KILIMANJARO IDP

AGRICULTURE

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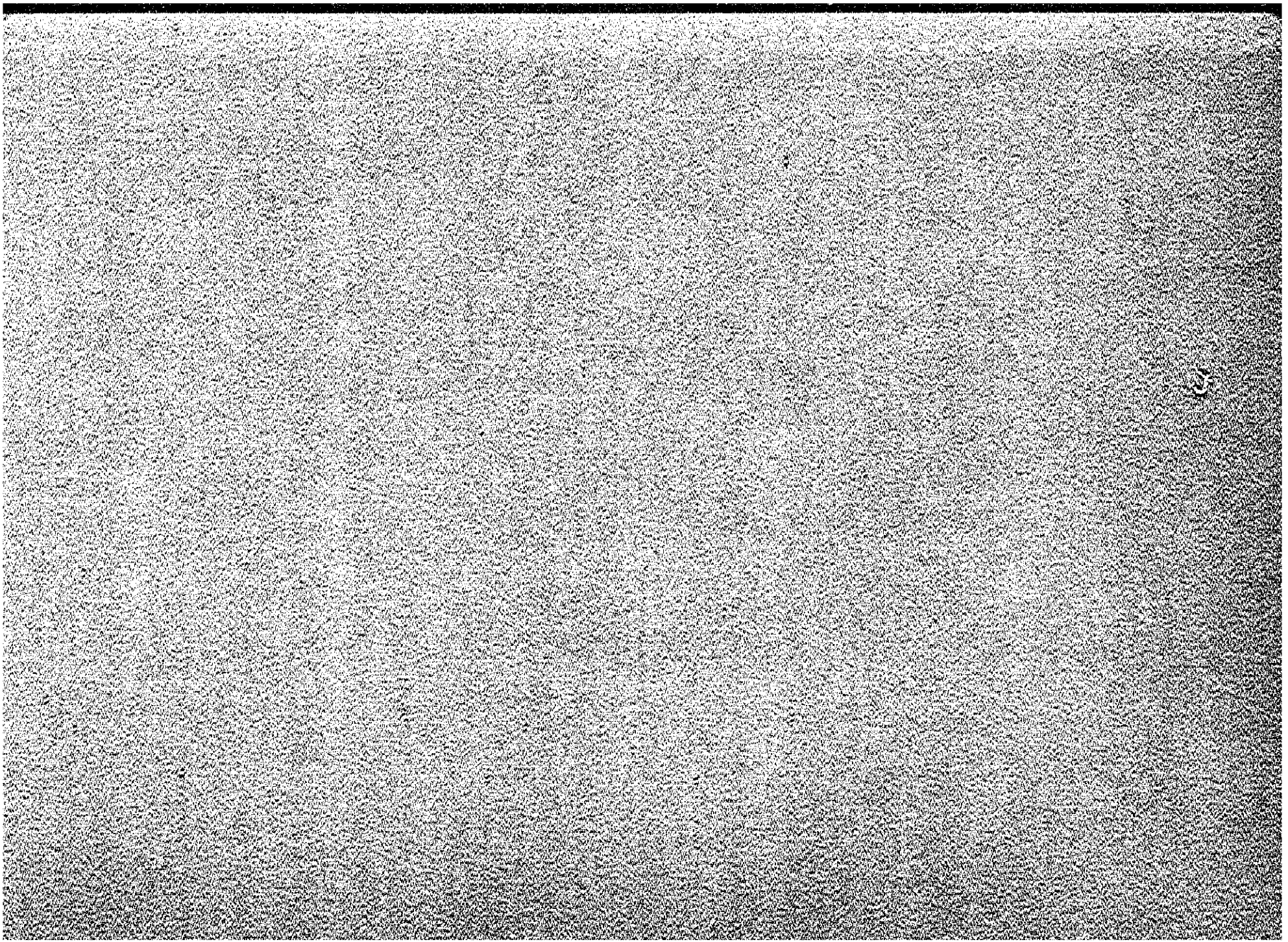

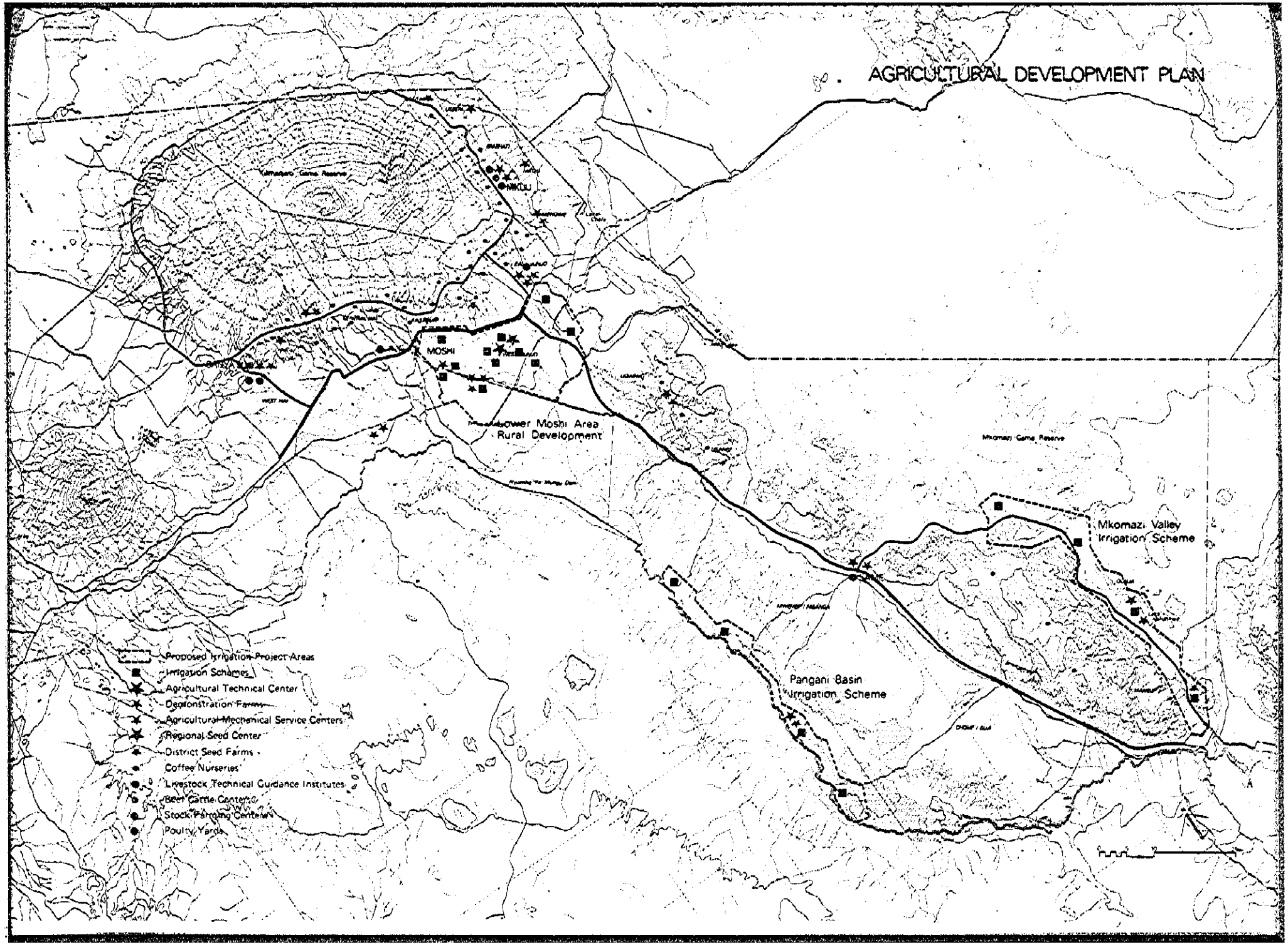
AGRICULTURAL DEVELOPMENT PLAN
MOSHI
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Rural Development
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Irrigation Scheme
Proposed Irrigation Project Areas
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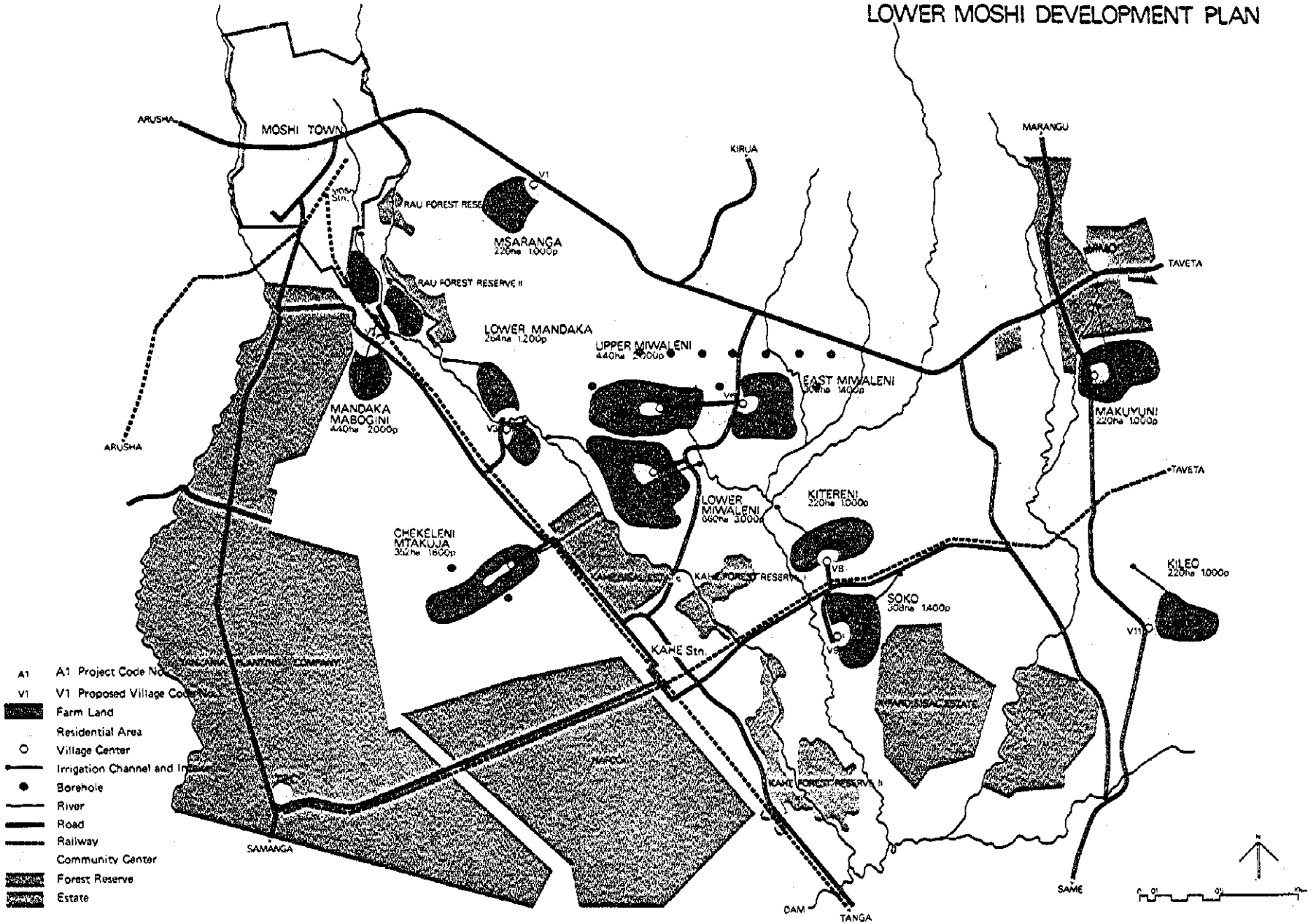
Beef Cattle Centers
Stock Farming Centers
Poultry Yards

LOWER MOSHI DEVELOPMENT PLAN



AGRICULTURE

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1. PRESENT SITUATION

1.1 General

In terms of elevation and topography, the Kilimanjaro Region can be roughly divided into two areas: highlands and lowlands. Reflecting the difference in rainfall according to elevation, the type of farming is distinctive in each of these areas. More specifically, the highlands, which are situated for the most part at altitudes of 1,100 m or more above sea level, are relatively abundant in rainfall and not too hot, making it possible to plant coffee, a typical export crop of Tanzania, and bananas, the staple food crop of the region, and support a very high population density. On the other hand, in the sparsely populated lowlands, which are for the most part below 1,100 m and have little rainfall, drought-resistant crops are cultivated because of the ardity and high temperatures. There mixed cultivation of maize and beans is representative, and cattle grazing is also practiced.

The rainfall and land utilization of each agricultural area are summarized in Table - 1 . Whereas coffee and bananas are cultivated in highland areas with an annual rainfall of 1,000 mm or more, maize and other crops are cultivated in lowland areas with an annual rainfall of less than 1,000 mm. In the dry season, irrigation is badly needed. However, lowland areas have little or no irrigation facilities, and almost all farmland depends on rainwater. Thus, even in areas with an annual rainfall of 700 mm to 1,000 mm, yields vary largely from year to year. In areas with less than 700 mm rainfall, where stable production of crops without irrigation is difficult, paddy and cotton are often cultivated by using water from rivers and other sources.

Under such climatic conditions, approximately 160,000 hectares of land are now under cultivation, of which approximately 110,000 hectares, or 70%, are cultivated by smallholders. According to the 1967 Census, the number of smallholders was 124,000 or 5.3% of that of the whole country. It accounted for approximately 94% of the total of approximately 132,000 households in the region. This figure is considerably higher than that for the whole country (84%). The number of smallholders in the region as of 1976 (on the basis of the 1967 Census, the same applying for all of the values below for 1976) is about 160,000, or 30% above the 1967 figure. According to the 1967 Census, the smallholding population in the region, was approximately 626,000 or 5.3% of the smallholding population of the whole country and 96% of the total population of the region, the corresponding percentage for the whole country being 95%. The smallholding population in the region in 1976 was approximately 806,000, for a 30% increase over the 1967 figure. In respect to the size of holding, as shown in Fig.-1, in the majority of cases it ranges from 0.5 ha to 1.0 ha, this range accounting for 68,227 ha or approximately 55% of the total of 124,000 ha. The second largest group of smallholders is those with an area ranging from 1.0 ha to 1.5 ha, accounting for 19,848 ha, or 16% of the total. (see Fig.-1) In the country as a whole, smallholders with an area ranging from 1.5 ha to 2.0 ha are the largest group, accounting for 1,313,200 ha, or 56% of the total. Next come those with an area from 1.0 ha to 1.5 ha, accounting for 586,250 ha, or 25% of the total. Households with an area ranging from 0.5 ha to 1.5 ha account for about 70% of the total number of smallholders in the region, whereas nationwide about 80% of the smallholders have an acreage ranging from 1.0 ha to 2.0 ha. It can therefore be said that farms in the region are fairly small in scale. And the trend today is toward further fragmentation of holdings as evidenced by statistics

showing that both in the country as a whole and in the region, farm households with 1.0 ha or over decreased between 1967 and 1976 while those with 1.0 ha or less increased. As of 1975, the average acreage under cultivation per household was 0.76 ha in Hai, 0.35 ha in Moshi, 1.36 ha in Rombo, and 0.97 ha in Pare, the average for the region being 0.7 ha. According to the 1967 Cemus, the working population accounted for by the agricultural sector was qpproximately 327,000 or 52% of the total agricultural population. The percentage is a little higher than the 45% for the whole country, and the age structure of the agricultural working population in the region is much the same as that for the whole country. Persons 20 to 40 years of age account for 45%, those between 40 and 50 years of age for 23%, and those between 15 and 20 years of age for 16%, these three age groups together accounting for approximately 85% of the total.

Many of the smallholders living in highland areas have farming plots for coffee and bananas in the vicinity of their houses and some additional plots in lowland areas where they grow maize and other crops. In cases where sufficient water supply is available, some live in lowland areas, growing paddy cotton, and maize by means of irrigation. Such cases, however, are few, and the level of farming technology is still low. Farmers are little interested in the use of fertilizers. However, manure is applied in coffee and banana cultivation, and the soil is generally made fertile by piles of dead coffee leaves. Agricultural chemicals are hardly used at all, except in coffee cultivation. Agricultural machinery is seldom used in highland areas due to the steep slopes and mixed cultivation, though in lowland areas large tractors have been introduced fairly intensively for plowing. In the case of maize, more than half of the planted area is plowed by tractors. Plowing is also done by oxen, but to a very limited extent. Thus, a considerable amount of plowing is still done by human power. Small farms being prevalent, farming is done mostly by self-employed labour. In the harvesting of coffee and the weeding of maize fields, however, hired labour is also employed, the expense thereof accounting for a large proportion of the total cost of running such farms. Livestock such as cows and oxen, goasts, sheep, and hens are raised. However, the manner of live stock feeding and the type of livestock fed in highlands are not the same in lowlands. Many farm households in highland areas keep several dairy cows (mainly zebu varieties together with some foreign varieties) in byres, plus some goats and hens, and in some cases hogs as well. In lowland areas beef cattle and goats are raised by pasturing, and not a few farm households keep as many as several dozens of them at a time.

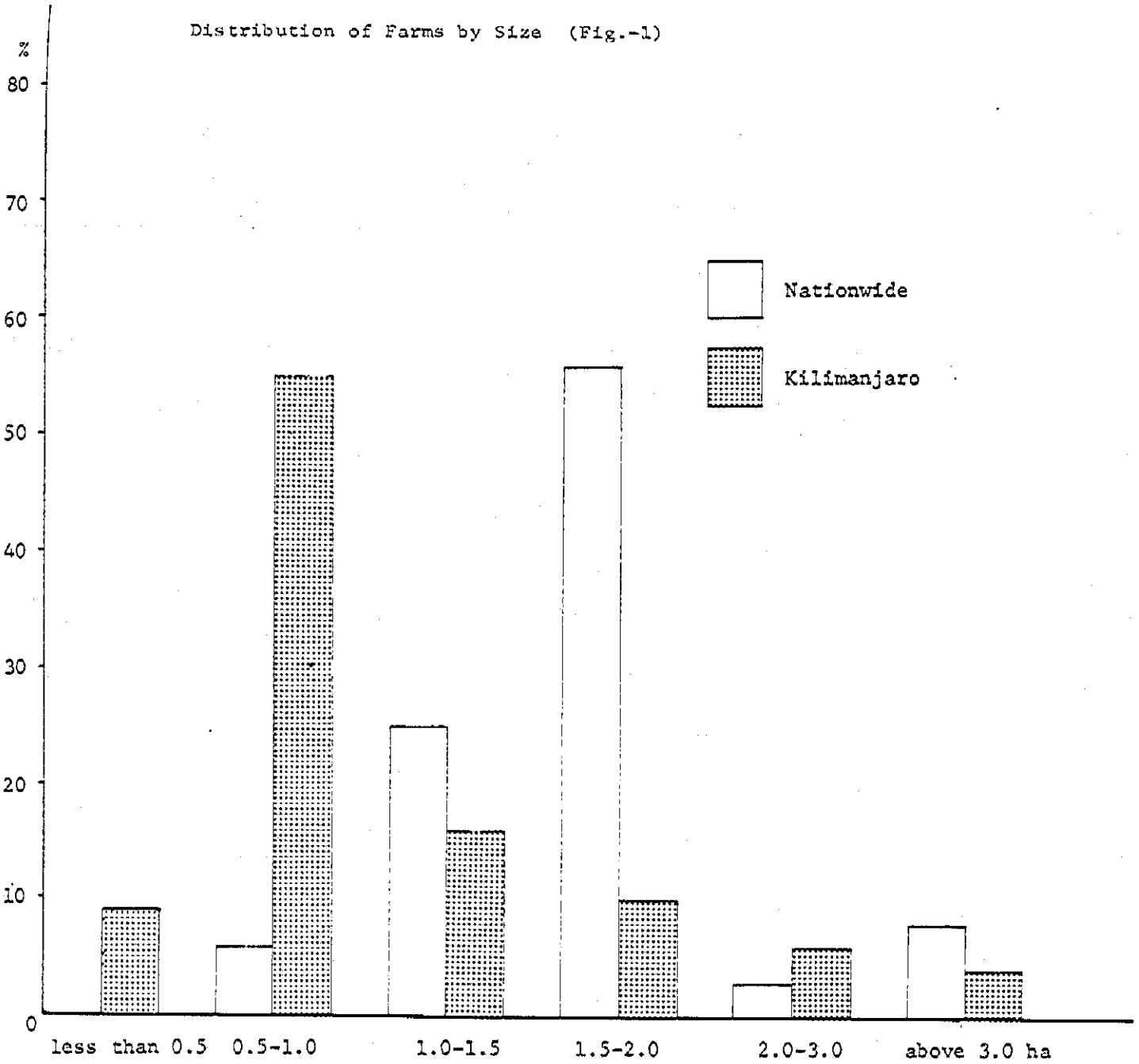
Agricultural production in the region thus depends mostly on smallholders. There is, however, another type of agriculture carried out on a large scale by both public and private estates. The largest of the large-scale estates is NAFCO in West Kilimanjaro, which grows wheat on an extensive tract of 13,000 hectares with the use of large machines. It also operates a farm in the Moshi District, where it grows paddy, maize, and bananas by means of irrigation. Typical among the private estates is TPC in Moshi District, which is engaged in the cultivation of sugar cane by means of irrigation and also in the production of sugar. Beside these, sisal is grown by public and private estates at 10 locations, but recently the acreages of these estates have been on the decline.

Thus, coffee, maize, beans, millet, and paddy are produced in the region mainly by smallholders making use of a limited water supply for irrigation. The most typical water utilization situation is that of the highland coffee zone, where from very early times virtually every drop of stream water

available has been used as irrigation water and sometimes as drinking water or for other purposes. Stream water is utilized most intensively in the Moshi District, where a full 25% of the land on which coffee is cultivated is under irrigation. The intensive use of water upstream deprives farmers downstream of water. However, along the Pangani River, with its vast basin and in the area to the southeast of Moshi Town, where spring water is available, there is a sufficient amount of water for irrigation. At present the prospects for efficient utilization of river water is under investigation with the completion of the Nyumba ya Mungu Dam. A comprehensive water supply plan for the whole Pangani River basin, including that part downstream in the Tanga Region, is very much needed.

