumer unit) in sampled families in Hanang was receiving 5% above the recommended number of calories from home produced food - 2,381 calories per person per day from crop production and 26 calories per day from livestock for a total of 2,407 calories. However, the average person in Arumeru was receiving only 1,992 calories or 85% of the recommended minimum requirements; on average, persons were receiving 1,969 calories from crops and 23 calories per day from livestock.

The distribution of the calories from crops for the average family in each district was as follows:

	Hanang	Arumeru
	%	%
Maize	70.5	70.7
Sorghum	9.1	0
Beans	12.4	15.9
Peas	0	0.5
Bananas	2.8	9.9
Cassava	2.2	1.2
Other	3.0	1.8
TOTAL	100.0	100.0

Because of the large quantities of maize consumed, maize provided 70% of the average total calorie intake; beans provided between 12 and 16% in the two areas. Bananas are much more important in providing calories in Arumeru, where they provide 9.9% than in Hanang, where they contributed 2.8% of total calories. Other vegetables and fruits, although not contributing a large percentage of total calories, are important for both protein and variety in meals.

Although the average person per family sampled is receiving adequate calories per day in Hanang and 15% below average in Arumeru from crops and livestock consumed on the farm, the distribution of crop calories per person is very different from the average, as is shown below:

	Hanang	Arumeru
	% of families	
Calories per person/day	%	%
Less than 1,600	40.0	38.1
1,600 to 2,295	14.3	28.6
2,300 to 3,999	25.7	23.8
Over 4,000	20.0	9.5
TOTAL	100.0	100.0

The distribution of persons' caloric consumption shows that almost 40% of the persons were receiving less than 1,600 calories per day in both districts while 54% in Hanang and 67% in Arumeru are receiving less than the recommended levels from home produced foods. Thus the distribution of caloric consumption is important in determining adequacy or deficiencies.

Utilizable Protein

What about protein levels of the average person in each district of Arusha region? On average persons were receiving recommended minimum requirements (41 grams of protein per day); the average in Hanang was 43, and in Arumeru 41, and for both areas 42 grams per person per day. But again the distribution was very skewed; 56% in Arumeru and 60% in Hanang had less utilizable protein per day than the recommended minimum.

	Hanang	Arumeru
	% of families	
Utilizable Protein per person/day	%	%
Less than 20 grams	17.0	30.0
20-40 grams	43.0	36.0
Over 41 grams	40.0	44.0
TOTAL	100.0	100.0

What is the contribution of each crop to the UP per person?

	Hanang	Arumeru
Percentage UP from crops	%	%
Maize	51.0	51.5
Sorghum	9.2	0
Dry beans	33.6	42.4
Pigeon peas	2.2	0.8
Bananas	1.3	4.9
Cassava	0.6	0.3
Other	2.1	0.1
TOTAL	100.0	100.0

It is noted that although maize is relatively low in protein (6-7%), such large quantities of maize are consumed that maize provides over half the

UP. Beans are important sources, providing 35% in Hanang and 42% in Arumeru. Bananas, also very low in protein, provide 5% of the UP in Arumeru because of the large quantities consumed.

Although on average persons in Arusha region were receiving adequate levels of UP, does availability vary by family size? Yes, the large families were more undernourished in terms of UP than small families; in Hanang, 76% of the large families (of more than 6 consumer units) were receiving less than the minimum recommended 41 grams while 33% were receiving more than the requirement; of the families of 6 consumer units or less, 54% were receiving more than the recommended and 46% less. Forty percent of all families were receiving the recommended amounts while 60% were not.

In Arumeru only 42% of all families were receiving recommended amounts of UP; of these families with more than 6 consumer units, 71% were receiving less than the recommended amounts.

Crude Protein (CP)

UP is more important than CP for health maintainance; however, it is also interesting to see the contribution of CP to families and persons' diets in Arusha region. For the region as a whole 96.1% of CP is supplied by crops and 3.9% by livestock consumed. The percentage contributed by each crop is as follows:

	Hanang %	Arumeru %
Maize	56.5	58.9
Sorghum	11.6	0
Beans	24.7	32.4
Pigeon peas	2.6	0.8
Bananas	1.3	5.4
Cassava	0.5	0.3
Other	2.8	2.2
TOTAL	100.0	100.0

Linear programs were run to ascertain if the sampled families in Arusha could obtain greater income and more calories and UP if different crops were planted, given the same labor and land constraints. It was found that with recommended required calories and UP met, more income could be generated by changing the farming systems as shown in Table 21.

Table 21. Changes in Crops Planted to Provided Recommended Calories and UP Levels and Maximize Income, Hanang, Tanzania, 1982

Crops	(1) Chosen by families (acres)	(2) Provide UP & Cal. (acres)	(3) L.P. Model (acres)	(4) Income from (1) (Tsh.)	(5) Income (3-2) (Tsh.)	(6) Income Intercropping (Tsh.)
Maize	3.9	2.4	3.4	2,047	1,169	1,169
Beans	1.9	1.0	1.0	753	0	1,132
Sorghum	1.1	.5	.5	581	0	0
Peas	.4	.9	.9	268	0	0
Coffee	.2	.0	1.7	132	2,448	2,448
TOTAL	7.5	4.8	7.5	3,781	3,617	4,749

Column 1 gives the acreages of crops planted by the average sampled families to meet food, income and risk objectives. Column 2 gives the acreages necessary to meet minimum recommended calories and UP objectives only, and column 3 is the LP model which meets all three objectives. Columns 4, 5, and 6 show the sales income from crops sold; since data on

farm operating cost were not available by crop, sales incomes are shown in these columns.