Turning to the problem of erosion on the southern skirts of Mt. Kilimanjaro, we see that the most serious erosion occurs principally in valleys at altitudes of 900-1,000 m, where annual rainfall is less than 1,000 m. This is somewhat lower than the coffee belt. Erosion here is usually attributed to excessive development of the coffee belt and extreme deforestation. The primary cause of erosion, however, is exposure of the surface of the soil, and therefore the planting of perennial crops like coffee and bananas or tree planting are effective means of soil preservation, except against calamities such as torrential downpours. The existing points of erosion are not the product of excessive development or deforestation upstream, but rather the result of planting annual crops on steep slopes. The best thing for these points is protection of the surface of the soil from exposure by using slopes as grassland for livestock.

Distribution of Farms by Size (Fig.-1)



Annual Precipitation and Land Use (Table - 1)

Annual precipitation	Area (thousands of ha)	%	Area	Land use for agriculture	Vulnerability to drought	Remarks
Over 1,000mm	123.6	9	Southern & eastern slopes of Mt. Kilimanjaro (97.54 ha)	Coffee, bananas	Little	
			North & south Pare mountain areas (26.14 ha)	Vegetables		
1,000-700mm	257.8	19	Areas along main roads around Moshi	Maize, beans	Some	
			East & west sides of north & south Pare			
700-500mm	498.0	38	Other areas	Maize, beans, wheat, sugar cane sisal	Great	Paddy and cotton are cultivated by means of irrigation.
Below 500mm	446.6	34	South & west of Arusha--Dar es Salaam Railway	Cattle grazing	Maximum	
			Kibo Peak			
Total	1,326.0	100				

Note: The area figures are as computed by planimeter on a map on a scale of 1:250,000.

Agricultural Production Averages From 1966 to 1970 and From 1971 to 1975 (Table - 2)

Crops	1966-1970 Quantity(i) (tons)	Princes in 1975/76 (shs.)	Value (thousands of shs.)	1971-1975 Quantity(i) (tons)	Princes in 1975/76 (shs.)	Value (thousands of shs.)	
Coffee	16,054	9/-	144,486	21,974	9/-	197,766	
Cotton	1,700	2/-	3,400	1,080	2/-	2,160	
Sugar	37,160	1/80	66,888	46,420	1/80	83,556	
Sisal	10,980	2/30	25,254	7,240	2/30	16,652	
Seed beans	516	2/20	1,135	640	2/20	1,408	
Pyrethrum	253	4/50	1,138	45	4/50	202	
Castor	267	0/80	214	122	0/80	98	
Subtotals			242,515			301,842	Annual growth of 4.6%
Bananas	289,800	0/50 (ii)	144,900	304,000	0/50 (ii)	152,000	
Maize	43,600	0/75	32,745	33,600	0/75	25,200	
Beans	2,640	2/-	5,280	2,520	2/-	5,040	
Finger millet	2,660	0/80	2,128	3,960	0/80	3,168	
Rice	3,740	0/80	2,992	4,860	0/80	3,880	
Wheat	9,720	1/-	9,720	8,740	1/-	8,740	
Cassava	2,360			3.000			
Irish potatoes	6,560	0/50 (ii)	5,363	10,000	0/50 (ii)	8,120	
Sweet potatoes	1,800			3,240			
Vegetables	2,560	1/- (ii)	2,827	3,100	1/- (ii)	3,580	
Fruit	267			480			
Subtotals			205,955			209,736	Annual growth of 0.4%
Totals			448,470			511,578	

Notes: (i) Annual average during each period.
(ii) The prices of bananas, potatoes and vegetables have been estimated on the basis of interviews of farmers by the Japanese team.

1.2 Cultivated Land

The acreage under cultivation in the region, as shown in Table - 3 , is 159,450 ha, which is 12% of the total land area of the region of 1,326,000 ha. This same percentage holds also for Tanzania as a whole. The largest portion is accounted for by smallholders: 109,300 ha, or 68%. The second largest portion is accounted for by NAFCO at two locations: 18,000 ha, or 11%. Then come nationalized farms, with 12,500 ha, the Tanganyika Planting Company, with 7,000 ha, sisal farms, and private estates, in that order. Old Ujamaa villages, with 824 ha at 17 locations, represent the smallest category. As for the distribution of cultivated land by district, Hai, with 50,368 ha, or 32% of the total, has the largest share followed by Moshi and Pare. Rombo's share is the smallest at 18% (see Table - 3).

Smallholders grow such food and cash crops as bananas and coffee in highland areas and such food crops as maize and beans in lowland areas.

NAFCO owns 13,000 ha of arable land in the West Kilimanjaro area of the Hai District, on about 6,000 ha of which wheat and beans are being grown (8,000 ha if the plots tilled during the short rainy season are included), the remaining acreage being used mostly as natural pasture. It also owns 5,000 ha of arable land in the Kahe area of the Moshi District, where the cultivation of kenaf started in 1970 with the use of an irrigation facility. However, kenaf is no longer grown there due to decline in demand as in the case of sisal, and today only about 1,000 ha of the land is being used to grow mainly maize, hay for feeding dairy cattle, bananas, paddy, etc.

On many of the national farms which were owned by private coffee estates prior to nationalization in 1973 coffee is still planted today. There are some, however, where maize is grown on a large scale. Such farms are restricted to the Hai and Moshi districts and are located north of the highway connecting Arusha and Moshi. Each of these farms runs on a self-paying basis and is managed under the responsibility of one manager. All their profits after operation and management costs are used as public investment funds for building schools and roads.

TPC, which manages a 7,000 ha sugar-cane plantation to the south of Moshi Town, is one of the four largest sugar-cane operators in the country and, in fact, the largest of the four. (The remaining three are in Morogro Region, and two of them are state-owned, while one is privately owned.) The plantation was opened some 43 years ago by Danish. At present, it employs about 3,000 workers and is engaged in highly mechanized cultivation aided by sprinklers as well as gravity irrigation.

Sisal is now cultivated on 10 farms with a total acreage of about 6,100 ha. Three of them are private estates with a total of 2,300 ha, and the other seven are run by TSC. Export market conditions, however, have been so discouraging in recent years that the farms are not very interested in proper control of fertilization and cultivation. Besides these farms, there are some private estates in the vicinity of the NAFCO farms in the Hai District. There beans and wheat are grown on a large scale and with intensive mechanization, as in the case of the NAFCO farms. Three farms in the Moshi and Pare Districts, moreover, produce jaggery but on a smaller scale.

Old Ujamaa villages are of little significance in the region in terms of either number or area. Since they are primarily located in lowland areas, they are not very productive in spite of the use of irrigation.

Cultivated Area By Management Type and By District (Table - 3)

(Unit: ha)

Management Type	Hai			Moshi			Rombo			Pare			Total			Major Crops
	Number	Area	%	Number	Area	%	Number	Area	%	Number	Area	%	Number	Area	%	Major Crops
Small-holders and Development village	42	22,930	46	135	26,975	100	37	28,321	100	84	31,074	86	298	109,300	68	cofee, banana, maize, beans, willet
NAFCO	1	13,333	26	1	5,000	11	-	-	-	-	-	-	2	18,333	11	Hai: Wheat, beans Moshi: maize, banana, paddy
National Farms	29	8,750	17	18	3,750	9	-	-	-	-	-	-	47	12,500	9	cofee, maize, beans
TPC	-	-	-	1	7,083	16	-	-	-	-	-	-	1	7,083	4	sugar
Sisal Farms	1	375	1	3	1,527	3	-	-	-	6	4,248	12	10	6,150	4	sisal
Private	(1)	(375)	-	-	-	-	-	-	-	(2)	(1,936)	-	(3)	(2,311)		
TSC	-	-	-	(3)	(1,527)	-	-	-	-	(4)	(2,312)	-	(7)	(3,839)		
Private Estates	1	4,940	10	2	105	0	-	-	-	1	215	1	4	5,260	3	Hai: wheat, beans Moshi, Pare: jaggery
Old Ujamaa Village	2	40	0	5	245	1	1	60	0	9	479	1	17	824	1	maize, beans
Total	-	50,368	100	-	44,685	100	-	28,381	100	-	36,016	100	-	159,450	100	
		32%	-	-	28%	-	-	18	-	-	22%		-	100%	-	

1.3 Water Utilization and Control

(1) Water Utilization

In the agriculture of the Kilimanjaro Region, water plays a very important role, as can be seen from the fact that 17.5% of the region's farmland is irrigated, compared with only 4% in the case of Tanzania as a whole. Within the region irrigation coverage is exceptionally high in the Moshi and Pare Districts at 34.6% and 25.0%, respectively. This is due to the fact that these two districts have densely populated mountainside areas where a large amount of water is consumed and the fact that an increasing number of people who are gradually being forced by population pressure to move downhill and settle in lowland areas are using an increasingly large amount of agricultural water for their newly cultivated fields.

Existing Irrigation Coverage in the Kilimanjaro Region (Table - 4)

District	Irrigated area (ha)	Cultivated area (ha)	Existing irrigation coverage (%)
Hai	3,200	50,368	6.4
Moshi	15,440	44,685	34.6
Rombo	296	28,381	1.0
Pare	9,000	36,016	25.0
Totals	27,936	519,450	17.5

Note: (i) The figures for cultivated area have been estimated on the basis of interviews with Kilimo officers.

(ii) The figures for irrigated area have been estimated on the basis of interviews with the district irrigation engineers and local people.

Water for agricultural use represents a full 94.3% of the total volume of water used in the region. Here, too, the figures for the Moshi and Pare districts are extremely high--95.7% and 96.6%, respectively--clearly revealing the importance of agricultural water in these districts. By contrast, water for agricultural use in the Rombo District accounts for only 43% of the total volume of water use as a reflection of the fact that this district relies heavily on natural rainwater, which is relatively abundant there, for its agriculture.

(i) Water Utilization as Classified by Sources

Approximately 85.1% of the water used in the region is obtained in the form of surface water, the remaining 14.9% being obtained in the form of subterranean water. Of the surface water utilized for irrigation, approximately 85% is taken in in a natural manner

Existing Water Utilization of Irrigation and Domestic Supply in Kilimanjaro Region (Table - 5)

Bitrict	Surface Capacity m^3/day	Surface %	Underground Capacity m^3/day	Underground %	Total Capacity m^3/day	Total %
Hai	11,436	5.6	2,421	33.5	13,857	6.5
	193,590	94.4	4,800	66.5	198,390	93.5
Moshi	28,796	5.1	1,896	1.2	30,692	4.3
	535,200	94.9	154,070	98.2	689,270	95.7
Rombo	23,424	59.5	311	13.9	23,735	57.0
	15,967	40.5	1,920	86.1	17,887	43.0
Pare	10,905	2.2	7,675	12.7	18,580	4.4
	475,344	97.8	52,680	87.3	528,024	96.6
Totals	74,561	5.8	12,303	5.4	86,864	5.7
	1,220,101	94.2	213,470	94.6	1,433,571	94.3

Note: The basis for the estimation of capacity is the same as that in Table - 6

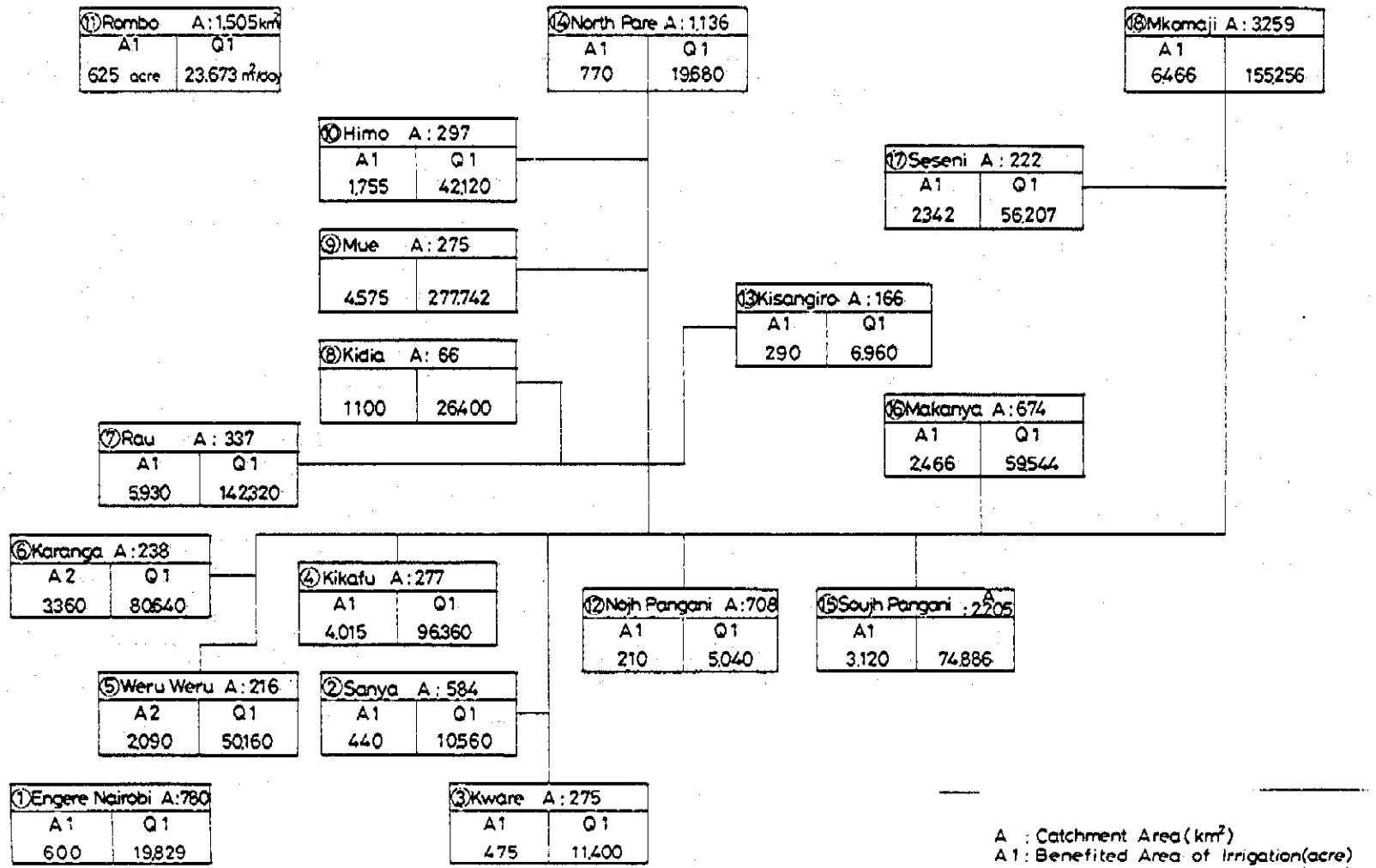
by means of weirs built with stones, trunks and leaves of banana trees, and other materials easily available on the spot and is conducted via mud irrigation channels, while the remaining 15% or so is taken in from rivers by means of pumps or from dams. In the Rombo District there is only one dam, but the water taken in from this dam represents 30% of the total surface water utilized. In areas of the Rombo District between 1,000 and 1,500 meters above sea level, the irrigation coverage is low because of a relatively large annual rainfall of 1,000 to 1,500 mm, but the demand for water is on the rise with development of lower Rombo areas. Since the Lume is its only river in which water flows all the year round, the district is not very well off in terms of water resources. Thus, of primary importance for further development in this district will be the identification of many sites at which earth dams can be built at low cost for highly efficient use of the limited amount of water.

As for the breakdown of the subterranean water utilized, 47% is obtained from natural (i.e., self-gushing) springs, and the rest from shallow or deep underground water veins via tube wells. In the Moshi District, where there are rich veins of subterranean water at the foot of Mt. Kilimanjaro, T.P.C. and other farms are obtaining irrigation water with the use of 18 bore holes. Irrigation water pumped up via bore holes by means of diesel engines is so expensive that at present its use is limited almost exclusively to sugar cane and other cash crops. When the abundant subterranean water of the Kahe basin is utilized in the future, it is essential that electricity be used as the source of power and that high productivity be achieved through proper selection of crops, proper water control and proper fertilization and cultivation control. In the three other districts, the subterranean water utilized is obtained entirely from springs.

(ii) Water Utilization as Classified by Scale of Irrigation

There are 637 areas in the region which are irrigated, 385 or 58.3% of them being up to 50 acres in size, 129 or 21.4% being between 50 and 100 acres, 108 or 17.8% being between 100 and 500 acres, and 15 or 2.5% being 500 acres or larger. Thus, the overwhelming majority of them are 500 acres or less in size. Farmers living on steep slopes have traditionally formed associations for irrigation works, but the intake facilities and irrigation channels leave much to be desired. Moreover, the channels as well as the farmland are located on very steep slopes. The irrigation associations are too small and too weak to make improvements on these facilities, with the result that water utilization is far from efficient. This being the case, it is essential in devising an irrigation scheme for the future that optimum scale of irrigation be determined, with due consideration being paid to climatic and other relevant natural conditions. Small and inefficient intakes should be combined into large ones, the channels should be improved, and the irrigation associations should be reorganized into larger units so as to facilitate efficient utilization of water.

Existing Irrigation System (Fig. - 2)



Existing Water Utilization by Type of Water Source in Kilimanjaro REgion (Table - 6)

	Surface Flow									Underground Water								
	Irrigation furrow			Traditional furrow			Reservoir			Spring			Bore Hole			Total		
	Area (acre)	Using capacity (m^3/day)	Number of furrows	Area (acre)	Using capacity (m^3/day)	Number of furrows	Area (acre)	Using capacity (m^3/day)	Number of furrows	Area (acre)	Using capacity (m^3/day)	Number of furrows	Area (acre)	Using capacity (m^3/day	Number of furrows	Area (acre)	Using capacity (m^3/day)	Number of furrows
Hai	600	20,790	2	7,130	171,120	99	30	720	2	240	5,760	16	NIL	NIL	NIL	8,000	198,390	119
	7.5%	10.5%	1.7%	89.1%	86.3%	83.2%	0.4%	0.3%	1.7%	3.0%	2.9%	13.4%	NIL	NIL	NIL	100%	100%	100%
Moshi	14,320	595,447	6	14,370	344,880	188	210	5,040	2	3,925	262,142	28	5,775	135,769	18	38,600	1,343,278	242
	37.1%	44.3%	2.5%	37.2%	25.7%	77.7%	0.5%	0.4%	0.8%	10.2%	19.5%	11.6%	15.0%	10.1%	7.4%	100%	100%	100%
Rombo	20	607	2	440	10,560	9	200	4,800	1	80	1,920	7	NIL	NIL	NIL	740	17,887	19
	2.7%	3.4%	10.5%	59.5%	59.1%	47.4%	27.0%	26.8%	5.3%	10.8%	10.7%	36.8%	NIL	NIL	NIL	100%	100%	100%
Pare	2,500	60,000	1	14,951	358,824	162	2.780	66,720	12	2,269	54,456	48	NIL	NIL	NIL	22,500	540,000	223
	11.1%	11.1%	0.4%	66.4%	66.4%	72.7%	12.4%	12.4%	5.4%	10.1%	10.1%	21.5%	NIL	NIL	NIL	100%	100%	100%
Totals	17,440	676,844	11	36,891	885,384	458	3,220	77.280	17	6,514	324,278	99	5,775	135,769	18	69,840	2,099,555	603
	25.0%	32.2%	1.8%	52.8%	42.2%	76.0%	4.6%	3.7%	2.8%	9.3%	15.4%	16.4%	8.3%	6.5%	3.0%	100%	100%	100%

Note: The figures for using capacity were obtained from the data in existing files. However, where such data were not available, using capacity was estimated on the assumption that water consumption is 24 m^3/day or 6 mm/day.

Utilization of Water for Agriculture (Number of Locations with Water Supply) (Table - 7)

	Below - 50 acres	50 - 100 acres	100 - 500 acres	500 - 1,000 acres	1,000 - 2,000 acres	Over 2,000 acres	Total
Hai	(68.1%) 81	(18.4%) 22	(11.8%) 14	(1.7%) 2	NIL	NIL	119
Moshi	(48.3%) 117	(23.6%) 57	(26.4%) 64	NIL	NIL	(1.7%) 4	242
Rombo	(78.9%) 15	(15.8%) 3	(5.3%) 1	NIL	NIL	NIL	19
Pare	(62.3%) 139	(21.1%) 47	(12.6%) 28	(2.2%) 5	(1.3%) 3	(0.5%) 1	223
Totals	(58.3%) 352	(21.4%) 129	(17.8%) 108	(1.2%) 7	(0.5%) 3	(0.8%) 5	603

Existing Water Utilization by River System in Kilimanjaro Region (Table - 8)

Name of Catchment	Catchment Area (km^2)	Water Source: Spring	Stream	Perservoir	Distribution System: Pipeline	Traditional furrow	Irrigation canal	Benefited (acre)	Using Capacity (A) (m^3/day)	Discharge 20% Probability Discharge (B) (m^3/day)	A/B x 100% (%)	50% Probability Discharge (C) (m^3/day)	A/C x 100% (%)
1. Engere Nairobi	(1,392) 780	NIL	2	NIL	NIL	NIL	NIL	600	19,829				
2. Sanya	(1,753) 584	NIL	11	NIL	NIL	11	NIL	440	10,560	10.797	98	71,260	15
3. Kware	275	3	16	NIL	NIL	19	NIL	475	11,400				
4. Kikafu	277	7	48	NIL	NIL	55	NIL	4,015	96,360	87,139	106	337,870	29
5. Weru Weru	216	17	21	NIL	NIL	38	NIL	2,090	50,160	79,326	63	178,362	28
6. Karanga	238	1	46	NIL	NIL	47	NIL	3,360	80,640	174,394	46	317,154	25
7. Rau	337	15	47	NIL	NIL	62	NIL	5,930	142,320	113,653	125	278,277	51
8. Kidia	66	12	14	NIL	NIL	26	NIL	1,100	26,400				
9. Mue	275	5	13	1	NIL	18	1	4,575	277,742	396,007	70	577,001	48
10. Himo	297	15	34	NIL	NIL	49	NIL	1,755	42,120	129,293	33	273,932	15
11. Rombo	1,505	7	10	1	1	16	1	625	23,673				
12. North Pangani	(1,193) 708	NIL	2	8	NIL	10	NIL	210	5,040				
13. Kisangiro	166	NIL	11	NIL	NIL	11	NIL	290	6,960				
14. North Pare	1,136	9	13	4	NIL	26	NIL	770	19,680				
15. South Pangani	(5,880) 2,265	NIL	8	NIL	NIL	8	NIL	3,120	74,880				
16. Makanya	674	31	38	1	NIL	70	NIL	2,466	59,544				
17. Seseni	222	4	18	NIL	NIL	22	NIL	2,342	56,207	80,060	70	134,161	42
18. Mkomaji	3,239	23	34	NIL	NIL	57	NIL	6,466	155,256	254,601	61	426,685	36
Totals	13,260	149	386	15	1	545	4	40,114	1,146,411				

The irrigation systems that are now under construction by the government as public works mostly fall into the range of 500 to 2,000 acres, a scale which is adequate in terms of both construction and water control.

(iii) Water Utilization as Classified by River Systems

Of the 18 river systems of the Kilimanjaro Region, those which are used intensively as sources of irrigation water include the Kikafu, the Weru-Weru, the Karanga, the Rau, the Mue, the Himo and other rivers that originate on the southern slopes of Mt. Kilimanjaro and the Seseni, the Mkomaji and other rivers that originate on the eastern slopes of the Pare mountains. The basins of these rivers are densely populated, and the demand for irrigation water and domestic water in them is very great. The volume of irrigation water obtained from these rivers is about 70% when they are at 20% probability discharge and about 30% when they are at 50% probability discharge. In the case of the Sanya, Kikafu, Weru-Weru and Rau rivers, the volume of water utilized is 90 to 125% of the 20% probable discharge. It is clear that the basins of these rivers are affected by drought at least once every five years, and insufficient surface water is a serious problem. The only possibility is to make the best use of limited water resources by improving irrigation channels, strengthening irrigation associations, and creating as many reservoirs as possible at such sites that would allow for construction of dams at low cost.

(iv) Water Utilization as Classified by District

(a) Moshi District

Water is utilized rather intensively in the agriculture of this district, 34.6% of the arable land being under irrigation. Of the total volume of water utilized, irrigation water represents a full 95.7%. As for the extent of the areas irrigated, they are generally larger in this district than those in the others, 50% of them covering 50 to 500 acres and four of them more than 2,000 acres. About 74.8% of the water utilized in this district is obtained as surface water, and the rest as subterranean water. Six of the irrigated areas, representing 49.6% of the acreage under irrigation by surface water, obtain such water by irrigation furrows for which water rights are established; 49.7% of the irrigated areas depend on traditional furrows; and the remaining 0.7% depend on reservoirs. As for areas irrigated by subterranean water, 40% rely on springs, and 60% on bore holes. The main sources of surface water in this district are the Rau, Mue and Weru-Weru rivers but down stream they offer virtually no water for irrigation purposes. The only river that has some spare capacity as a new source of irrigation water is the Himo. Since the water resources available in this district has already been utilized to a large extent, shortage of surface water is a very keenly felt problem. In coffee and banana producing areas, the period of irrigation is from Octoberthrough March, in October through December the

from the monthly volume of river flow at 20% probability discharge, there is some surplus water during the rainy season of April and May, but since it is utilized by the Nyumba ya Mungu Dam downstream, it will be very difficult to develop a new source of surface water in this district in the future. Owing to such lack of surface water, an increasingly larger volume of subterranean water is now used in lowland areas of the district. At T.P.C. and in Miwaleni Ujamaa village, subterranean water is pumped up from depths of 50-100 m by means of bore holes. The water of the Miwaleni Spring is used in the Kahe irrigation scheme, and the water of the Njoro Spring is used by Chekereni Ujamaa village.

The direction in which the water utilization shemes of this district should be developed in the future is toward better and more efficient water utilization in highland areas through rearrangement of the traditional furrows and lining of the irrigation channels and construction of a number of small-sized dams. What is necessary in lowland areas is the use of subterranean water in the Kahe basin and other areas which have abundant supplies thereof. In tapping the subterranean water sources, it is essential to see to it that pumps of bore holes and other facilities are of the type that are run by electricity which incur lower fuel and maintenance costs than other types. In such areas as Msaranga, Mandaka, and Miwaleni that are often hit by floods, it is important to construct kasumi-type banks (banks with openings here and there), to build farm roads or footpaths along the contour of the hills parallel to each other at intervals of 100 meters, and to plow the soil well so as to let it absorb water well. When a flood takes place, flood water is allowed to soak the fields through such openings. With the water on the fields, the surface is agitated in such a way that will not result in much evaporation so as to prevent the loss of moisture in the lower layer of water. This method, by making use of vast tracts of land, serves two purposes at a time; it prevents flood damage and increases the amount of moisture contained in farmland soil.

(b) Hai District

Approximately 6.4% of the farmland in this district is under irrigation. Of the total volume of water utilized, irrigation water represents 93.5%. Irrigated areas in this district are generally small, 68.1% of them covering no more than 50 acres. Moreover, there are only 119 such areas. Thus, utilization of water in agriculture in this district is far less intensive than in the Moshi and Pare Districts. An overwhelming 97% of the irrigation water is obtained as surface water. Of all surface water put to use, a full 92% is conducted by means of traditional furrows. Moreover, all subterranean water utilized is obtained from springs.

A serious question concerning water utilization in this district is where to find reliable sources of water to facilitate development of West Kilimanjaro and lower Hai areas. As in the case of the Moshi District, the direction in which water utilization schemes for highland areas should be developed is toward better and more efficient systems through lining of irrigation channels and construction of small-sized dams and by puting subterranean water sources to better use.

(c) Rombo District

In this district irrigation water is utilized in agriculture only to a very limited extent. Only 1.0% of farmland in this district is under irrigation. Of the total volume of water utilized, irrigation water accounts for only 43%. Irrigated areas in this district are very small, 78.9% of them covering 50 acres at most. The number of irrigation facilities is extremely small, king only 19. Surface water accounts for 90%, and subterranean water 10%. Approximately 67% of the surface water utilized is conducted by means of traditional furrows, 30% taken from reservoirs, and 3% conducted by means of irrigation furrows. The subterranean water is obtained only from springs. Not much effort has been made so far in this district to develop new sources of irrigation water since the district has 1,000-2,000 mm of annual rainfall and since the amount of arable land has been rather limited. Now, however, the question of where to find reliable sources of water for the development of the lower Rombo area is an urgent one. The direction in which water utilization should be developed is toward better and more efficient utilization of water through construction of small dams and by lining existing irrigation channels conducting a long-term investigation into the volume of water that can be obtained from Lake Chala so as to facilitate the development of the lower Rombo as well as into the economic feasibility of this plan. It is also important to investigate the amount of subterranean water available.

(d) Pare District

In this district, as in the Moshi District, water is utilized in agriculture rather intensively. About 25% of the farmland in the district is under irrigation. Out of the total volume of water utilized, irrigation water accounts for 96.6%. Irrigated areas in this district are quite large, five of them covering more than 2,000 acres each.

Surface water accounts for 89.9% of the irrigation water utilized, and subterranean water 10.1%. Of the surface water utilized, 74% is caught by means of traditional furrows, 14% by means of reservoirs, and the remaining 12% by means of irrigation furrows. In other words, much of the surface water utilized is caught in a natural manner without the help of machines. All the subterranean water is obtained from springs alone.

This district can be divided into four areas on the basis of the state of water utilization: the Pangani area, the Mkomaji Valley area, the North Pare area, and South Pare mountain area. In the basin of the Pangani River downstream from the Nyumba ya Mungu Dam water is caught at 8 different spots, conducted by traditional furrows, and used to irrigate approximately 3,000 acres. Judging from the volume of river flow, development of an additional 5,000 acres or so should be possible, but such an undertaking may prove to be too costly because of the soil problem in construction and the high cost of the necessary social infrastructure. Such a construction plan should therefore not be put into effect until detailed investigations of the soil and the topography have been completed. In the North Pare area there are 22 irrigated areas

covering a total of 770 acres, the source of water being springs in the case of 9 and river water in the case of the other 13. In order to secure water sources for the sake of agricultural development in the lowland areas of the North Pare area, small dams need to be constructed, and an inquiry must be made into the possibility of using the water of Lake Jipe. In the Mkomaji Valley area, a total of 8,808 acres of land is under irrigation by water supplied by 27 springs and by river water taken at 52 points in a non-artificial manner. Plots of land in this area that are fertile enough are planted with a crop of paddy and a crop of maize or beans each year. In order to make water utilization more efficient, it is of course essential to improve such facilities as irrigation channels and irrigation channels and intakes, but it is no less important to put the fields into better shape. This is because in this area, even minimal readjustment of fields for water control and fertilization control, such as levelling of the ground, provision of footpaths, and readjustment of branch channels, would assure a remarkable increase in yield. In the South Pare mountain area there are several spots suitable for construction of dams. It is expected that in the long run multi-purpose development of the water resources of this area will be carried out not only to secure irrigation water but also to generate electricity and to supply city water and industrial water. In such a case, farmers' vested rights to irrigation water must be protected by all means. In the South Pare mountain area, the traditional furrows need to be rearranged, and the existing irrigation channels need to be lined so as to make water utilization much more efficient.

(v) Condition of Facilities

Some of the irrigation facilities now being in use have been made by local farmers with the use of the traditional techniques, while others have been constructed as public works. The typical structures of these two varieties are shown in Fig. - 3, 4 and 5.

(a) Intake

Water from rivers and springs is usually taken in by means of weirs, which can be roughly divided into three types: those built of banana leaves and wooden piles, those made of stones and mud, and those built of concrete. Most of the weirs made of concrete have been built as public works, and this type of weir accounts for less than 1% of the total number. The other types have been made by local farmers themselves, with the use of readily available materials such as stones, wooden piles, and mud. Those made of wood are not permanent and have to be repaired at least once a year, and those made ot stones and mud, too, are repaired by members of irrigation associations. Since these intake facilities are not sufficiently effective, local farmers would very much like to improve them. At present each point of intake has only one unit, but it is possible to improve the efficiency of intake by installing two or three of them at one point and by using different materials for each.

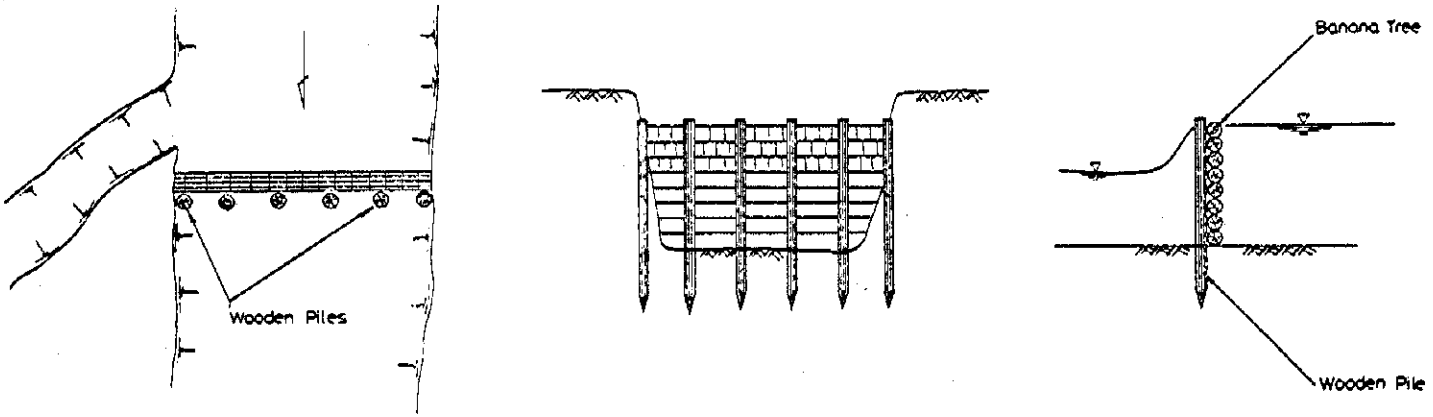
(b) Channels

Irrigation furrows and traditional furrows are usually made of mud, regardless of whether they are main channels or branch channels. The use of concrete is limited only to special segments

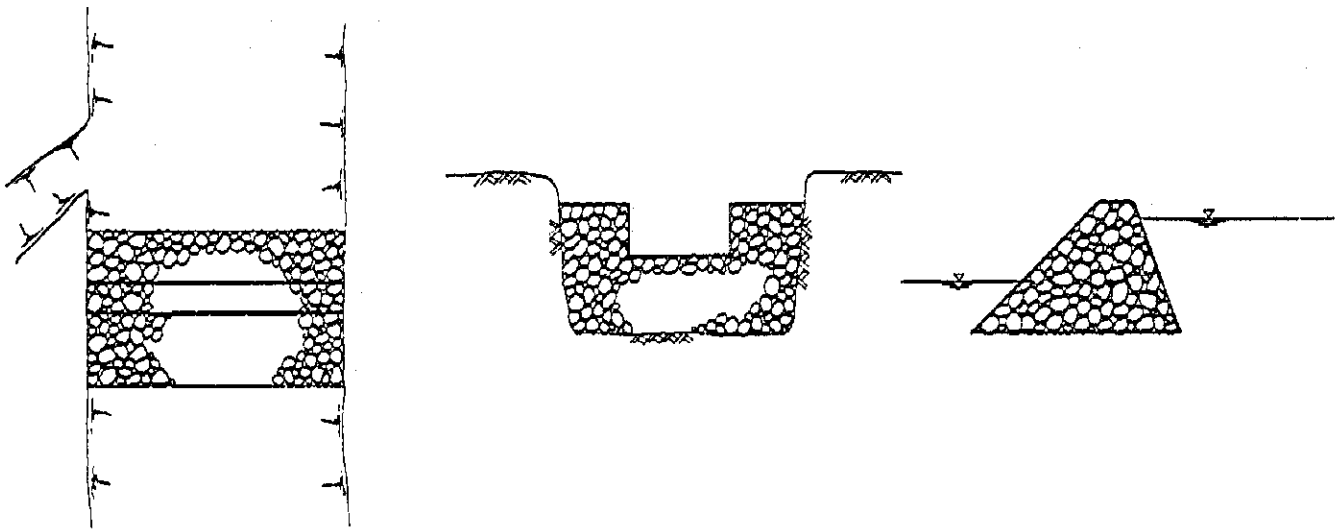
Typical Structure of Exsiting Institution (Fig. - 3)

INTAKE

Type-1 (TRADITIONAL WEIR MADE BY WOOD)

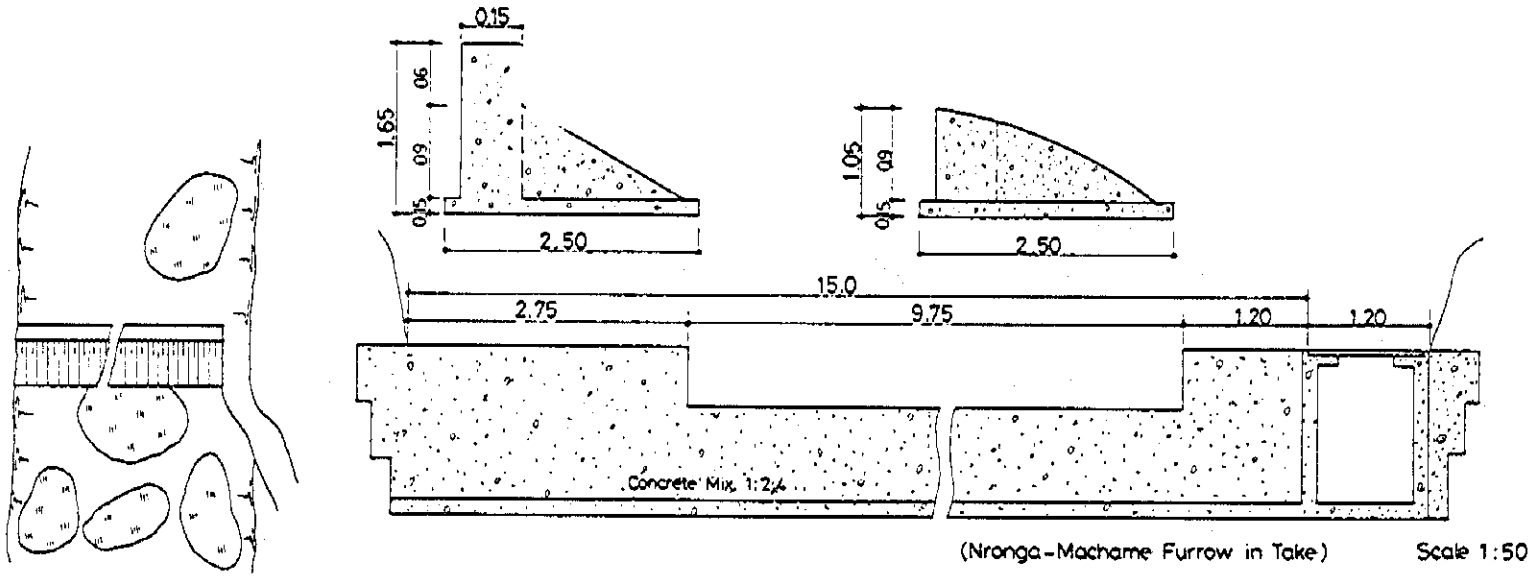


Type-2 (TRADITIONAL WEIR MADE BY STONE)



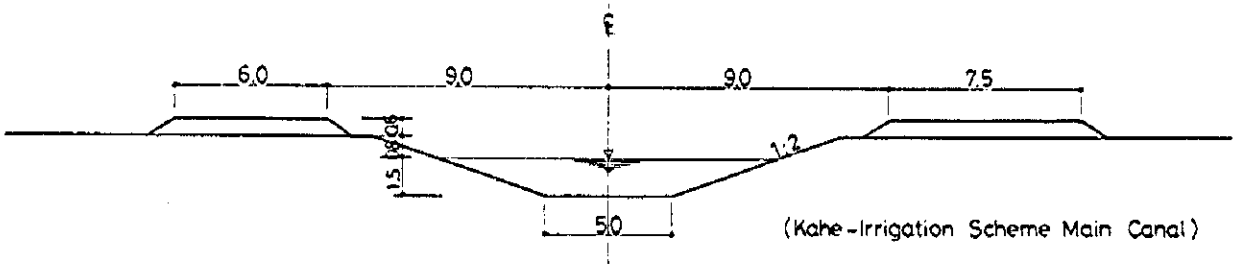
(Fig. - 4)

INTAKE
Type-3



(Nronga-Machame Furrow in Take) Scale 1:50

CANAL
Main Canal

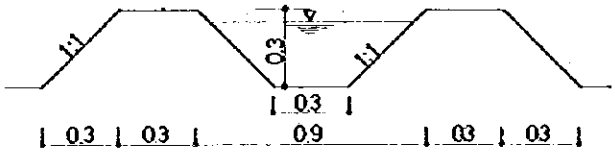


(Kahe-Irrigation Scheme Main Canal) Scale 1:200

(Fig. - 5)

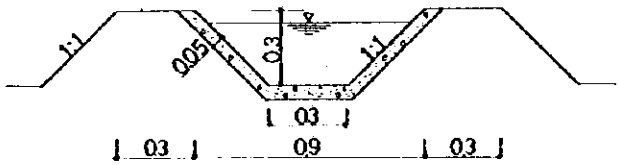
BRANCH CANAL

Type 1



Scale : 1/20

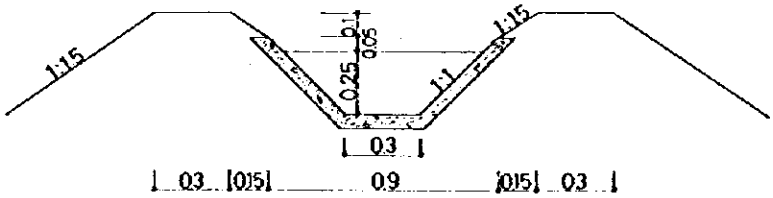
Type 2



Scale : 1/20

(Miwaleni sub station branch canal)

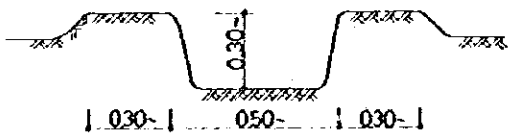
Type 3



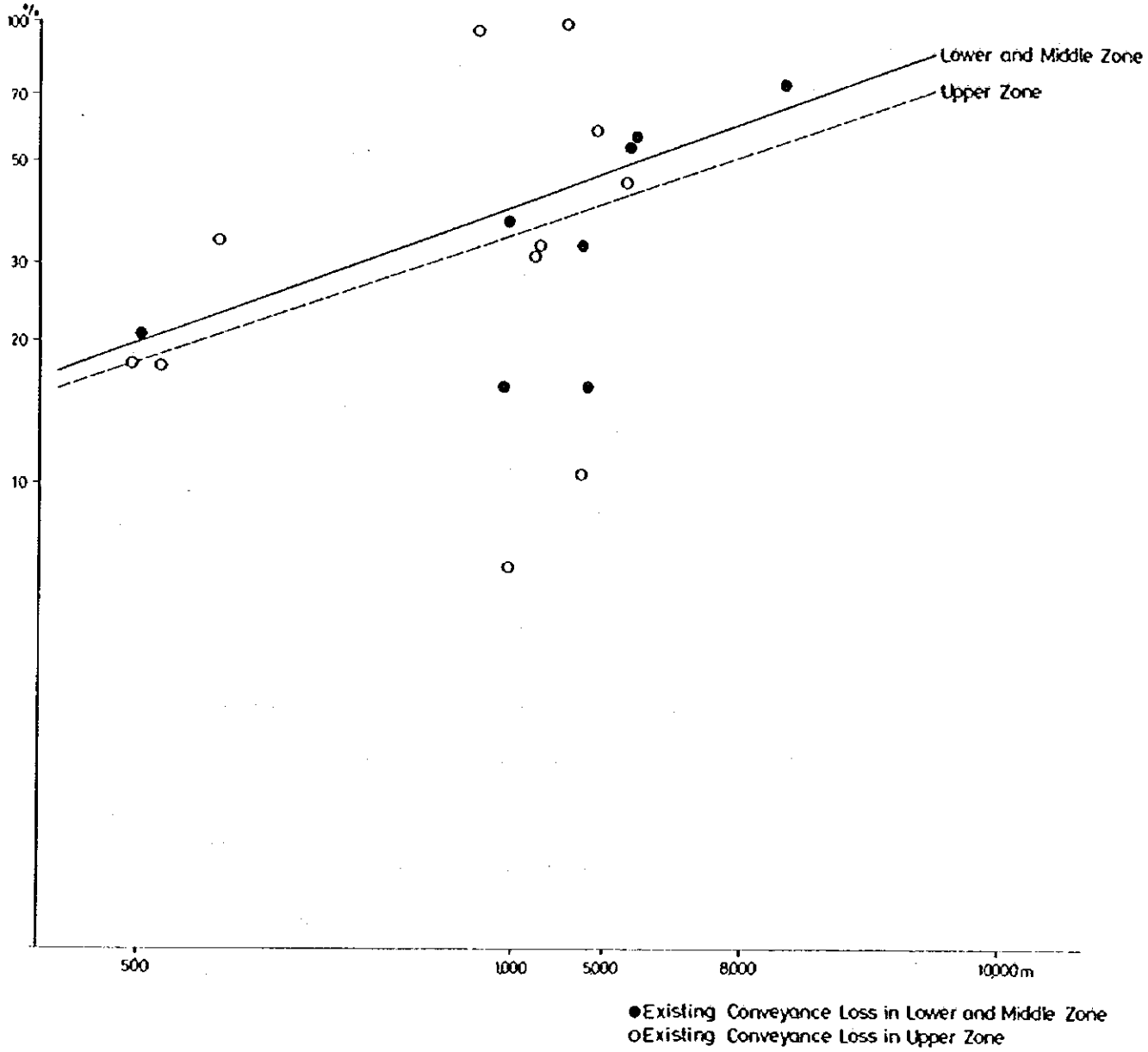
Scale : 1/20

(Miwaleni sub station branch canal)

TRADITIONAL FURROW



Water Conveyance Loss (Fig. - 6)



such as those inside a pilot farm and those that are too seriously broken down. Those segments of furrows that are built of concrete hardly account for 1% of the total furrow length. Furrows made of mud, if built on a hillside, are liable to break down as it has too steep a slope. Also, since they are built along contour lines, they tend to be far longer than those laid on flat land and thus tend to incur a large amount of leakage. By contrast, furrows built on flat land have a gentle slope and therefore a large cross section. Since water in such furrows moves very slowly, much of the loss of water conveyed in them is ascribable to thick growths of water plants and to evaporation.