The average family planted 7.5 acres with crops shown in column 1 and sales income in column 4. The same average family would only have to plant 4.8 acres (column 2) to meet calorie and UP objectives, assuming no loss in food from storage. In this case all crops would be consumed and no income would be available for family living expenses. In column 3, calorie, UP and income objectives are met; now the family plants less maize, beans and sorghum and more peas and coffee; income is shown in column 5, assuming current prices and yields.

Intercropping is useful not only in terms of labor minimization and income generating but also in terms of nutrition. When maize and beans are consumed in a 90:10 mix (maize:beans) the UP value is 75% higher over separate time consumption of the same quantities (21, p. 54). Total UP for the family could be provided by 1.6 acres of maize and 0.5 of beans whereas without joint consumption 2.4 acres of maize and 1.0 acres of beans are needed. Income from the intercropping model is shown in column 6. It should be noted that families do intercrop in column 1 but the crops are shown as if this did not occur.

It is obvious that the current farming system of the sampled families provided the recommended levels of calories and UP and revenue for other expenses. If the families were providing only for the minimum recommended levels of calories and UP, and none of these were lost in storage, families would need to plant only 4.8 of the current 7.5 acres per year. Income could be increased and minimum levels of calories and UP maintained by changing the cropping systems as suggested in Column 3 of Table 21 and

growing more coffee and less maize, given current prices and yields. UP could be increased by families consuming more beans, peas and livestock.

Conclusions

This report summarizes the results of research undertaken to provide baseline and farming systems data in two regions of Tanzania between 1980 and 1982. It also describes briefly the general economy of Tanzania while these studies were being undertaken and the importance of beans in these farming systems. Also included is the adequacy of provision of minimum recommended levels of calories and protein from home-produced food per family and the development of a linear programming model which would provide these recommended adequacy levels while maximizing farm income.

Often farming systems are assumed to be homogeneous with a given country; this is certainly not true in Tanzania. Climate, rainfal, soils, and other factors vary sufficiently so that systems chosen by farm families in each district are very different. However, the average sized farm per family was fairly similar in the differing geographical areas - 8.4 acres in Kilosa district, 5.5 in Mgeta district in Morogoro region and 7.8 in Arusha. The varieties of beans preferred vary widely within the country. The preferred varieties of beans were Canadian Wonder and small red and black in Kilosa, Kebwebwe and Kenya in Mgeta, and Canadian Wonder and Masai red in Arusha. Data are included on family bean preferences for yield, consumption, storage and sale for each major area, as well as production constraints for beans.

Amounts of total crop production consumed and sold are also similar between regions except for Mgeta (1981); 50% were consumed in Kilosa (1980) and 49% in Arusha (1982) in contrast with 61% consumed in Mgeta (1981).

Farm operating expenses were much higher per farm in Arusha region where more hired, mechanized ploughing is done and oxdrawn equipment used for ploughing and planting when compared to the more labor-intensive farming of the other regions. Thus net returns from farming and off-farm employment were 3,442 Tanzanian shillings in Kilosa and 3,414 in Mgeta (1980), 2,976 in Mgeta (1981) and 8,183 in Arusha (1982).

Females contributed almost one-half the family labor on the major crops and more than half on garden crops; in adition they were responsible for child rearing and household tasks and collecting water and fuel. Female labor contributions in farming were not remarkably lower in Arusha region although more mechanized equipment was utilized; there, females contributed 47% of the labor on major crops compared with 48% in Kilosa and 48% in Mgeta. Further details on labor contributions by crop and by cropping practice are discussed in the text.

It is generally assumed in Africa that off-farm income earning opportunities are very limited. Data collected which differentiated off-farm income by sex confirm that families generate substantial income from these sources, especially those families in Arusha region. Income per family so generated is shown in Table 18.

Analysis of consumption data in Arusha region showed that on average families were receiving adequate minimum recommended levels of utilizable protein (41 grams) but that these were highly skewed with large families much less well nourished than small families. On average persons were also receiving adequate minimum levels of calories in one district (Hanang) but were 15% deficient in the other district (Arumeru). These distributions too were highly skewed with large families less well nourished than small families. However, the farming system does attempt to provide for adequate

family consumption; a linear programming model was developed which provided recommended levels of calories and protein and maximized income given land and labor constraints.

Beans are an important component of these farming systems providing both consumption and income sources. Beans represented the largest single intercrop, with as much as 45% of the total acres having beans as part of the intercropping pattern.

In addition, beans were grown by at least 90% of the farm families sampled, second only to maize in the three regions. Like maize, beans constituted an important component of both food and income requirements.

While farmers cited several reasons for farming, the first priority was provision of adequate food for the family; the second was generation of income. Given the importance of beans in the farming systems, improvements in yields and prices would improve family income and nutrition.

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