In an effort to find out how much water is lost while it is being conveyed in a furrow, actual measurement was made with a V-notch and a current meter for a total of 9 traditional furrows. The results of the measurement are given in Fig.-6. (For further details, see the Technical Report.) The percentage of water lost in a traditional furrow built in a highland area is 18% when the furrow is 500 m long, 35% when it is 1,000 m long, 45% when it is 5,000 m long, and 85% when it is 10,000 m long. In the case of a furrow in an upper lowland or lowland area, the corresponding percentages are 20% for 500 m, 40% for 1,000 m, 50% for 5,000 m, and more than 90% for 10,000 m. Since loss of water during conveyance is said to be between 5 and 10% in the case of a concrete furrow and 5% in the case of a pipeline, the use of concrete and pipes will drastically reduce such loss.

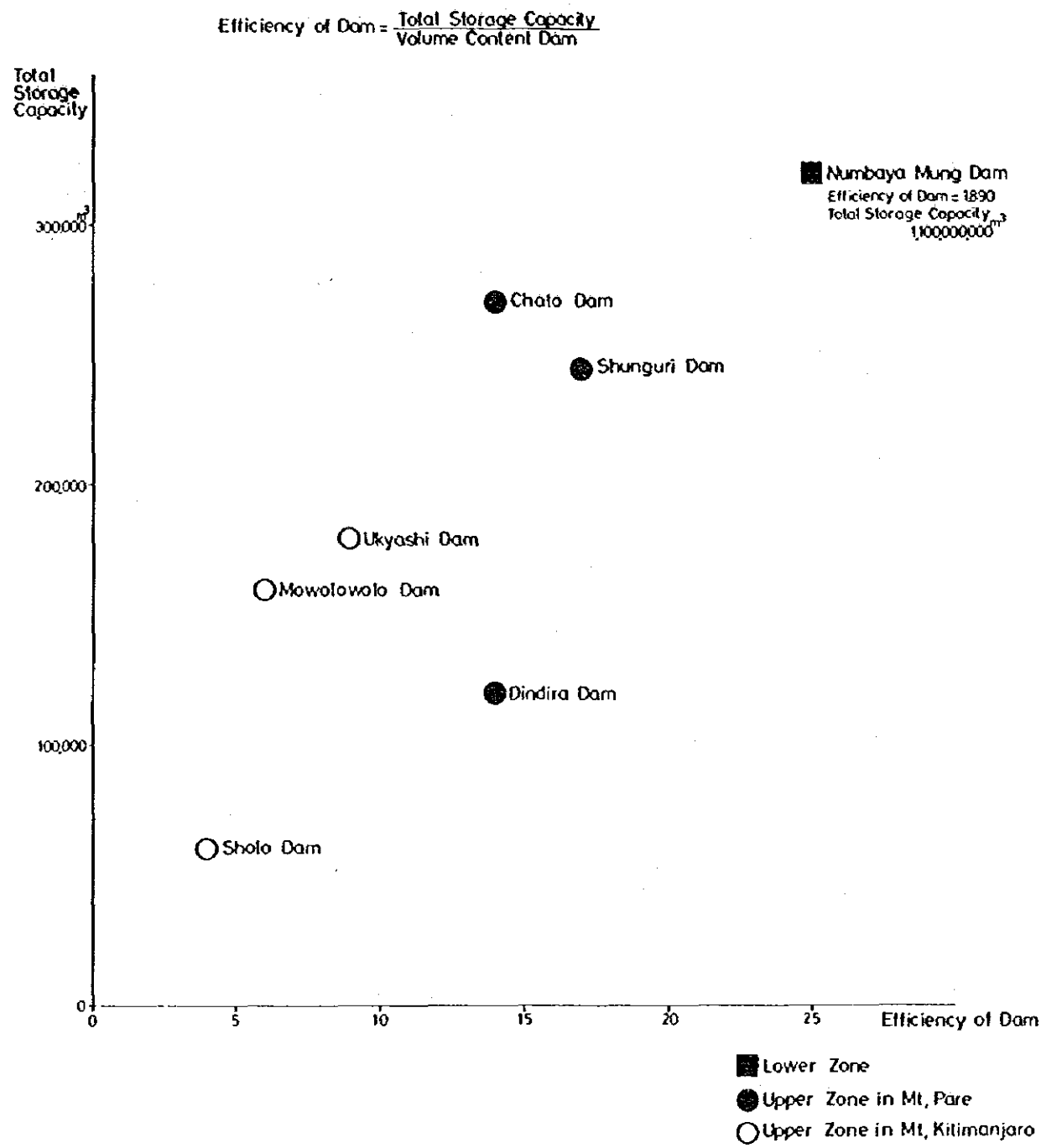
(c) Reservoirs

There are six "dams" in the region which have been built across watercourses of rivers, mainly for the sake of supplying irrigation water. One is a rock-filled dam, and the other 5 are earth-filled dams. The Nyumba ya Mungu Dam and one other are banks of flood controlling reservoirs in lowland areas, while the remaining four have been built on mountain sides. The former can store as much as 10 m million cubic meters of water capacity of the latter is somewhere between 200,000 and 300,000 cubic meters.

Besides, the lowland dams perform much more efficiently. The dams located on mountain sides vary significantly in efficiency. While the efficiency coefficient of the dams located on Mt. Kilimanjaro in the Moshi District is between 4 and 10, that of those in the Pare mountain system is between 10 and 20, (see Fig.-7). So long as adequate flood controlling reservoirs are available, construction of large dams like the Nyumba ya Mungu and Kalimae dams is very rewarding as they not only store a large volume of water but also help control floods.

Among small dams built on hill sides, those of the Pare mountain system are more efficient than the others. Small dams of this type ought to be built in a larger number in the future, for these dams, in addition to those built across watercourses, prove very effective in storing a portion of surplus water during the rainy season and discharging it at the turn of seasons or at a time when rainfall is scarce. Fluctuations in rainfall from one year to

Efficiency of Dam (Fig. - 7)



another can thus be leveled and regulated to better suit the needs of crops under cultivation, to facilitate stable cultivation, to help extend the period of cultivation, to bring about greater yields and to drastically increase productivity.

(d) Bore holes

Bore holes are used at only 18 locations in the Moshi District--mainly at T.P.C. and in Miwaleni Ujamaa village--in order to pump up subterranean water for use as irrigation water. At T.P.C. bore holes are directly connected to sprinklers and driven by electricity. In Miwaleni, on the other hand, water pumped up is stored in a reservoir and then utilized as it spills down naturally. In the utilization of subterranean water as irrigation water in the future, it is essential to use electricity as a power source and to make efficient use of water with reservoirs.

(2) Control Organizations

There are two types of associations in charge of irrigation water: one type controls, as a matter of traditional practice, the use of irrigation water in the traditional furrow concerned, and the other type controls irrigation water in a case where the irrigation furrow concerned has been constructed as a public works, where the District Development Director (D.D.D.) holds the water rights, and where the water is used by the village concerned.

In the case of the first type, the chairman of the village is entrusted with authority for control, while villagers hold membership to the association. Those who offer a prescribed amount of labor in order to repair the channels or weirs or to carry out construction works are exempted from water utility fees. Other persons using irrigation water must pay a prescribed amount of money or number of goats.

In an irrigation association which is in charge of irrigation water of which water rights belong to the D.D.D., it is also the village chairman who is entrusted with authority for control. Maintenance and repair works are carried out directly by villagers, and no utility fee is collected from them.

(3) Traditional Practice of Water Utilization and Rights to Irrigation Water

(i) Subject of Traditional Practice of Water Utilization

Where irrigation water from traditional furrows is used as a matter of traditional practice, the village concerned is the subject of such practice. In cases where the village is formally given the rights of ownership, the D.D.D. is designated as the owner.

(ii) Method of Water Distribution

The Ministry of Water and Electricity and the Ministry of Agriculture determine the appropriate amount of water to be distributed to each village. Within a village the chairman distributes the water among the villagers according to irrigated acreage.

(iii) Transfer of Water Rights

An individual possessor of water rights who does not use them any longer may transfer them with the permission of the Government. The water rights to be transferred are returned to the Government without compensation and then transferred by the Government to a third person with compensation.

(iv) Collection of Water Utilization Fees and Other Charges

As a general rule, members of an irrigation association are obliged to supply the labor needed for maintenance and repair of existing irrigation facilities and for construction of new facilities. A member who fails to fulfill this obligation owing to unavoidable circumstances must make up for such failure by paying to the association a prescribed amount of money or a prescribed number of goats or other means of payment.

1.4 Agricultural Zones

In trying to clarify how well the region is suited for agriculture, it seems quite proper to look at each of the districts closely by further dividing it into smaller agricultural zones, as in Table - 9 , according to their natural and social conditions. Each district is divided into 3 or 4 zones, which have their respective characteristic features as summarized below.

(1) Hl, Ml and Rl

Zones Hl, Ml and Rl, covering a total area of 67,800 ha with mixed cultivation of coffee and bananas, are typical zones in the region. Located on the southern and eastern slopes of Mt. Kilimanjaro at heights of 1,100 to 1,800 meters and having many ups and downs, these zones are climatically very favoured and very densely populated, accommodating more than 80% of the region's population. Although more than 60% of the area of these zones receives over 1,000 mm of rainfall annually, much of it is concentrated in the rainy season, with the result that in the dry season both coffee and bananas suffer from lack of water. Hence the fact that these zones are rather well irrigated. In terms of the percentage of acreage under irrigation, zone Ml (in the Moshi District) ranks first with 25%, followed by zone Hl (in the Hai District) ranking with less than 5%. The effects of drought are also felt in zone Rl (in the Rombo District) as in zones Ml and Hl, but reflecting the fact that the rainfall in this zone during the short rainy season of October, November and December is somewhat greater and thus drought damage is somewhat less severe than in the other two zones mentioned above, scarce acreages are under irrigation in this zone.

Land is very intensively utilized in these zones, arable land accounting for as much as 47,317 ha or 70% of the total area of 67,800 ha. Of the three zones, Rl boasts the highest rate, 86%, followed by Hl's 68% and Ml's 62%. In addition to coffee and bananas, vegetables are grown on these farmlands and are supplied to the market in Moshi Town and to nearby open-air markets located in each district. Furthermore, since many of the coffee and banana growing farm households in these zones rear dairy cattle as well, these zones are also milk-supplying areas.

(2) The zone Pl is located in the hilly area of north and south Pare at heights of 1,200 to 1,800 meters above sea level. Encompassing 22.300 ha (8,200 ha in north Pare and 14,100 ha in south Pare), this is a zone in which coffee and bananas are planted side by side. All of this zone lies in an area with an annual rainfall of over 1,000 mm, but due to the fact that much of the rainfall is concentrated in the rainy season, as in the case of (1) above, irrigation is practiced in this zone, too, as a means of mitigating the effects of drought. Approximately 10% of the land is irrigated, mainly by means of traditional furrows.
Out of the total area of 22,300 ha, 7,573 ha or 34% is arable, which is an extremely high percentage for the Pare District. Yield of coffee per unit of farmland in this zone is smaller than in the zones of (1) above. As for comparison between north Pare and south Pare, the latter outranks the former in terms of the acreage planted in coffee, but in

terms of the amount of production the former, by turning out 60% of the total, outranks the latter.

(3) The H2, located on the western slopes of Mt. Kilimanjaro, is that in which wheat, beans, and dairy products are produced by farms of large size. The zone lies between 1,200 meters and 1,800 meters above sea level, with the upper limit directly bordering on a forest zone. On large plots of farmland developed on gently rolling hills, NAFCO and one private farm are engaged in highly mechanized contour cultivation on a large scale. In this zone, one of the major wheat producing areas of the country along with the Arusha Region, the acreage planted with wheat in both the long and short rainy seasons totals 8,000 ha. In addition to wheat, beans and other crops are also grown.

Of the total of 51,200 ha, arable land represents 18,273 ha, or 36%. However, a large part of the arable land is not planted at all, and hence the much smaller figures for acreage under cultivation. In addition, about 400 ha is used as pastures for dairy cattle. The plots now planted with wheat are located in areas with an annual rainfall of 600 to 700 mm, but owing to rather violent fluctuations in the rainfall from one year to another and in the seasonal rainfall distribution, the wheat yields are not stable. In addition to dairy farming practiced by large farms, cattle and goats are grazed in natural pastures on the Masai Steppe.

(4) H3 and M2

These are zones which border on and extend to the south of the coffee and banana producing zones on the southern slope of Mt. Kilimanjaro (i.e., zones H1 and M1), and border to the south on the Kikuletwa River and the Pare District. Encompassing the flat parts of the Hai and Moshi Districts, these two zones are between 900 meters and 1,100 meters above sea level. The landscape is generally very flat, except the area to the north of the highway connecting Arusha and Mombasa, where the landscape is gently rolling. These are typical zones where maize and beans are grown side by side. In the southern part of these zones, paddy rice and cotton are grown with the use of river water, and in the T.P.C. farm extending over 7,000 ha sugar cane is produced with the aid of irrigation.

Maize and beans are usually produced by farmers who commute as far as 10 kilometers from their homes in the coffee and banana producing zones. The area to the north of the road between Arusha and Mombasa enjoys a fairly stable yield thanks to a good amount of rainfall between 700 mm and 1,000 mm per annum. As one moves southward, the amount of rainfall becomes smaller, and the yield becomes more unstable. In these areas, maize and beans are cultivated once a year in the long rainy season. In the southern part of the zones where irrigation water is available, paddy, cotton, and maize are cultivated in rotation, and in many cases double cropping of paddy and maize or maize and maize is practiced. The southern part of the zone is said to be endowed with abundant subterranean water, and in fact it has many springs, including the one at Miwaleni. It should be easy to develop this area, provided that water from these springs and from the existing river systems is utilized in an efficient way.

Of the total acreage of 162,000 ha in the zone, arable land represents 43,730 ha, or 27%. The steppe, which is not included in the arable land, is utilized as pastures for cattle and goats.

(5) R2

This zone borders on and extends to the east of the coffee and banana producing zone on the east slopes of Mt. Kilimanjaro (i.e., zone R1). On the east it borders on Kenya. A long strip of land extending in a south-north direction and having a gently rolling landscape, this zone is located between 1,100 meters and 1,200 meters above sea level. Annual rainfall is about 700 mm, the eastern part of the zone getting somewhat less. Since, however, this zone has some rainfall during the short rainy season as well as during the long rainy season, as explained in (1) above, it is better suited for crop raising than other zones. This is why this zone, though consisting of lowland areas, has 14,114 ha of arable land out of a total of 20,300 ha.

Combination of cultivation of finger millet alone during the long rainy season and mixed planting of maize and cow peas (beans) during the short rainy season--i.e., double cropping--is the most typical manner of land utilization in the zone. However, the yields depend heavily on the rainfall distribution as rainwater is the major source of water supply. Although efforts are now being made to develop new sources of water, the prospects for the zone's development are not too bright as it is blessed neither with river water nor with subterranean water.

As in the case of (4) above, farmlands in this zone are tilled by farmers who commute from their homes in the coffee and banana producing zones.

(6) P2

This zone encompasses vast tracts of flat land less than 900 meters above sea level that stretch to the east of the hills of north and south Pare and up to the national boundary with Kenya. The southern part of the zone is about 600 meters in altitude. Even areas along mountain, which are favoured with a relatively larger rainfall than the rest of the zone, the annual rainfall is only about 700 mm. Furthermore, although no direct data is available in this respect, areas closer to the border with Kenya seem to receive less rainfall than those farther from it.

The zone covers an area of 313,200 ha, of which approximately two-thirds is taken up by the Mkomazi Game Reserve, with arable land being restricted to the flat land at the foot of the mountains with a considerable amount of rainfall. Lake Jipe is located in the northern part of the zone bordering with Kenya, and Lake Kalimawe is located at the southern foot of the mountains. Downstream the lake water is used in the cultivation of paddy. The paddy fields at present cover about 3,000 ha. Yields can be increased drastically if cultivation techniques and water control are improved. Also worth consideration is expansion of the acreage of paddy cultivation. Major crops other than paddy include cotton, maize and banana.

Of the total area of 313,200 ha, only 4%, or 11,089 ha, is arable land which is of course the lowest percentage in the region.

(7) P3

This zone encompasses vast tracts of flat land less than 900 meters above sea level that stretch to the west of the hills of north and south Pare and up to the Pangani River, the southern part near the Pangani River lying only about 600 meters above sealevel. Even in the limited hilly areas which have relatively more rainfall than the rest of the zone, annual rainfall is only between 600 mm and 700 mm. In the vicinity of the railway that extends in a south-north direction the annual rainfall drops to about 500 mm, and in the vicinity of the Pangani River, too, the annual rainfall is only about 400 mm. In fact, areas with less than 500 mm of rainfall represent 90% of the zone. Much of the zone is savanna land, with the farmlands being limited to the foot of the mountains, the immediate vicinity of the railway tracks, and the vicinity of the Pangani River.

The major crops in this zone are maize, sisal, and cotton. Of the total area of 300,700 ha, 17,354 ha, or 6%, is arable, only Zone P2 having a lower percentage of arable land. The savanna lands, which are not classified as arable, are used to graze cattle and goats.

Nevertheless, the prospects for the zone are not all that bleak, as the construction of the Nyumba ya Mungu Dam is expected to open up the possibility of development of the area along the Pangani River both through improvement of the existing irrigation facilities and through creation of new irrigation facilities. Thus, farmlands are expected to be expanded in the area along the river, and it is not at all unrealistic to suppose that they will eventually form a major agricultural area based on better utilization of water in the Pare District. Given the fact, however, that the area along the Pangani River is far from major road systems and urban centers, it seems imperative for the realization of this ideal to provide the conditions essential for maintenance of social life, especially roads directly connected with major road systems, educational facilities, and other indispensable public facilities.

(8) H4, M3, R3 and P4

Zones H4, M3 and R3 are in the area of the Kilimanjaro National Park. The lower parts of these zones bordering on the coffee-banana belt are covered by forests where coffee and banana growing farmers mow green grass with which to feed their dairy cattle. In many parts of zone H4 at heights of 1,800 to 2,000 meters, Irish potatoes and pyrethrum are planted on deforested plots during the period of several years until newly planted trees get to be too large to allow for continuation of this practice.

Zone P4 consists of the steep mountain areas of north and south Pare, where tree coverage is poor.

Zoning of Agricultural Area (Table - 9)

Items	Hai					Moshi				Rombo				Pare					Grand Total
	H1	H2	H3	H4	Total	M1	M2	M3	Total	R1	R2	R3	Total	P1	P2	P3	P4	Total	
Altitude (meter)		1,200 -1,800				1,100 -1,800	900 -1,100	above 6,000			1,100 -1,200			1,200 -1,800	600 -900	600 -900	above 900		
Topography		gently sloped				gently steep slpes	even	steep slopes			gently sloped			gently steep slopes	even	even	steep slopes		
Rainfall (mm/year)	(The same as H1)	700 -500	(The same as H2)	(The same as H3)		above 1,000	700 -500	below 700		(The same as R1)	700 -500	(The same as R3)		above 1,000	below 700	below 600	700 -500		
Land use		wheat beans dairing				coffee banana	maize bean	forest			maize beans millet			coffee banana	maize paddy cotton	maize paddy cotton	forest		
Management		extensive				intensive	extensive				extensive			intensive	extensive	extensive	-		
Population Density		Sparsity				density	sparsity				sparsity			density	sparsity	sparsity	-		
Hectorage (i)	21,900	51,200	75,400	61,300	209,800	29,400	86,600	41,000	157,000	16,500	20,300	102.2	139,000	22,300	313,200	300,700	184,000	820,200	1,326,000
Cultivated Land (ii)	14,800	18,273	17,295	-	50,368	18,250	26,435	-	44,685	14,267	14,114	-	28,381	7,573	11,089	17,354	-	36,016	159,450
Ratio (ii)/(i)	68	36	23			62	31	-	28	86	70		20	34	4	6		4	12

Note: (i) Hectorage computed by planimeter on a map with a scale of 1/250,000.
(ii) Cultivated land is estimated on the basis of Kilimo's data.

1.5 Changes in Areas Planted With Crops and in Yields

The changes in areas planted with major crops and in the corresponding yields, which are detailed in the technical report, can be summarized as follows.

(1) Areas Planted With Different Crops

The table below gives indices for the areas planted with major crops in 1975, the base year, in which the indices stood at 100, being 1966, except in the case of cardamon and sunflowers, in which the base years are 1970 and 1971, respectively.

Variation of Cultivated Area of Crops (%) (Table - 10)

Increase of over 50%	Cardamon	(525)	Sweet potatoes	(320)
	Paddy	(217)	Seed beans	(190)
	Sugar	(165)	Finger millet	(164)
	Irish Potatoes	(156)		
Increase of 20% to 50%	Fruits	(150)	Cassava	(149)
	Vegetables	(145)	Maize	(131)
Increase of less than 20%	Coffee	(118)	Mixed beans	(118)
	Banana	(114)	Wheat	(111)
Decrease	Castor	(12)	Pyrethrum	(33)
	Sunflower	(52)	Jaggery	(52)
	Cotton	(61)	Sisal	(64)

Among various crops whose areas of cultivation increased by 50% or more, one crop of special significance in terms of the acreage of cultivation is paddy, which has grown popular, especially in the Pare District, and is now planted on 3,500 hectares, which is about 2.2 times its cultivation area 10 years ago. This seems to be partially due to the fact that the tastes of the local population have changed in favor of rice. And given the fact that an increasingly larger amount of irrigation water will be made available from now on, it liiks like the area under cultivation for paddy rice is going to increase still further. Equally noteworthy are finger millet and sugar cane, which gained 64% and 65%, respectively. Finger millet gained in acreage of cultivation as it become much in demand as a material for brewing a local liquor. Sugar cane fields, too, are still being expanded, and these new plots of land are becoming increasingly dependent on subterranean water, the amount of subterranean water available being the factor that will decide the pace of expansion of sugar cane fields. Irish potatoes and sweet potatoes are steadily gaining in acreage of cultivation. What is especially noteworthy is that the area now planted with sweet potatoes, 1,600 hectares, is 3.2 times that of 10 years ago. The gain in acreage scored by cardamon is tremendous in terms of percentage (as it has more than 5 times the area it had 10 years ago), but the crop still remains insignificant in terms of the absolute acreage it occupies.
Included in crops which gained in acreage of cultivation by up to 50% are the two representative crops of the region--coffee, which gained by 19%, and bananas, which gained by 14%. Maize, a major food crop, gained by 31% and is now cultivated on about 46,000 hectares. In the case of vegetables the acreage under cultivation has also increased steadily to

1,600 hectares. Among fruits, citrus scored a sharp percentage increase in cultivation acreage, but in terms of the absolute acreage, it still remains rather insignificant.

Among those crops which lost acreage of cultivation, the case of castor is most conspicuous as this crop, which was planted on 3,816 hectares in 1966, is now planted on only 440 hectares. This sharp decline is said to be the result of the fact that the price of castor, which is not a food crop to begin with, has declined too much. In terms of the rate of decline, castor is followed by pyrethrum and sunflower, which are now planted on 33% and 52%, respectively, of the area they were planted on in 1966. The setback suffered by pyrethrum is said to be partially due to the fact that lands suitable for pyrethrum have already been used as coffee and banana growing farms, not much land being left for pyrethrum. Sunflower, on the other hand, began to become popular around 1969 as a material for edible oil, reached a peak in 1972, when it was planted on 620 hectares, and has been on the decline since then. This decline is explained partly by the lack of rainfall in the lowland areas where sunflower is cultivated, and partly by the decline in its price. Sisal has been continuously on the decline for the last 10 years due to the decline in demand from overseas. The area on which sisal is cultivated has decreased to 6,150 hectares, or 64% of the level in 1966. Cotton, which was planted on approximately 7,000 hectares of land 10 years ago, sharply lost acreage for several years, but in the last 5 years its acreage has remained rather stable. The acreage of cotton cultivation at present is 4,200 hectares, which is 61% of the peak.

(2) Changes in Yields

Since rainfall was quite irregular from 1971 to 1975, the yields in this period fluctuated very violently from one year to the next. Thus, rather than selecting a base year for comparison, it seems more appropriate to examine the changes in the yields by comparing the average figures for the latter half of the decade under consideration (i.e., 1971-1975) with the average figures for the first half, (i.e., 1966-1970) which have been given the index value of 100 as the base of comparison.

Variation of Production Of Crops (%) (Table - 11)

	Crops			
Increase of over 50%	Sweet potatoes	(181)	Fruits	(124)
	Irish potatoes	(153)		
Increase of 20% to 50%	Finger millet	(149)	Coffee	(137)
	Paddy	(131)	Cassava	(127)
	Sugar	(125)	Seed beans	(124)
	Vegetables	(121)		
Increase of less than 20%	Banana	(100)		
Decrease	Pyrethrum	(18)	Jaggery	(24)
	Castor	(45)	Cotton	(62)
	Sisal	(66)	Maize	(77)
	Wheat	(90)	Mixed beans	(96)

Note: Since cardamon and sunflowers were not cultivated during the period 1966-1970, they have been omitted.

Reflecting the fact that rainfall in the period 1971-1975, with the exception of 1972, was less than usual, the rates of increase in the yields of many crops have not been as significant as the rates of increase in cultivation acreage. This is especially the case with the three representative crops of the lowland areas: maize, wheat, and mixed beans. Whereas in the past 10 years these crops gained 31%, 11%, and 18% respectively, in terms of acreage of cultivation, their yields in the latter five-year period fell short of the figures for the first five-year period by 5 to 20%. The fact that Irish potatoes mainly grown in the upper land area of Hai district gained in terms of the yield in proportion to the increase in acreage of cultivation under a climatic condition such as explained above suggests that the area now being planted with Irish potatoes is bleassed with much rainfall. The case of coffee is the only exception in that the rate of increase in the yield was greater than the rate of increase in the acreage of cultivation. This seems to be due partially to the fact that the uppler land where coffee is grown is bleesed with a better climatic condition than the lower land and also partially to the innovations made in ferrilization and cultivation control and other techniques.

As for the changes in the relative significance of cash crops versus food crops in the agriculture of the region, following table offers an overall picture. As clearly evidenced by Table - 12, cash crops are on the decline while food crops are gaining much in the acreage of cultivation.

Cultivated Area of Cash Crops and Food Crops (Unit: ha) (Table - 12)

	1966		1975		75/76
	Area	(%)	Area	(%)	(%)
Cash crops (i)	51,319	36	48,149	30	94
Food crops (ii)	90,180	64	114,628	127	127
Totals (iii)	141,499	100	162,777	100	115

NotesL (i) Coffee, sugar, seed beans, cardamon, cotton, pyrethrum, sisal, castor, sunflower, jaggery, maize, finger-millet, paddy, wheat, mixed beans, cassava.

(ii) Irish potatoes, sweet potatoes, banana, fruits, vegetables.

(iii) 1.3%.

1.6 Features of Main Agricultural Products

(1) General

Here we will consider present conditions and features of main agricultural and livestock products of this region, problems regarding them, and their present and future importances. The production of these products is significant in terms of the national economy and in terms of the livelihood that it affords the producers and especially peasant farmers. Theoretically these two aspects should agree with each other. In actual fact, however, there is some discrepancy between the two when it comes to details.

This IRDP maps out future programs for agricultural and livestock industries in the national and regional economies which must be acceptable to peasant farmers. We will therefore take into full account the standpoint of peasant farmers in dealing with each category of agricultural production in the following.

Data on production of main crops in the region in the past 10 years is given in the Technical Report. The ratio of the cultivated area of food crops to that of cash crops is 7:3, and the ratio of the production value of the former to that of the latter 4:6. Furthermore, 70% of the cultivated area of these crops is owned by smallholders. Large farms like estates total approximately 50,000 ha, or only 30% of the total cultivated area.

(2) Food Crops

(i) Maize

Maize is a major staple food for the people of Tanzania. The cultivated area of this crop has increased steadily in the past 10 years. In 1975 it amounted to approximately 46,000 ha. This is the largest area for any crop in the region. Some observers are of the opinion, moreover, that in reality, this crop is cultivated on a much larger area than these official Kilimo statistics indicate.

In the region, maize is cultivated mainly in areas below the rainy coffee-banana belt where rainfall is in the range 900 - 500 mm. Such cultivation depends mainly on rainfall, except in a few small areas where irrigation is possible. When rainfall is small, yields are inevitably low. In the past several years, the production has decreased despite the increase in cultivated area in the past 10 years. This is because, as in the case of many other crops, rainfall has been unusually small since 1970, except in 1972.

A national maize project was launched in 1975/76, with the Kilimanjaro Region, too, participating. This project is coming along quite well. We believe, however, that greater efforts should be made to raise productivity.

Maize is sowed in October and November in areas near the highland areas, where the rainy season is short, but in the greater part of the lowland areas, it is sowed in March and April. Where irrigation is possible, however, sowing begins in January and February.

Mainly late maturing maize is cultivated in rainy regions where there is irrigation with early maturing varieties being grown in lowland areas without irrigation.

Improved hybrid seeds are produced by the Tanzania Seed Company Limited (T.S.C.L.). They are widely used along with seeds produced in Kenya. The use of these seeds helps increase productivity. But many of the hybrid seeds are late maturing. Moreover, hydbrid seeds are effective in increasing production only when there are intensive irrigation, fertilizer and pest controls. Under loose controls there is generally no increase in productivity over local varieties. In encouraging use of hybrid seeds, it is important to emphasize this point.

Many test fields and demonstration farms should be operated for the purpose of determining which varieties, especially hybrids, are most suitable for the natural conditions of each area.

In cultivation of maize, ploughing and weeding entail the greatest amount of labor. Ploughing is done by tractor on about half the maize cultivation area. On the remaining area manpower is depended upon for the most part, the use of cattle being very rare. As cultivation by manpower is very hard, inefficient work, hoeing is done only where seeds are sowed. Weeds, therefore, grow thick where the ground is left unploughed, and removing them is a big problem.

Accordingly, ploughing by tractor or cattle should be encouraged. At present, use of tractors is limited mostly to ploughing. But in future, ridging in irrigated fields, too, should be done by tractor or cattle since ridging by manpower is too heavy labor.

The effect in increasing production of use of fertilizers and agricultural chemicals is great. But it is better to stress irrigation for the sake of economy. The following cultivation technology is necessary in order to increase production of maize: (1) selection of seeds, especially hybrid seeds, suitable to the soil, (2) proper spacing of plants, which will vary according to the soil, the variety of maize, and whether there is irrigation or not, (3) use of proper fertilizers, (4) timely weeding and pest control, and (5) proper irrigation, especially to ensure that the soil is not allowed to dry out in the tasseling period.

(ii) Mixed Beans

There are many kinds and varieties of beans, including those the dried seeds of which are harvested and those the young pods of which are harvested. As the latter type are classified as vegetables, the former are what are usually meant when referring to beans. Both the cultivated area and production of beans have not much increased in the past 10 years.

In many cases, beans are sowed together with maize. Since many varieties of beans can be harvested in 75 to 100 days after they are sowed, they can be sowed later and harvested earlier than maize. In addition, they do not affect the production of maize as their height is low and they need little fertilizer.

But bean cultivation has not been controlled much to date, and the yield is usually less than 0.5 t per hectare because of such mixed cultivation. With irrigation, however, it should be possible to raise yields to over 1.5 t per hectare, which will make beans a highly profitable crop at present prices. Control of aphides and weeding, however, will be indispensable.

The protein content of beans is over 20% in dried seeds. In addition, they fix atmospheric nitrogen in soil, and they are comparatively highly priced. They are therefore a good crop for peasants to incorporate in their crop rotations.

Since, however, they do not stand up well to drought, they would not be very profitable in lowland areas where irrigation is impossible.

(iii) Finger Millet

The cultivated area of this crop increased from 3,500 ha to 6,000 ha in the five-year period from 1966 to 1971. It did not increase at all, however in the five years thereafter. This is probably because its value as a staple food has declined as that of maize has risen.

At present, much of this crop is used as raw material for the local liquor mbege. But it is inconceivable that such use will increase greatly in the future. Finger millet is mainly cultivated in Shamba lands below the coffee-banana belt of Hai and Rombo. It is partly cultivated together with maize. As it is cultivated in the long rainy season, usually it is sowed around March. The yield per ha is about 0.7 t as there is no irrigation. However, the yield can be raised to about 1.5 tons with good control.

Although this crop has the advantage of seldom being damaged by vermin in storage, the seeds are small, there is considerable unevenness of sowing for the same reason, and the stand is not uniform. In addition, much labor is needed for thinning and weeding, and this work cannot be done thoroughly since it is difficult to distinguish the small seedlings from weeds. Besides, damage by birds before harvesting is very great. All of these factors are obstacles to increasing the yield.

(iv) Paddy

The cultivated area of this crop has increased from 1,600 ha to 3,500 ha in the past 10 years. This is probably due to its profitability in comparison with other crops on farms with irrigation and on damp land. Over 90 percent of the 3,500 ha is located in the Mkomaji Valley in the Pare District. The remaining portion lies southeast of Moshi Town in the Moshi District.

Production has increased by only 30 percent in spite of a remarkable increase in cultivated area. This is probably due to recent drought and to the fact that the necessary technical knowhow has not been adopted widely enough to keep pace with the rapid expansion of area under cultivation.

Yield per hectare is second only to that of bananas among food crops cultivated in the region in terms of calorie content. The amount of proteins produced per hectare is also second only to that of wheat. Moreover, rice suits the palate of the people of the region very well. Unfortunately, however, the price is higher than that of maize and other staple food crops.

Ninety-six percent of the rice produced is consumed by the producers or traded freely by them, only 4 percent being sold to National Milling Corporation. Black market activity seems to be predominant.

The paddy yield in the region is about 1.8 tons per ha. But according to results of experiments at the Lyamungu Research Institute's Miwaleni Substation, a harvest of 6 tons per ha can be achieved. Paddy can be more profitable than maize if there is proper control at places where water can be obtained for irrigation. It is a crop that should be actively promoted following development of new agricultural water in the future.

However, present cultivation technology must be improved greatly, the possibility of doing so being higher than in the case of maize.

The first improvement that should be made is levelling of cultivated land. Otherwise, too much water will be used, growth will be uneven, and yield will be small. Land improvement work such as levelling, adjustment of partitions of farmland, and consolidation of farm roads should be carried out simultaneously with construction of irrigation facilities, these works being helpful for cultivation of other crops as well. A second improvement that is necessary is selection of suitable varieties. Different varieties should be selected for different soil fertilities and different planting seasons. A third necessary improvement is the planting of good seedings, which will increase yields. The fourth is fertilizers. According to the results of experiments, an increase in production of 50-70 percent is possible just by using nitrogen fertilizers. The fifth is space of plants, control of vermin, and weeding.

The techniques for these last four improvements should be fully tested on many farms under different conditions, and farmers must be informed of and given guidance regarding the improved techniques. Furthermore, the rice production project now under way should be reinforced.

On irrigable cultivated land, two crops a year should be cultivated as far as possible, combining paddy rice with maize, vegetables, or other crops. With proper crop selection, two-crop cultivation can be easily introduced over a wide area. This will result in even use of labor throughout the year, increased income through increased crop production and savings on irrigation and land improvement costs.

The greatest hindrance to paddy production is damage by quelea, for which there is no safe and economic countermeasure. But efforts should be made to minimize the damage by keeping a watchout for them, catching them with nets, and practicing collective cultivation over large areas.

(v) Wheat

The cultivated area of wheat has increased from 6,300 ha to 7,000 ha since 1966. This is because the areas of NAFCO and private estates in the West Kilimanjaro area of the Hai District, which account for 96% of the total cultivated area, have remained almost unchanged. On these estates, wheat is cultivated with agricultural machinery. It would be difficult, however, to find new land suitable for cultivation of wheat in the region. Production has decreased in comparison with what it was 10 years ago because rainfall has declined in recent years. As water cannot be obtained for irrigation, yields fluctuate greatly from year to year.

Wheat is the crop in the region with the largest output of protein per hectare. Its production should therefore be encouraged. Moreover, wheat bran is excellent as a feed. It will be difficult, however, to increase production because of the difficulty of expanding the amount of area under cultivation.

New techniques can be easily employed, however, as wheat is cultivated on large farms and this makes for a relatively high technical level. Hopefully, new varieties resistant to drought and scientific cultivation methods can be developed. At the same time, improvement of management to make the most of the present manpower and machinery of large farms can be expected to help to increase production.

(vi) Irish Potatoes

The cultivated area of Irish potatoes increased from 1,600 ha in 1966 to 2,500 ha in 1975, 70% being in the Hai District at altitudes of 1,500 to 1,800 meters above sea level. It is possible to cultivate Irish potatoes on sites where forests have been felled and which have not yet been afforested, or if afforested, for a short period of three years during which the planted seedlings are still small under a system called Squater's System. This is an advantageous system for both forestry and agriculture. The climate of the region is cool enough to be suitable for potatoes, and rainfall, too, is adequate. Thus, the yield per ha increased even during the recent drought. And as the cultivated land is changed every three years, there is no soil exhaustion problem.

In the Hai District, planting begins in March or April, and the crop is harvested after about 100 days. In the Rombo District, however, it is planted in October or November, when the short rainy season begins.

Although a problem in connection with this crop is phyto-phthora infestant and bacterial wilt, obstacles can be avoided by adoption of resistant varieties and change of cultivated land.

Irish potatoes are to be encouraged more than other root crops as they yield a much higher output of protein per hectare than other root crops such as cassava and sweet potatoes. Problems standing in the way of major increase in production, however, are availability of additional suitable land for their cultivation, transportation, and storage.

(vii) Cassava

The cultivated area of this crop has increased by about 50% from 900 ha in 1966 to 1,340 ha in 1975. The increase between 1971 and 1975, however, was only 10%. As this crop stands up well to drought, however, the yield per hectare has been larger than in the past even in drought years. Total production is more than twice that in 1966. Since this crop does not require much rainfall, it can be cultivated in lowland areas in all districts of the region.

Besides being resistant to drought, this crop has other excellent properties as well. For instance, it can be producted even on infertile land, and the harvest season is long. Therefore, labor need not be concentrated. In addition, it is easier to store than other root crops. If this were the only criterion, this crop would be cultivated more in lowland areas of the region. Working against this, however, is its inferiority to maize as a staple food.

The greatest problem in production of this crop is virus "mosaic disease." Upon close investigation, almost all plants will be found to be infected by virus. This makes for serious damage in

the case of a decline in the state of health of the crop, with a consequent decrease in yield. There is no variety which is completely immune to virus, but encouragement of resistant varieties and supply of healthy seedlings can assuage the problem.

(viii) Sweet Potatoes

The cultivated area of this crop has more than tripled from 500 ha in 1966 to 1,600 ha in 1975. The yield per hectare has not decreased in spite of drought conditions in recent years.

Since sweet potatoes are more resistant to soil dryness than Irish potatoes, but less than cassava, they are cultivated in areas with a fair amount of rainfall in all districts.

The results of experiments show that sweet potatoes can bring the highest yields and largest profits per hectare of all root crops, provided that they are cultivated in adequately damp soil and their cultivation is well managed under the same conditions as for other crops. They can be a profitable crop in comparison not only to other root crops but to such nonroot as maize as well.

It would seem, however, that the techniques and labor required by seedling cultivation and the labor required for harvesting are great obstacles to expansion of the cultivated area of this crop. Furthermore, it is inferior to maize and rice as a staple food in terms of both taste and storability.

As in the case of other root crops, in order to substantially expand the production of sweet potatoes under a long-range program, the use of the crop must be increased through processing, and the problems of storage and transportation, too, must be solved.

(ix) Bananas

The cultivated area of bananas increased slightly from 30,000 ha in 1966 to 34,100 ha in 1975. The increase in output, too, was small.

But bananas are a major staple food the production of which is larger than that of any other crop in the region. Much of it is used as a raw material for the local liquor, mbege. In addition, its leaves and stems are used as food for livestock and for malting on coffee farms. Its calorie yield per hectare is second only to that of sugar.

The crop is produced and consumed mostly in highland areas, which account for 80% of the population of the region. But its importance as a staple food will decline in the future. As it has low resistance to drought, it is cultivated only in high-altitude, rainy areas or where there is a good supply of underground water. Usually it is cultivated together with other crops on smallholder coffee farms.

Thus, as suitable land for cultivation is limited, the prospects for expansion of cultivation are slim. It is quite possible, however, that production can be increased through improvement of cultivation technology, chiefly with respect to the following points:

(a) Selection of good varieties from among scores that are available.

(b) Proper pruning of suckers. Especially when bananas are cultivated together with other crops on coffee farms, attention must be paid to pruning and the number of stands so that the crop will not overshade the coffee.

(x) Vegetables

Cultivated area expanded steadily from 1,100 ha in 1966 to 1,600 ha in 1975. According to statistics, there has also been an increase in production, which is now estimated at 3,000 t. These statistics, however, seem to be incorrect, for this level of production would allow for per-capita consumption of vegetables in the region of less than 4 kg a year.

Judging from tomato and onion sales at two public markets in Moshi Town and on roadsides, it is evident that the people of the region eat much more vegetables than that. The figure of 3,000 t is probably only the amount sold at public markets in Moshi Town.

Consumed the most in the region are tomatoes, cabbages, and onions. Carrots, garden peas, Spanish paprikaes, cucumbers, egg-apples,

okraes, pili pili, and beets, too, are generally consumed, and a vegetable of the amaranthus family is also to the liking of the local population.

The history of cultivation in this country of many of these vegetables does not seem to be very long. Nevertheless, tomatoes and onions are favorite foods. The quality is not so good, but the quantity seems to be sufficient for consumption in the region. Sales outside the region, however are still very small. Some tomatoes and pili pili are processed as raw materials for sauce, but the quantity is not large.

Many of these vegetables are cultivated mainly in rather cool highland areas with adequate rainfall. In lowland areas their cultivation is almost impossible without irrigation.

There would not seem to be much of a problem involved in producing enough vegetables for the region's own needs even if the population increases considerably. What is needed, however, is selection of varieties preferred by consumers and qualitative improvement. Moreover, a medium-range plan for sales outside the region of both vegetables and fruits and their processed products should be

considered. For this purpose, too, better selection of varieties and qualitative improvement are important. For instance, in planning production of vegetables for large consuming areas like Dar es Salaam, qualitative improvement and reduction of prices for competitiveness with highland vegetables shipped from Morogoro and Lushoto are a must. Besides such technical improvements and strengthening of services, the storage, transport, and processing aspects must be improved.

(xi) Fruit

The cultivated area of fruit increased greatly from 140 ha in 1966 to 255 ha in 1975, and the output, too, according to statistics, increased from 70 t to 550 t, citrus fruits accounting for 75 ha and 100 t, respectively, in 1975. These statistics, however, could be even less reliable than those for vegetables.

Judging from sales at public markets in Moshi, at open-air markets and on roadsides, citrus fruits (oranges, lemons, limes, mandarines, and grapefruits), mangos, papayas, avogados, bananas, and plums are produced and consumed almost the year round. But some of the citrus fruits and pineapples consumed in the region are imported from other regions.

The amount of fruits cultivated in orchards in the region is very small. Most of them are planted and harvested around gardens and shambas. But from the standpoint of increasing farmers' income in the future, fruits must be given a more commercial nature. For this purpose, as in the case of vegetables, better selection of varieties and qualitative improvement are imperative, especially for sales to tourists (even if the amount is not very large) and to other regions and countries. In the case of exports, especially exports abroad, intense competition with foreign products must be met with respect to vegetables, fruits, and their processed products.

This will be more difficult in the case of fruits than in the case of vegetables because fruits other than pineapples are perennial plants, which take a long time for renewal and improvement of varieties. Moreover, such renewal and improvement requires the the operation of special orchards for that purpose.

(3) Cash Crops

(i) Coffee

Coffee is the biggest export crop of this country. And the product from the Kilimanjaro Region is largest in amount. The product is of the Arabica species, the price of which is higher than that of the Robusta species.

The cultivated area only increased from 24,000 ha in 1966 to 28,300 ha in 1975, but the output increased greatly from 19,000 t to 27,000 t in the same period. This is only smallholder output, there also being about 4,000 ha of estates.

Seventy percent of the coffee of the region is cultivated at 1,200-1,800 m above sea level, where the annual rainfall is about 1,000 mm. It is also cultivated at about 900 m above sea level where irrigation is available.

Usually coffee is cultivated under shade trees. On estates, grevillea rabusta and other trees serve as shade trees. But smallholders plant banana trees among coffee trees. Smallholders with only small kihamba and shamba cannot give up mixed cultivation with bananas, but in the case of smallholders having larger kihamba and shamba, it is desirable to widen the spacing of the banana trees for coffee.

Coffee production involves a great deal of labor because of the intensive control that it requires as a cash crop. But labor is distributed over the seasons in such a way that there are no shortages other than at harvesting. Furthermore, the labor required for coffee cultivation does not cause any shortage of labor for cultivation of maize on shamba lands.

In view of the demand and supply situation in the world coffee market, it will be impossible to greatly increase coffee production in Tanzania alone. Accordingly, efforts should be concentrated on qualitative improvement and reduction of production costs.

The price of coffee has more than tripled since 1974 because of a worldwide supply shortage due mainly to frost damage in Brazil in 1975. But it is expected that in a year or two production in various countries will be restored to normal, that keen competition in terms of price and quality will resume among producer nations, and that consequently the present high prices will come down. It is necessary for both the Tanzania Coffee Board (T.C.B.) and producers to establish the conditions and basis for competing successfully then since the profits at stake are large.

Towards that end, investment must be made for qualitative improvement and reduction of costs. For qualitative improvement, prevention of diseases is indispensable. But pulping after harvesting also has a bearing on quality. In the region, it was planned to establish 47 central pulping facilities, but so far only 16 have been established. This is because it has not been possible to obtain the agreement of farmers on account of the fact that such facilities were not very successful.

Pulping can be done by the farmers themselves, but from a long-range point of view, central pulping facilities are desirable. Efforts should be made, therefore, to improve their operation and management.

(ii) Sugar

Sugar is produced by the Tanganyika Planting Company (T.P.C.), which accounts for over 40% of the sugar production in Tanzania. If sugar is taken into account, the per-capita calorie intake from food in the region amounts to about 2,200 even now, which exceeds the future standard for nonsugar calories intake.

Cultivated area and output increased from 4,300 ha and 35,000 t in 1966 to 7,000 ha and 49,000 t in 1975.

Besides T.P.C., local factories are producing a small amount of molasses, and sugar cane is cultivated for local brewing and chewing. But in both cases the amounts involved are negligible.

At present, sugar production in this country is a little short of demand. Plans call, however, for self-sufficiency and, beyond that, exports in the near future.

T.P.C. is cultivating sugar cane under a modern mechanized large-farm system with complete irrigation with surface and underground water. A large increase in production of sugar will therefore require considerable expansion of water sources.

Since increasing the production of sugar is a national requirement, part of the water resources that are newly developed should be allocated to the cultivation of sugar cane. Such allocation, however, should be made under a water utilization program for the whole region, without letting cultivators develop and use water arbitrarily.

(iii) Sisal

Sisal used to be an important export crop of this country. Demand for it declined, however, as rope, which accounted for almost all of the fiber's production, came to be manufactured with chemical fibers. Nor can the demand for rope be expected to increase in the future.

Cultivated area and output of sisal decreased from 9,600 ha and 13,500 t in 1966 to 6,100 ha and 4,500 t in 1975. Seventy percent is produced in the Pare District, and the remainder in the Moshi and Hai districts.

Sisal is produced entirely on estates and processed into fiber there. This crop is one of the most drought-resistant, and not much labor or fertilizers are needed for cultivation. It is, therefore, a crop very suited to lowland areas of the region, where rainfall is scarce. Accordingly, it will be worthwhile increasing production of it if demand increases.

The future of this crop depends on whether or not it will be possible to create large demand in an area other than rope manufacturing--in paper manufacturing for instance.

(iv) Cotton

The production of cotton in the region decreased drastically from 6,900 ha and 2,600 t in 1966 to 200 ha and 780 t in 1975. Furthermore, the region accounts for less than 1% of cotton production in Tanzania. It is also important for self-sufficiency in clothing production. Besides, 20% of the cooking oil consumed in the country is extracted from cotton seeds, and then oil cakes are used as fodder. Thus cotton is a crop having a high production priority in Tanzania, the fibers, oil, and fodder obtained from it being important to the industrial development of the country.

Cotton is very drought-resistant, but it requires sufficient water before and after flowering. It can adapt to almost any soil, including alkaline or sandy soil. As it requires a warm climate, it is cultivated mainly below 1,000 m in this region.

Production has increased slightly in the country as a whole. It has decreased, however, in the region in spite of positive efforts on the part of national authorities and the Tanzania Cotton Authority (T.C.A.) for greater production. This is because there are many problems regarding cultivation technology for this crop. Great damage is wrought by droughts before and after flowering, by weeds when the crop is young, by diseases and insects, and by rains before harvesting, all of which mean considerable risk for cotton growers.

To increase production of cotton, therefore, efforts should be made to get more cultivators to adopt techniques to overcome these obstacles as well as fertilizing techniques. At present, technical guidance for this purpose is offered by T.C.A., but further strengthening of such guidance is desirable.

The present prices paid to farmers are 2.0 shs per kg for Grade A and 1.0 shs per kg for Grade B. These prices are rather low, however, considering the labor and material costs of production of this crop. This is probably why farmers are reluctant to plant this crop.

1.7 Use of Agricultural Machinery

In this region, as already explained before, farmland is roughly divided into the coffee and banana belt of highland areas and the maize and beans belt of lowland areas. In the former it is difficult to use large machinery because of the steep slopes and the irregularity of the terrain.

In the maize and beans belt, however, large machinery can be used except in especially stony areas as the terrain is generally flat. Mechanized agriculture is already being practiced by such large entities as N.A.F.C.O. and T.P.C. In addition, large tractors are being widely used by smallholders as well for the ploughing of maize fields.

The state of use of large tractors by smallholders in lowland areas is as follows.

At present throughout the region the use of large tractors is limited mainly to ploughing and is concentrated in the two months of January and February before the sowing of maize, which is cultivated in the long rainy season.

The numbers of tractors and ploughs now used in this region are given in the table - 13 below. Since the beginning of the 1960's there have been as many as 200 tractors in the region at peak times of the year and at least 130 even during slack periods, including those borrowed from Shinyanga, Mara, Mwanza, Singida, and West Lake.

Number of Tractors and Other Farm Equipment, 1975 (Table - 13)

	Belonging to the region		Introduced from outside the region	Totals
Ownership	Private*	Government	Private	
Tractors	80	21	127-201 (average 164)	228-302 (average 265)
Disc ploughs	80	21	164	265
Planters	9	7	-	16
Disc harrows	-	7	-	7
Trailers	-	5	-	5
Cultivators	-	6	-	6

Source: Data from Kilimo of the Region

* Numbers do not include machines and equipment owned by estates like NAFCO, TPC, etc.

These tractors are used for ploughing (disc ploughing) during a limited period of two months. Their periods of operation, however, vary according to the owner. The areas of operation of these tractors are shown in Table (7)-2 below on the basis of a Kilimo survey.

Operation Areas (ha) of Tracors (Table - 14)

	Belonging to the region		Introduced from outside the region	Totals
Ownership	Private	Government	Private	
Operation area per unit in season	200	60	250	-
Total area ploughed in season	16,000	1,200	41,000	58,200
%	28	2	70	100
Remarks	200 ha x 80 tractors	60 ha x 21 tractors	250 ha x 164 tractors	

Source: Kilimo

The government's target for tractor operation in season is 200 ha per unit. Up to now, however, only 60 ha, or 30% of this target has been achieved. This is only 24% of the area of 250 ha operated by a single tractor in other regions. Thus, efficiency is very low in comparison with private tractors, on which almost all ploughing work depends.

Tractors from outside the region account for 70% of the total ploughing area. These tractors are operated for 12 hours a day on the average and sometimes into the night with the use of lighting.

This ploughing work is all done by contract, the standard cost being about 173 shs. per hectare (70 shs. per acre). However, at some places it is as much as 222 shs. per hectare (90 shs. per acre). Thus, the cost of ploughing by contract is comparatively high. According to the results of a survey on farm costs, it represents 20-30% of the total cost of running a farm.

The two months of January and February, when this ploughing work is done, are a slack season for farmers cultivating coffee and bananas. Moreover, manual ploughing by hoe is possible. But this ploughing work by contract will no doubt continue to be accepted by farmers in view of the hard labor under a burning sun that they would otherwise be subject to and the time that they would lose in commuting to distant fields.

It is inevitable from the standpoints of labor and management that the ploughing work that requires the hardest labor is shifting to large tractors. But the cost must be reduced lest it should become a large burden on farmers.

For this purpose, it is an urgent matter to consolidate official machinery services so that their machines may be operated efficiently and systematically. At the same time, it is necessary to complete systems for training of drivers and repair of machines. After results of these measures are obtained, new tractors and ploughs must be introduced gradually.

Regarding the future course of mechanization, it is desirable to extend it to such work as harrowing, ridging, and the like.

And regionally, too, it is necessary to consider introduction of small tractors that can be used not only in lowland areas but also in highland areas.

The greater use of oxen encouraged by the government is desirable from the standpoint of use of night soil as fertilizer and saving of foreign exchange. In this region, it is prevalent mainly in the Hai and Moshi districts. According to a survey by Kilimo, the area involved is about 2,300 ha, which is still very small.

Usually ploughing is done by two oxen. The efficiency is low--as low as 5-6 ha per plough in a season. The main reasons for such low efficiency are that the oxen used are not very robust and farmers are not very technically skilled in ploughing. Extending the use of oxen will not be an easy matter considering the fact that fodder is scarce. A key to the wider use of oxen is therefore the breeding of stout work oxen capable of efficient ploughing work, the securing of fodder for them, and improvement of farmers' ox training techniques.

Wider use of oxen is desirable and recommendable from the standpoint of the economical and agricultural situation of the country. It must be admitted, however, that much effort and time will be needed for realization of this goal.

1.8 Farm Income

In the region, smallholders account for the greater part of the agricultural production. However, a great difference exists in their way of farm operation between the climatically favorable highland areas and the climatically unfavourable lowland areas. Coffee is almost the only income source for the smallholders in highland areas while in lowland areas their income comes from cotton and cereals.

Farm operation in the highland and lowland will be described below by taking two cases of typical farming household.

(1) Coffee-Banana Farmer (highland)

This farmer has lived in Kirua Vunjo northeast of the City of Moshi for about 20 years. Around his farmhouse situated at an altitude of 1,600 m there is a plot of coffee and banana fields on a slope with an inclination of 10 to 20 degrees. The farmhouse is about one kilometer from a local highway and 13-15 km from his maize field in a lowland area. He usually takes a bus to work on the maize field. He ranks above the average coffee-banana planter in highland areas.

Details of his farm are summarized below and are shown in the Technical Report.

(i) Size of farm

(a) Family size: Parents and 9 children
Labor force: 3.5 persons

(b) Land utilization

(Table - 15)

	Field	Acreage (ha)	Crops planted	Competing crops	Remarks
Highland	1	2.0	Coffee (whole year)	Bananas (whole year)	(1) As a competing crop, green maize is grown in small quantities from May to January.
Lowland	2	0.8	Maize (Jan-Aug.)	Finger millet (Jan-Aug.)	
	3	0.4	Maize (Jan-Aug.)	-	(2) No farmland is irrigated.
	4	0.4	Maize (Jan-Aug.)	Beans (Jan-Aug.)	
	Subtotal	1.6			
	Total	3.6			

(c) Livestock and poultry

Dairy cows (exotic)	5	being milked	- 3
		dry	- 2
Hens	12		

(ii) Farm operation by crop

(a) Coffee and bananas (highland areas)

The total number of working hours annually in the 2 ha of coffee-banana fields is 6,608 hours, of which 3,480 hours are spent by hired laborers. The period from October to December, the harvest peason is the peak working time. The distribution of working hours per hectare by type of farm operation is shown in Table - 16 .

Breakdown of Working Hours Per Hectare (Table - 16)

	Working hours	%
Digging	100	3
Removal of moss	55	2
Prunning	495	15
Spraying	462	14
Application of herbicides	18	1
Plucking	1,789	54
Washing	110	3
Drying	43	1
Selling (cherries)	85	3
Selling (dry)	35	1
Total	3,304	100

As shown in the above table, plucking is the most time-consuming job, accounting for 54% of the total working hours per hectare. Plucking is done by six hired workers and the parents of the farming household. The working days total about 20 days per month. Pruning is normally done in January and February, and in its simpler form the job continues into March to May.

Spraying is done almost every month, but is finished by the parents in a week or so each month. The present farmer uses herbicides and does not have to do any weeding. Usually farmers in the district do not employ herbicides, instead spending some

500 hours a year on weeding. Most of the farmers in highland areas, including the present farmer, do not use any chemical fertilizer. Instead, they use fallen leaves of coffee and banana trees and farmyard manure (cow dung) with good results, and the soils are generally fertile.

The total working hours for bananas interplanted with coffee on the 2 ha of fields are 187 hours. Because are grown in the off-season using family labor. Digging and weeding the coffee crop have a good effect on bananas as well, and even taking this time into consideration, the hours spent in raising bananas are much fewer than those required for the coffee crop.

(b) Maize and beans or maize and finger millet growing (lowland areas)

As already mentioned, maize is interplanted with beans or finger millet in lowland areas. For this reason, it is practically impossible to give the number of hours spent for each crop on ploughing and weeding, the major work involved in cultivation of these crops.

The working hours on the 1.6 ha of land can only be totalled and cannot be broken down by crop. The total annual working hours are 2,421 hours, of which 1,365 hours represent hired labor and the remaining 1,056 hours the farmer's own family labor. The distribution of working hours per hectare is shown in Table - 17 .

These crops in lowland areas are planted in March, when the long rainy season starts, and all the work is completed before September when the harvesting of coffee starts. Thus the allocation of labor is very reasonable.

Breakdown of Working Hours Per Hectare (Table - 17)

	Working hours	%
Ploughing	2	0
Planting	150	10
Weeding	1,039	69
Harvesting	322	21
Total	1,513	100

Note: Working hours per hectare on 1.6 ha of land where maize and beans or finger millet are grown.

As can be noted from the above table, 69% of the total working hours are spent on weeding by the parents of the farmer and four hired workers 10 days a month from April to June.

Harvesting, the second most time-consuming work, accounts for 21% of the total working hours and is carried out by about 10 hired workers with the help of the family for a period of 15 days in the peak month of July.

Planting is taken care of only by the farmer's own family labor. If germination is retarded or impeded by the lack of rain, planting is done in two or three stages, taking advantage of rainfall. The result is that even more time is consumed than indicated in Table - 17 .

Most of the farmers in the district, including the present farmer, perform ploughing on a contract basis. When the job is done by human power, it is done in January and February. Other farm jobs include manuring and spraying of chemicals, which are included in weeding since they do not require very much time.

The cultivated fields are 13 to 15 km from the farmhouses in the highland areas, and the farmers get there by bus or other means of transportation. The hours spent on all types of farm work except ploughing include the hours needed for commuting to and from the fields. Such commuting and the haulage of harvests present a big problem that ought to be given serious study.

(c) Dairy Farming

The farmer spends a total of 3,960 hours a year on the breeding of five dairy cows. The breakdown of hours spent per day on cattle breeding are shown in Table - 18 .

Breakdown of Working Hours Per Day (5 Cows) (Table - 18)

	Working hours	%
Milking	1.5	14
Cleaning	0.5	4
Cutting grass	8.0	73
Fetching water	1.0	9
Total	11.0	100
Working hours per person	2.2	

Grass for use as roughage is mowed in the morning and in the afternoon. As shown in Table - 18 , the hours spent on this job in a day are 8 hours, including the time required for the breeding of five cows. Milking, which is done in the morning and in the evening, ranks second, followed by the carriage of drinking water for the cattle.

In places where water is hard to obtain, all water, whether potable or not, has to be carried on the head by family members from a valley at some distance. The carriage of water is a job which must be done by all family members and is the biggest problem facing the farmer. Cleaning of the cattle is the housewife's duty, and she does the job once every two days.

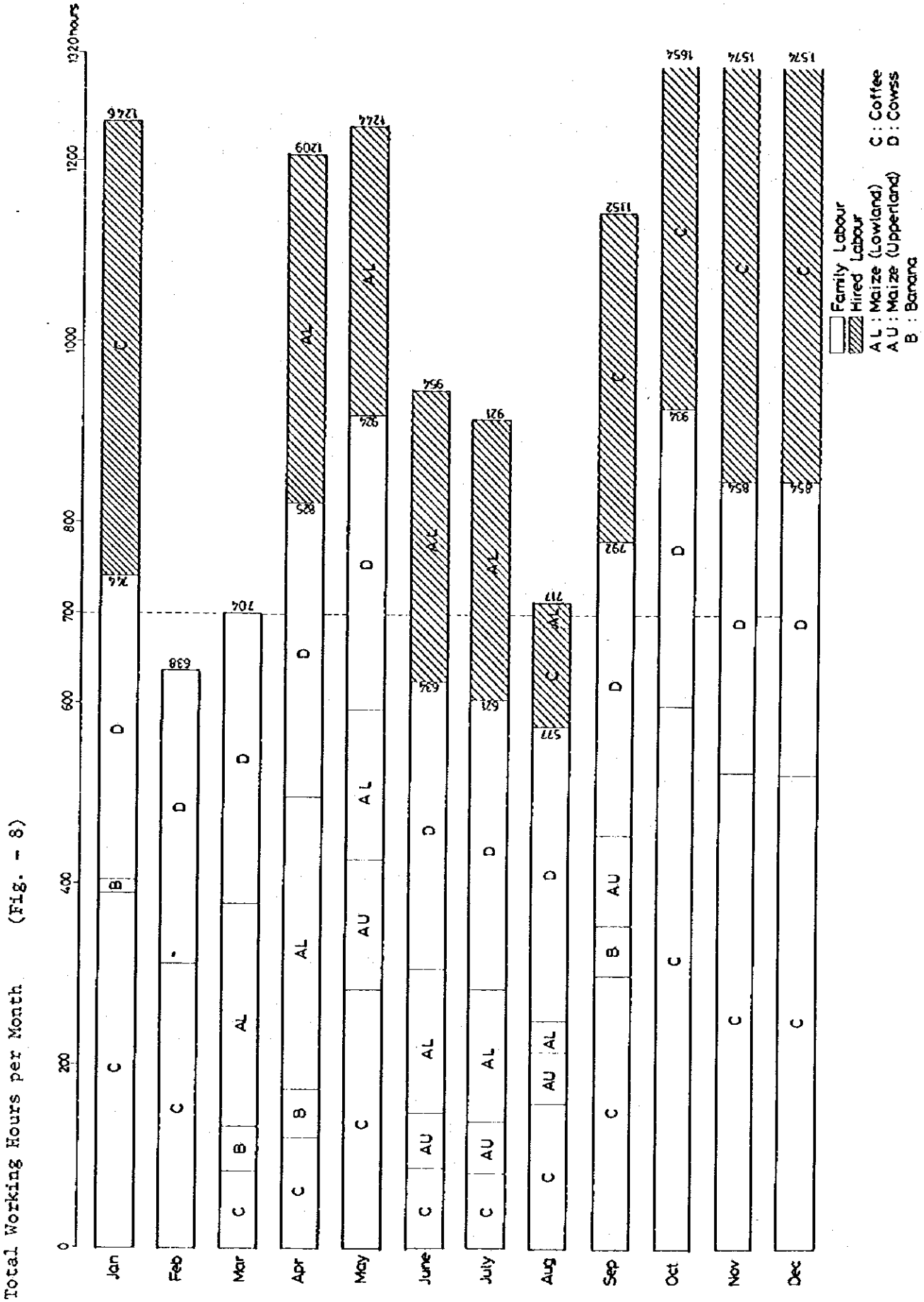
The farmer obtains roughage in a nearby forest belt at an elevation of 1,600 m. However, farmers living in lower areas get it in low-

land areas. In both cases, many hours are spent cutting and carrying grass. This is likely to be a big problem for dairy farming in the highland areas in the future.

(d) Total working hours

As stated already, coffee-banana planters plant and harvest maize, beans and other crops in lowland areas during the off-season. This labour allocation is quite reasonable. However, as can be seen from Fig.(8)-1, the working hours each month of farmer's family labor force are unreasonably long. Since his family labor force is 3.5 persons, including children, the ideal working hours per month should be 8 hours/day x 25 days/ month x 3.5 persons = 700 hours. The working hours for the seven months of January, April, May, September, October, November and December exceed 700 hours. Particularly in October, the coffee harvest time, the working hours reach 934 hours, or about 11 hours per day, assuming 25 working days per month. Adequate rest is indispensable for the health of the farming family. In this sense, it is desirable to improve the current method of farming so as to keep the total monthly working hours below 700.

In the case of the present farmer, improvement of his dairy management practices would be a good idea. The working hours spent by his family on dairy farming average 330 hours per month. However, in August when the farm work is relatively slack, the time spent on dairy farming accounts for as much as 57% of total family work hours. In October, when family working time is the longest, the dairy working time is 35% of the total. These high percentages are attributable primarily to the labor-intensive jobs of cutting and carrying grass for use as roughage. The supply of roughage is an important problem for which an adequate solution must be found as urgently as possible in order to foster the dairy industry in the region and to achieve higher efficiency in farm management.


Total Working Hours per Month (Fig. - 8)
0
200
400
600
700
800
1000
1200
1320hours
Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec
1246
764
638
704
1209
825
1244
924
954
634
921
621
717
577
1152
792
1654
924
1574
854
1574
854
C
D
B
AL
AU
Family Labour
Hired Labour
AL : Maize (Lowland)
AU : Maize (Upperland)
B : Banana
C : Coffee
D : Cowss

(iii) Farmer's Income

As in seen from Table - 19 ., the gross income of the farmer is 23,124 shillings, operating expenses 13,460 shillings (excluding the labor cost of farmer's family), and net income 9,664 shillings.

Farmer's Income (Unit: Shillings) (Table - 19)

	Gross Income (i)		Operating expenses (ii)		Net farmers Income	
Highlands (2 ha)						
Coffee	12,000					
Bananas	2,520					
Subtotal						
Amount	14,520	(63%)	7,111	(53%)	7,409	(77%)
%	100		49		51	
Lowlands (1.6 ha)						
Maize	1,350					
Beans	360					
Finger millet	324					
Subtotal						
Amount	2,034	(9%)	1,734	(13%)	300	(3%)
%	100		85		15	
Milk						
Amount	6,570	(28%)	4,615	(34%)	1,955	(20%)
%	100		70		30	
Total						
Amount	23,124	(100%)	13,460	(100%)	9,664	(100%)
%	100		58		42	

Note: (i) Income from the sale of coffee is based on the average price for the last three years, income from the sale of maize, beans and finger millet on the 1975 government prices, and income from the sale of milk on the open-air market price obtained through interview by the Japanese team.

(ii) The breakdown of operating expenses by crop is impossible because all crops are interplanted and expenditures are inseparable.

As can be noted in Table - 19 , highland crops (primarily coffee) account for as much as 77% of net income, followed by milk with 20%. The combined income from maize, beans and finger millet represents only 3%. As for the ratio of the operating expenses to gross income, it is 49% in the case of coffee and bananas, which compares very favorably with the 84% in the case of maize and beans and the 70% in the case of milk. Maize, beans, and finger millet are not profitable but nonetheless are indispensable for food self-sufficiency. How to keep operating expenses to a minimum so as to increase the farmer's net income continues to be a key point. The high expense-to-income ratio of 70% for milk can be ascribed to the high prices of livestock feed. In this sense, it is highly recommendable to reduce this ratio by producing livestock feed of good quality and adequate quantity on a self-sufficient basis.

(2) Maize-cotton Farmer (lowland area)

The present farmer has been engaging in farm work at Ruvu Mferejini on the Pangani River west of the town of Same in the Pare District some 15 years. This area, with alluvial soil, is located at an altitude of 750 m and is very flat. In it the farmland is irrigated since annual rainfall is only about 400 mm, the least in the region. There are fields in the vicinity of the farmer's house, which is convenient for his farm work. On the other hand, the area is some 30 km distant from the town of Same and is served by bus only once a day, and therefore, transportation and daily life in the area are not convenient. The farm under review ranks among the larger farm in the area. Details are outlined below and are described in greater detail in the Technical Report.

(i) Farm size

(a) Family size: Parents and 6 children
Labor force: 2.0 persons

(b) Land utilization

Field	Area (ha)	Crop planted		Remarks
1	1.6	Maize		
		0.8 ha	(Jan.-Jun.) (Jun.-Nov.)	First cropping
		0.8 ha	(Apr.-Aug.)	Second cropping
2	0.8	Cotton	(Feb.-Dec.)	
3	0.6	Bananas	(all year)	
4	0.2	Vegetables	(all year)	
Total	0.3			

Note: All farmland is irrigated.

(c) No livestock

(d) Crop rotation system

Of the total of 3.2 ha of farmland, 0.6 ha is devoted exclusively to banana growing, and 0.2 ha is used as the family's own vegetable garden. The rotation system for maize and cotton is shown below. The 2.4 ha of farmland is divided into three 0.8 ha fields for a 3-year crop rotation cycle. However, single cropping is practiced on the maize fields due to a shortage of labor.

The rotation system for maize and cotton

	1	2	3	4	5	6	7	8	9	10	11	12
1st year												
1 (0.8 ha)					Cotton							
2 (0.8 ha)						Maize						
3 (0.8 ha)	Maize						Maize					
2nd year												
1 (0.8 ha)	Maize						Maize					
2 (0.8 ha)					Cotton							
3 (0.8 ha)						Maize						
3rd year												
1 (0.8 ha)						Maize						
2 (0.8 ha)	Maize						Maize					
3 (0.8 ha)					Cotton							

(ii) Farm operation by crop

(a) Maize

Maize is raised each year by pure stand on a total of 2.4 ha of farmland. The total working hours are 2,296 hours, of which 312 hours represent hired labor, and 1,984 hours the farmer's family own labor. Table - 20 gives a breakdown of working hours per hectare by type of farm operation.

Breakdown of Working Hours per Hectare (Table - 20)

Working hours	Field 1 Hours	%	Field 1 Hours	%	Field 2 Hours	%
Cropping season	Jan. - June		June - Nov.		Apr. - Aug.	
Cultivation	420	47	630	53	200	25
Planting	160	18	160	13	160	21
Irrigation	60	7	60	5	60	8
Weeding	140	15	220	19	240	31
Harvesting	120	13	120	10	120	15
Totals	900	100	1,190	100	780	100

Since this area is at a good distance from the town, farm tractors cannot be made available on a contract basis. Like other farmers in the area, the present farmer employs human power only for plowing. In April and June plowing is done with the aid of hired labor. In each cropping season considerable time is spent on plowing. For the field where double cropping is practiced, plowing accounts for as much as 53% of the total working hours in each cropping season, including the hours required for the clearing of the field after the harvesting of the preceding crop of maize.

All farmland is irrigated by farmers in shifts. Irrigation period per field is two days. On each of these days, irrigation is carried out for about 12 hours from early morning to night. This is a job of the head of each farming household. Although the hours spent on irrigation represent a low percentage of the total farm labor hours, the 12-hour work a day is quite a hard job. Since water supply for irrigation is not sufficient, it seems to be a difficult job to conduct water to the field.

Not much time is required for weeding maize grown from January to June, but in other months it is. The average working time spent on the 2.4 ha of farmland is 960 hours per hectare, which is equivalent to about 64% of the average working time spent on maize-beans fields in lowland areas by coffee-banana farmers who commute from their homes in highland areas. It is also noteworthy that hired labor is very scarce.

(b) Cotton

Cotton, a good cash income source, is planted on 0.8 ha of land each year in a 3-year crop rotation system. The total working time for the cotton field is 2,240 hours, of which 132 hours are represented by hired labor and the remaining 2,108 hours by the farmer's own family labor. The breakdown of working time by type of farm operation is given in Table - 21 .

Breakdown of Working Hours Per Hectare (Table - 21)

	Working hours	%
Cultivation	585	21
Planting	160	6
Irrigation	150	5
Weeding	380	14
Spraying	15	0
Harvesting	970	35
Grading	450	16
Removal of sticks	90	3
Total	2,800	100

The peak working hours in cotton raising are in October and November, when harvesting is in full swing. Harvesting and grading represent 51% of the total working hours in cotton raising. Cultivation of cotton closely follows that of maize, which starts in January. Plowing of the cotton field requires 21% of the total working hours spent to grow cotton, followed by planting and irrigation.

Irrigation of the cotton field is carried out in rotation as explained in the section on maize. Although the working hours spent on irrigation in a day are long, their share in the total number of working hours is small. As in the case of maize, hired labor is employed only for cultivation of the cotton field in March, all other jobs being done by the farmer's own family.

(c) Bananas

Banana is planted on 0.6 ha of land on a single crop basis. The total working time is 404 hours, including 48 hours by hired labourers. The breakdown of working hours per hectare by type of farm operation is given in Table - 22 .

Breakdown of Working Hours Per Hectare (Table - 22)

	Working hours	%
Removal of old stems	120	18
Cultivation	80	12
Replanting	67	10
Irrigation	120	18
Weeding	286	42
Total	673	100

Banana growing is practiced primarily with the farmer's own family labor, but cultivation, which accounts for 12% of the total hours spent on this crop, is done by hired labor. The cultivation work, including spraying of herbicide, is performed usually in February. Weeding takes the most time, and irrigation also requires a considerable time. Also, removal of old stems, replanting, and irrigation take considerable time.

(d) Total Working Hours

Since in this area plowing by tractors is not very common, the present farmer also performs this job manually from January to April when cotton planting is finished. During the February-April period, some farm hands are hired to speed up the work. Although planting is carried out again in June to raise maize on a double cropping basis, the period after mid-April is devoted mainly to management and harvesting of the cotton crop. As seen in Fig. - 9 , the farming family is free from farm work from early December, when cotton shipments are completed, to January. However, the farmer's own family labor is fully employed during the February-November period.

Since the available labor force of the present farm is 2 persons, their ideal working time is 8 hours/day x 25 days/month x 2 persons = 400 hours/month.

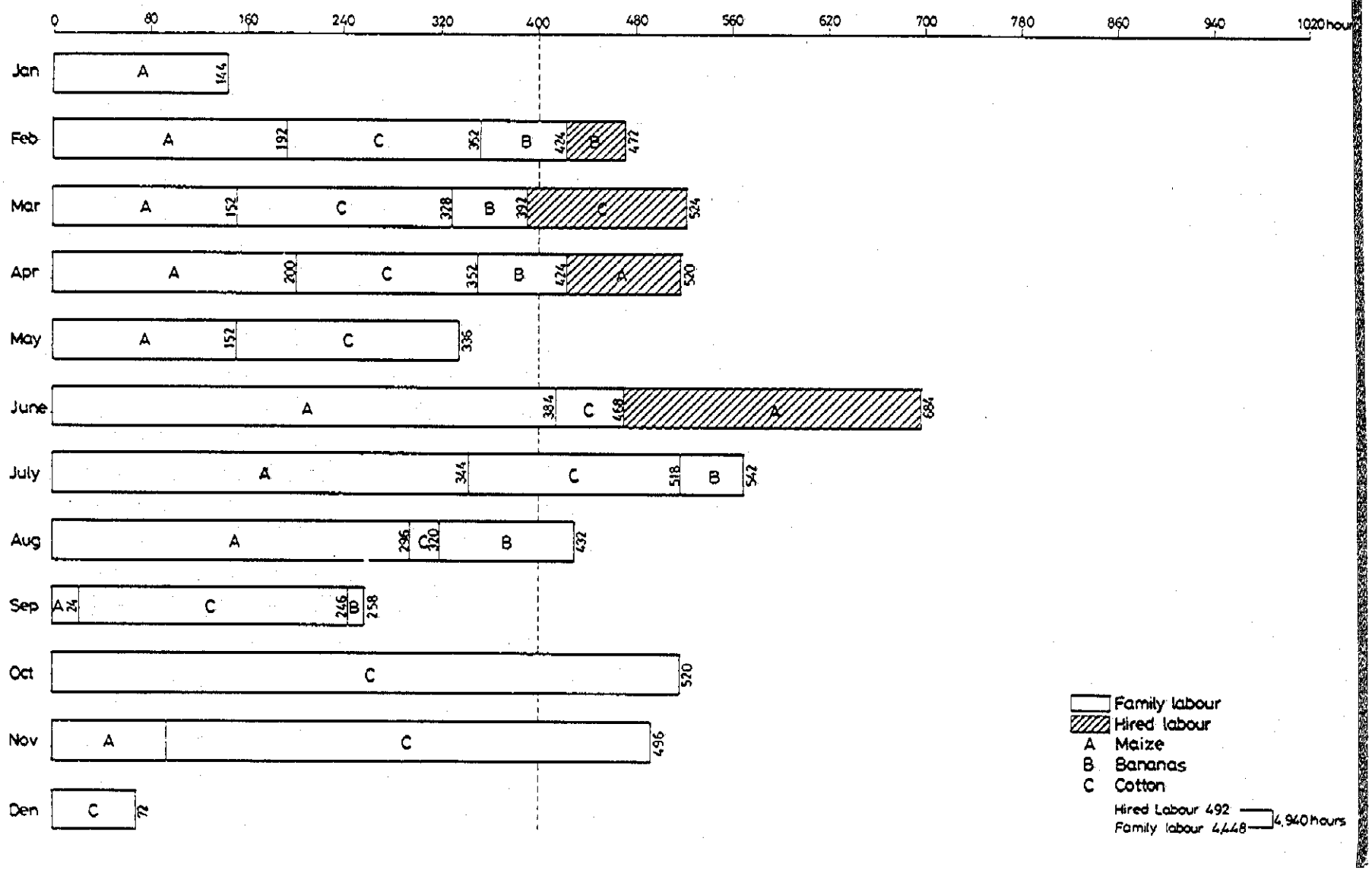
As noted in Fig. - 17 , the working hours are below 400 hours per month only in the five months of January, March, May, September and December and exceed the target in the remaining seven months. However, the excesses are not great except in July, October and November. The distribution of labor can therefore be said to be reasonable.

Physically hard work must be performed over the February-April period, when the maize and cotton fields are plowed and seeded. If large tractors can be used for plowing, the physical work involved can be greatly reduced. Of the 1.6 ha of land which can be planted to maize with the highest yield, which is grown over the January-June period, only 0.8 ha is utilized. If a tractor can be used for plowing and seeding can be done early in the morning on the entire area of 1.6 ha., the production of maize can be expected to rise, and the farmer's net income will be improved. It is highly desirable to introduce tractors in this area in order to achieve higher efficiency in farming and facilitate the raising of appropriate crops in the best seasons.

(iii) Farmer's Income

Table - 23 gives the income and expenditures of the farm. The gross income, operating expenses (not including the family labor cost) and net income are 5,765 shillings, 769 shillings, and 4,996 shillings, respectively.

Total Working per Month (Fig. - 9)



Farmer's Income (unit: shillings) (Table - 23)

	Maize		Cotton		Bananas		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
Gross income	2,565 (44%)	100	2,400 (42%)	100	800 (14%)	100	5,765 (100%)	100
Operating expenses	428 (56%)	17	221 (29%)	9	120 (15%)	15	769 (100%)	13
Net farmer's income	2,137 (43%)		2,179 (44%)	91	680 (13%)	85	4,996 (100%)	87

Note: Income is based on the 1975 government prices for the different crops.

As can be seen in the table, the income structure of the maize-cotton farmer is very different from that of the coffee-banana farmer. In the case of the coffee-banana farmer, gross income is not large, but operating expenses, too, are very small. In order to operate his farm on a limited income, the farmer uses his own family labor to the full and makes great efforts to curtail expenditures. The ratio of operating expenses to gross income is 17% for maize and 9% for cotton. The net income of 4,996 shillings is much lower than that of the coffee-banana farmer, and its ratio to the gross income is 87%, which is high in comparison with the 42% for the coffee-banana farmer. The cost of hired labor accounts for over 60% of total expenses and is the biggest cost item for the maize-cotton farmer.

In lowland areas, which are less favoured in terms of natural and social conditions than the highland areas, where coffee-banana farmers live, it is highly desirable to provide an adequate supply of water for irrigation and to introduce more profitable cash-earning crops. As the first step, high-yielding January/June maize should be planted on all cultivable fields. For this purpose, large tractors must be made available, as pointed out previously. At the same time, a reasonable crop rotation system involving the utilization of large tractors should be introduced so as to improve farmers' income.

1.9 Marketing

(1) Marketing Pattern

(i) Marketing through official routes

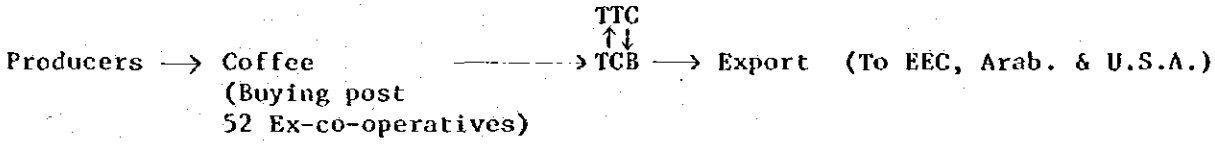
Coffee and other major crops of the region, except sisal and sugar, are collected at local co-operatives and divided into export and domestic use by authorities. There are 65 co-operatives in the region, of which 52 handle coffee, maize and rice and 13 only cotton. On the average there is one co-operatives for every five villages. Table - 24 shows the distribution of co-operative

Distribution of Co-operatives (Table - 24)

District	Co-operatives handling coffee, maize, etc.	Co-operatives handling only cotton	Total	Number of villages	Number of villages per co-operatives
Hai	13	3	16	42	2.6
Moshi	22	5	27	135	5.0
Rombo	8	0	8	37	4.6
Pare	9	4	14	84	6.0
Totals	52	13	65	298	4.6

Fifty-two co-operatives were established as the sub-system of KNCU (Kilimanjaro Native Cooperatives Union). However, since the abolishment of KNCU in 1976, they have been operating under the control of CUT (Co-operatives Union of Tanzania Nation). The government policy is to set up one co-operatives in every village and to prohibit shipment of crops to other co-operatives to ensure more accurate crop collection. However, the implementation of this policy is not showing so much progress as expected, and consequently, the existing 52 co-operatives carry out collection of coffee and other crops as a sub-system of CUT.

The distribution channels of the major crops are described below. Coffee, the major crop, accounting for about 40% of regional crop production, is made into dry coffee (parchment) after drying and preparing and brought to the co-operatives to which farms belong by human power (mostly carried on the head). Coffee thus collected is exported through TCB (Tanzaniya Coffee Board, which is in charge of marketing and administration) after being weighed, cured, bagged and marked by TCC (Tanganyika Coffee Curing Company, which is a subdisiary of TCB). The shipment channel of coffee is as follows:



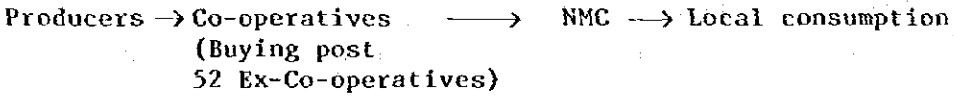
Maize and beans, the major crops in lowland areas, are collected at 52 co-operatives and are sold for local consumption through NMC (National Milling Corporation).

Cotton is brought to the 13 co-operatives that handle only cotton and collected by NMC acting for TCA (Tanzania Cotton Authority), through which cotton is sold for domestic consumption or exported to EEC countries.

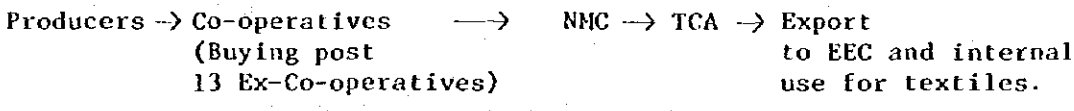
Castors, cardamons and sunflowers are collected at 52 co-operatives. Castors and cardamons are exported to EEC and other countries through GAPEX (General Agricultural Product Export Corporation), while sunflowers are used for domestic consumption. Sunflowers used to be exported, but with the growing domestic demand for cooking oil they are now used only for domestic consumption.

These shipment channels can be shown as follows:

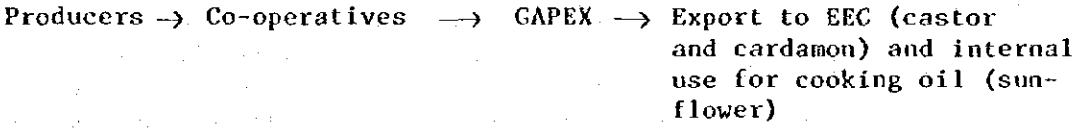
Maize, beans, rice & finger millet



Cotton

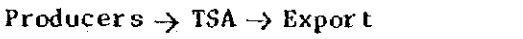


Castor, sunflower and cardamon



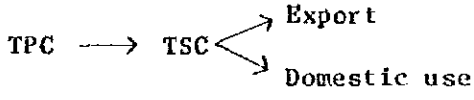
The shipment channels of sisal and sugar, which are produced by large farms, as follows:

Sisal



- Private farms
- TSC (Tanzania Sisal Corporation)

Sugar



Sisal is produced at three locations by private farms and at seven locations of TSC. TSA (Tanzania Sisal Aurhority) collects, processes and expors sisal abroad from the port of Tanga. However, due to decline in overseas demand, sisal production has been on the decrease for the past several years.

Sugar is produced on a large scale by TPC and is sold for export and domestic use by TSC (Tanzania Sugar Corporation).

Pyrethrum is produced by smallholders and exported by TEC (Tanzania Export Company), although its production has greatly decreased in recent years.

(ii) Marketing other than through official routes

Besides the above-mentioned crops, vegetables and fruits are sold at open-air markets. These open-air markets are set up in each district as shown in Table - 25. There, in addition to the above two items, cereals and milk not sold through official routes, clothing and other daily necessities are sold.

Number of Open-air Markets (Table - 25)

	Number of markets	Remarks
Hai	8	
Moshi	18	Including two markets in Moshi Town
Rombo	6	
Pare	7	
Total	39	

These open-air markets are held regularly once or twice a week and on open spaces adjacent to main roads. On market days crops raised in each farm are carried to these markets, mostly by housewives on their heads. The crops carried are of a fairly great variety, but since they are carried on the head, their volume is limited. The markets are usually closed before noon. Each farmer is a buyer and also a seller in the market. In some cases, certain crops such as bananas are purchased and carried to the places of consumption by dealers, though in small quantities. Maize that is not handled through official routes is sold at about double the government price. The exact volume of the agricultural produce marketed at these open-air market is not known. About 70% of the vegetables and 20% of the bananas produced are estimated to be sold there, however.

There are two permanent public markets handling vegetables, fruit and meat in Moshi Town, which has a population of 50,000, and one of them is a large market.

(2) Sales Volume and Value of Each Crop at Official Market Prices

Table - 26 shows sales volume, sales value and ratio of sales volume to the total production of each crop officially sold by producers through the proper authorities in 1975.

Production, Sales Value and Sales Volume of Officially Marketed Main Crops, 1975 (calendar year) (Table - 26)

Crops	Total production (tons)	Sales volume (tons)	Sales volume / Total production (%)	Sales value (shs.)	%	Remarks
Coffee	31,751	31,437	99	143,488,042	76	
Sisal	4,467	4,467	100	9,968,691	5	
Seed beans	800	800	100	1,680,000	1	
Pyrethrum	47	47	100	200,100	0	
Cardamon	33	19	60	356,582	0	
Castor	69	69	100	50,360	0	
Cotton lint	1,375	1,375	100	1,164,367	0	
Sugar	49,103	49,103	100	22,734,689	12	
Maize	28,000	4,027	14	3,221,904	2	
Wheat	6,200	6,000	97	6,000,000	4	
Paddy	4,200	178	4	178,000	0	
Finger millet	1,800	200	11	-	0	Sales value is negligible.
Jaggery	600	600	100	-	0	Sales value is negligible.
Sunflower	78	78	100	62,240	-	
Total	-	-	-	189,104,975	100	

According to Table - 26 , 100%, or nearly 100%, of coffee and other crops are marketed through official routes, while staple foods such as maize, finger millet and paddy are marketed through official routes in very small quantities. The sales volumes of these crops have been decreasing for the past several years due partly to the fact that farmers store these crops for their own consumption. The ratio of sales volume of paddy to total production is only 4%. This is due to the growing popularity of rice, which has resulted in a supply shortage and to the low government purchase price, as mentioned before. Paddy production should be encouraged in areas where water is available, and the government purchase price should be fixed at a level more advantageous to farmers. Finger millet is consumed in large quantities as a raw material for the local production of "mbege" owing to the high prices on the black market. However, since its use is limited, the sales volume through official routes is expected to be small in the future.

The sales value of coffee is overwhelming, accounting for 76% of all sales. This is followed by sugar, sisal, and wheat, in that order. Table - 27 shows their sales values by district.

Moshi is the district with the largest sales value--90,348,658 shillings, or 48% of the total sales of the region. Next come Hai and Rombo. The Pare District has the lowest sales value--12,580,000 shillings, or only 6% of the total.

Coffee is the predominant crop in the three districts other than Pare, but other crops vary from district to district. In Hai the sales value of coffee is 38,269,140 shillings, or 79% of the total, followed by wheat, whose sales account for 12% of the total, seed beans and maize. Cotton is also marketed, but in very small quantities. In Moshi the sales value of coffee is 63,085,890 shillings, or 70% of the total. This is the highest sales value throughout the region, but the percentage is lower than those in Rombo and Hai. This is due to the growing sales of sugar produced by TPC in the Moshi District, which account for 25% of the total. In Rombo there is no crop of special mention except coffee, although maize is marketed in small quantities as a staple food. Although Pare accounts for 62% of the land area of the entire region, unlike the other three districts, its climate is unfavourable and agricultural production is low. Its sales value is extremely small, the total being only 12,580,003 shillings. Sisal has the largest sales value--7,077,771 shillings, or 57% of the total. Next comes coffee with 4,671,720 shillings, or 37% of the total. Cardamons, cotton, and paddy follow, all in small quantities. Pare is the only district where paddy is sold through official routes.

At present there is little need for warehouses to store staple food grains such as maize and paddy, since they are marketed only in small volumes through official routes. However, these crops are expected to grow in production so that food self-sufficiency can be attained. To ensure smooth supply to consumers, storehouses will be needed by NMC, and other organizations. Warehouses for agricultural chemicals and fertilizers will also be necessary.

Sales Value of Crops Sold on Official Market, 1975 (calendar year)
(Table - 27)

District	Co-operatives	Crops	Sales volume (tons)	Sales value (shs.)	(%)	Ratio of district sales value to total sales (%)
Hai	13	Coffee	7,826.0	38,269,140	79	
	(8)	Maize	2,012.8	1,610,240	3	
	(1)	Prethrum	43.6	185,300	0	
	(7)	Castor	30.8	24,600	1	
	3	Cotton	176.9	315,397	1	
	-	Wheat	6,000.0	6,000,000	12	
	-	Sisal	260.0	598,121	1	
	-	Seed beans	800.0	1,680,000	3	
Subtotal	-	-	-	48,682,798	100	26
Moshi	22	Coffee	12,901.0	63,085,890	70	
	(16)	Maize	1,992.8	1,594,240	2	
	(9)	Sunflower	77.8	62,240	0	
	(5)	Castor	10.1	8,800	0	
	5	Cotton	320.0	570,000	1	
	-	Sugar	49,103.0	22,734,689	25	
	-	Sisal	1,017.0	2,292,799	2	
Subtotal	-	-	-	90,348,658	100	48
Rombo	8	Coffee	7,646.0	37,461,292	100	
	n.a.	Maize	21.7	17,424	0	
	n.a.	Prethrum	3.7	14,800	0	
Subtotal	-	-	-	37,493,516	100	20
Pare	9	Coffee	1,155.3	4,671,720	37	
	(9)	Cardamon	19.0	356,582	3	
	(4)	Paddy	178.0	178.0	1	
	(4)	Castor	21.2	16,960	0	
	5		419.4	278,970	2	
	-	Sisal	3,190.0	7,077,771	57	
Subtotal	-	-	-	12,580,003	100	6
Total	-	-	-	189,104,975	-	100

Note: (i) The figures in parentheses in the column "Co-operatives" are included in the number of coffee co-operatives.

(ii) Figures for coffee indicate solely sales by smallholders.

Producers' Crops Prices (shs./kg.) (Table - 28)

Product	Price			1975/76 / 1973/74	1975/76 / 1974/75	Remarks
	1973/74	1974/75	1975/76			
Coffee	4/60	4/80	9/-	1.96	1.88	Smallholders
Coffee	5/90	6/50	11/-	1.86	1.69	Estates
Maize	-/35	-/50	-/75	2.14	1.50	
Wheat	-/80	-/80	1/-	1.25	1.25	
Cotton	1/50	1/75	2/-	1.33	1.14	
Pyrethrum	3/30	4/20	4/50	1.36	1.07	
Sisal	2/20	2/80	2/30	1.04	0.82	
Sugar	1/02	1/35	1/80	1.76	1.33	
Paddy rice	-/61	-/72	-/80	1.31	1.11	
Finger millet	-/3-	-/70	-/80	2.67	1.14	
Seed beans	1/70	1/80	2/20	1.29	1.22	
Sunflower	-/4-	-/70	-/75	1.87	1.07	
Castor	-/60	-/75	-/80	1.33	1.07	

1.10 Agricultural Service Facilities

(1) Agricultural Services

In the region five agricultural service facilities have been established, of which three are state-controlled and two are privately run, as shown in Table - 29 .

There are seven ARTI (Agriculture Research & Training Institute) throughout the country, Lyamungu in the region being one of them. It has 17 sections, each conducting research in its specialized field. Since this institute originally was established for coffee cultivation research and experimentation, its main activities still centers on coffee research, and more than half of its 100 staff members are engaged in it. It also has facilities for the training of 30 coffee extension officers at a time. Lyamungu also has been conducting research on wheat for the past several years with the help of Canadian specialists and operates test farms in the Hai District and Arusha Region. It has three sub-stations within its jurisdiction. One of them is located at Miwaleni in the Moshi District and carries out research and testing of crop cultivation techniques.

Two Folk Development Colleges in the Moshi and Pare Districts have been established for the training of rural villages leadership. Short courses lasting 2-3 months are offered to anyone over 19 years of age. Training in practical operations (field training) in all phases of agriculture accounts for most of the training time. Courses in accounting, farm management, and political science are also offered.

The YMCA Farm Training School has been set up to train village leaders. It is a two-year school, which anyone who has completed the seven-year primary school education is qualified to enter. Emphasis is placed on acquisition of basic agricultural knowledge. The tuition fee of 1,100 shs. a year is supplemented by subsidies from the YMCA and proceeds from the sale of farm products.

Kilacha Center is a privately run institution where training courses is scheduled to start in 1977. At present the center is used for test cultivation of crops, breeding of dairy cattle and goats, as a hatchery, and for the promotion of small-scale industries, such as sisal carpet making. It is equipped with a hatchery for broilers and is expected to raise 1,000,000 chickens a year. At present the level of production of chickens is only 25% of that target.

(2) Agricultural Technical Staff in the Region

Table - 30 shows the present agricultural technical staff.

The assignment of technical staff is as follows:

R.A.D.O. (Regional Agricultural Development Officer)

The highest responsible post of the agricultural sector in the regional administration, dealing with all matters relating to agriculture and acting as a coordinator for the Ministry of Agriculture.

D.A.D.O. (District Agricultural Development Officer)

The highest responsible officer of the agricultural sector in the district who deals with all matters related to agriculture and acts as a coordinator for R.A.D.O.

A.O. (Agricultural Officer)

Officer in charge of special crop projects in the region, such as National Maize Program and C.B.D. Program.

A.F.O. (Agricultural Field Officer)

Officer in charge of land utilization program and assisting in the works of R.A.D.O. and D.A.D.O.

A.F.A. (Agricultural Field Assistant)

Person in charge of all matters related to agriculture in the division and acting as a coordinator to other departments.

A.F. Aux. (Agricultural Field Auxiliary)

Person assigned to a number of villages to act as a coordinator for the ward.

As can be seen in Table - 30 , the existing number of technical staff members is 244, or 20% (or 62 persons) short of the established requirements. There is a particularly acute shortage of A.F.A. and A.F. Aux. in charge of divisions and villages, accounting for 59 of the total vacancies. Due to lack of local transportation (land rovers and motorcycles), each field staff member has to cover several villages on foot in the performance of guidance work, which is a great obstacle to agriculture extension services.

Agricultural Service Facilities (Table - 29)

Name of Facilities	Supervised by	Place of Facilities	Number of Staff	Area (ha)	Items		Number of Students
ARTI (Agriculture Research & Training Institute)	Ministry of Agriculture	Lyamungu, Hai District	103	260	Divided into 17 sections		30
Lyamungu							
Folk Development	Ministry of National						
(1) Msinga	Education	Kibosho, Moshi District	23, two of which are teachers	20	coffee - banana	1.6 ha	35
					banana (pure stand)	1.0	
					maize	2.0	
					orchard	0.4	
					vegetables	0.2	
(2) Same		Same, Pare District	21, six of which are teachers	120	goats grazing	40.0 ha	100
					finger-millet	4.0	
					maize	2.0	
					lucerne	2.0	
					vegetables	1.0	
Y.M.C.A. Form Training school	Y.M.C.A.	Morangu, Moshi District	19 (permenent)	53	maize	40.0 ha	120
					cotton	4.0	
					coffee - banana	4.0	
					vegetables	2.0	
Kilacha Center	Private	Himo, Moshi District	5 (permanent)		currently used for agriculture	25.0 ha	No student enrollment as yet.
					dairy cows	20	
					goats	40	

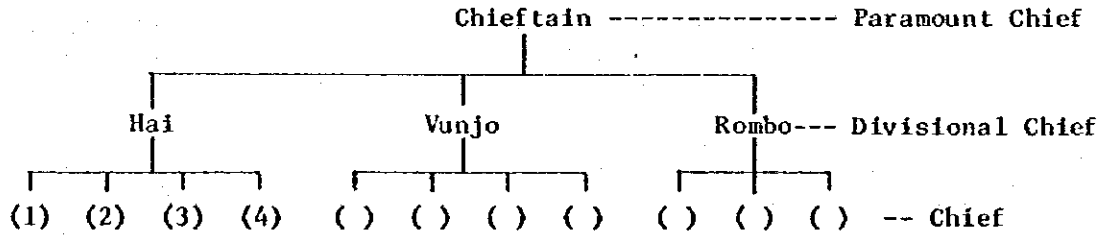
Approved and Actual Numbers of Agricultural Officers and Vacanies by Category (1976/77) (Table - 30)

	Approved Establishment	Strength	Strength by District					Vacancies
			Region	Hai	Moshi	Rombo	Pare	
1. R.A.D.O.	1	1	1	-	-	-	-	-
2. A.O. I/II/III	2	1	-	-	1	-	-	1
3. D.A.D.O.	4	4	-	1	1	1	1	1
4. A.O. Crop Specialist	1	-	-	-	-	-	-	1
5. A.F.O. I	3	2	2	-	-	-	-	1
6. A.F.O. II	2	2	1	-	-	-	1	-
7. A.F.O. III	6	6	1	1	2	1	1	-
8. A.F.A. I	25	8	1	1	2	2	2	17
9. A.F.A. II	15	14	2	4	3	1	4	1
10. A.F.A. III	75	57	2	15	12	15	13	18
11. A.F. Aux. I	50	49	1	15	21	10	2	1
12. A.F. Aux. II	120	98	-	32	36	14	16	22
13. A.F.A. Publ.	1	1	1	-	-	-	-	1
14. Personal Secretary	1	1	1	-	-	-	-	-
Total	306	244	13	69	78	44	40	62

1.11 Land Systems

As mentioned before, 80% of the region's population lives in the banana belt at altitudes of 900 to 1,800 m on the east and south slopes of Mt. Kilimanjaro. Coffee/banana plantations called kihamba have survived for generations according to the customs of the Chagga tribe. In the old days, when the population was much smaller, people could live on kihamba alone. However, with the shortage of kihamba due to population increase, drought-resistant crops such as maize came to be cultivated in lowland areas, with farmers commuting in season to such fields from their homes on kihamba land. The lowland fields are known as shamba. Thus, the agriculture of this region has depended on two different types of land. These two types of crop cultivation are explained below.

Kihamba is a coffee/banana plantation with farmer's residence in the center and enclosed with masare (botanical name: Dracene Afromontana Mildbr Delemeneis). In a broader sense it also means the traditional land distribution system. Before independence in 1961, kihamba was organized as shown in the chart below. In 19 chiefdoms which make up the Chagga tribe, each chieftain distributed land to his people by strict adherence to traditional custom. In the old days, when the population was smaller, the land was equally divided among the children, with the youngest male child succeeding his father except under special circumstances.



With the nation's independence in December 1961, the land was nationalized and the chiefdoms were abolished. Further, the kihamba system was abolished by political decisions in January 1975, and land readjustment was carried out by the ward secretary. However, the kihamba is still regarded as private property, and inheritance as well as transfer of the land is allowed in accordance with decisions reached at clan meetings. Due to a scarcity of land, however, transfer of the land outside the clan is virtually forbidden by the clan.

Shamba (which means "field" in Swahili), as distinct from kihamba, refers to farmland in lowland areas cultivated by farmers commuting from the highland coffee and banana belt. Like kihamba, it is regarded as private property, and inheritance or transfer of the land is allowed according to clan decisions. Shamba owned by the Chagga tribe extends to the highway connecting Arusha and Mombasa and is located some dozen kilometers away from the place of habitation. The main crops raised are maize, beans and finger millet, and maize is interplanted with beans. One farm usually cultivates 1.0-2.0 ha of land, but some own 4.0-5.0 ha. The shamba that has a house and is fenced by masare is called kihamba, regardless of the kind of crops raised. This type of shamba is limited to areas irrigated by springs or by intake from rivers.

In the mountain areas of Pare, a land system similar to the kihamba and shamba of the Chagga tribe is practiced among the Pare tribe cultivating coffee and bananas. As mentioned before, the population increase in the Chagga land has made even the distribution of kihamba to children nearly impossible. On the other hand, land is relatively abundant in the Pare land. The kihamba in Pare has "reserved land" set aside for future use which is either uncultivated or used for temporary cultivation. In Pare, as in the case of the Chagga tribe, the other children get married and start cultivation of the reserved land of their parents as coffee/banana plantations, such land is given to them, and new kihambas are created. Kihamba land is thus handed down within a family and, as in the case of the Chagga, there is virtually no selling of Kihamba.

Shamba in lowland areas are planted mainly to maize, beans, and cotton. Since Pare mountain areas are generally steeply sloped and have poor road conditions, many farmers face difficulty in travelling from kihamba to shamba. Both land inheritance and transfer to others are carried out with relative ease if approval is given by the clan.

As for land other than that owned by the Chagga or Pare tribes, it can be developed and cultivated by obtaining village approval and making application to the ward secretary (Land Advisory Committee).

1.12 Livestock Farming

(1) The Position of Stock Farming in Agriculture

As already explained, the major characteristic features of the Kilimanjaro Region are that it has a dense agrarian population, that the farm household is small, and that there is very little leeway for development of new farmland in highland areas. It is also characteristic of this region that the districts differ in type of agriculture according to the climatic conditions peculiar to each.

Coffee, bananas, corn, sugar, sisal, and wheat are the major crops cultivated in the region. According to the 1967 Census, 42% of the total agricultural production of the region was crop production, and only 0.4% production of stock farming. Notwithstanding, stock farming in the region is playing an increasingly important role as the major source of animal protein, demand for which is increasing along with population increase. Another important aspect of stock farming in the region that should not be overlooked is development of flat land, which are now undertaken as a means of alleviating the problem of land shortage in highland areas and relocating population from there. Indeed, it is quite difficult to introduce crops in such flat areas, which are predominantly savannah, characterized by extreme dryness and high temperatures.

That the government is making it a national policy to increase the production of livestock products to secure animal protein essential for improving the nutritive conditions of the population attests to the importance of stock farming in this region.

The region is endowed with abundant natural resources suitable for stock farming. So long as the water resources of the region are properly exploited and its natural pasture is expanded and put to better use, stock farming has a very bright future in this region.

(2) The Present State of Livestock Breeding

Districts with different climates--especially with regard to rainfall, temperature, and landscape, which are closely related to the difference in altitude--very understandably differ from each other in terms of the varieties of domestic animals raised and also in terms of the methods employed in the breeding of these animals. Generally speaking, however, the scale of stock farming is rather small, mostly carried out as a side business of a farm household.

Domestic animals currently raised in the region are: cattle, goat, sheep, swine and chickens. Of course, cattle and goats are central to stock farming in the region; these animals are raised in greater numbers and considered more important than the other animals.

The following table gives the number of domestic animals raised in each district of the region in 1975.

(Table - 31)

	Hai	Moshi	Rombo	Pare	Totals
Cattle	132,000	301,000	130,000	188,823	751,823
Goat	9,000	65,000	22,000	96,810	192,810
Sheep	28,500	20,000	10,500	40,211	99,211
Swine	4,000	4,185	4,000	115	12,300

The indices for 1975 when the figures for 1966 are given indices of 100 are 141.8 for cattle, 160.6 for goats and 125.5 for sheep.

The average number of domestic animals raised per farm household in the region is 4.7 cows or oxen, 1.2 goats and 0.62 sheep. What is characteristic about stock breeding in the region is that farm households seldom specialize in the breeding of one specific animal, but instead simultaneously breed a small number each of cows or oxen, goats, sheeps and chickens.

In view of the fact that cattle and goats are on the increase in lowland areas and swine in the Pare and Rombo Districts, the future of the development of stock breeding in lowland areas is very promising.

(i) Control of Breeding

The method of breeding control employed in highland areas (1,000 meters or more above sea level with an average annual rainfall of 1,000 mm or more) is different from that employed in lowland areas (1,100 meters or less above sea level with an average annual rainfall of 1,000 mm or less, sometimes as little as 300 to 500 mm as in the plains to the west of the Pare mountain range extending up to the Pangani River) in the sense that in the former dairy farming is popular and dairy cattle are raised in byres, while in the latter beef cattle are raised mainly by pasturing.

(a) Highland areas

The highland areas consist of the southern (Hai and Moshi Districts) and eastern slopes (Rombo District) of Mt. Kilimanjaro and of the higher areas of the Pare mountains.

The areas are densely populated and intensively cultivated. The land is cultivated so intensively that there is scarcely any room left for stock farming. Indeed, because of the land shortage, most of the farm households here have some plots of land in lowland areas.

The type of stock breeding commonly practiced is raising of dairy cattle in byres. The majority of the dairy cattle raised here are of the indigenous Zebu breeds, with some mixed breeds between these and foreign breeds and some foreign breeds, although in smaller numbers. The major foreign breeds include Jersey,

Frisian and Sahiwal, and among the cattle of foreign breeds, those that are nearly unmixed are mostly raised 1,300 meters or more above sea level.

In addition to cattle, farmers in highland areas raise several smaller domestic animals such as goats, sheep, and swine. They often raise fowl for family use. Goats and fowl are especially important since they can be readily converted into money at a nearby marketplace.

As for the methods of breeding employed, pasturing is practiced on natural grasslands adjacent to forest reserves farther up raised either in byres, pens, or the like, or outside fastened by rope. Feed usually takes the form of admixture of maize husks, banana stems and leaves, and wild plants. In many cases wild plants are carried all the way from lowland areas at the expense of a great deal of time and effort. Farm households which raise foreign breeds grow some pasture on small plots of land around their houses and along roads. The varieties of grasses that are commonly grown include Guatemala grass, Guinea grass, Napier grass, Setaria grass and Rhodes grass. Some farm households use these grasses together with maize cut while green, and others use concentrated feed. Although, generally speaking, areas located on the breast of a mountain are most suitable for livestock raising as far as the climate is concerned, the shortage of land available and the absolute shortage of roughage are standing in the way of efforts to increase the number of animals.

The techniques of raising dairy cattle are being improved along with progress in the campaign for wider application of new-agricultural techniques.

(b) Lowland areas

Lowland areas are dry, flat areas located below 1,100 meters and having annual rainfall of 1,000 mm or less and sometimes as little as 300 to 500 mm, as in the Pare District. The population density is low, and the majority of farmers are engaged in both crop cultivation and stock farming on a small scale. In the southern and northern parts of such areas, where there are many estate farms, a small number of Masai people are leading a quasi-nomadic life. Some of them cultivate small plots of land, while others, who are landless, raise beef cattle, goals and sheep.

Most of the farmers in the area keep several heads of cattle, and some of them as many as 40 or 50. Improved breeds are seldom seen in this area. As for smaller animals, indigenous breeds of goats and sheep are most commonly raised here, mainly for the sake of obtaining meat and skins. These are the domestic animals best suited to the area.

Domestic animals here are raised by way of pasturing, sometimes in crop fields after harvesting and sometimes in natural pasture or bushes. Facilities such as byres or pens are not found in the area, simple fences five keeping animals during the night being the only facilities worth mentioning. The type of natural pasturing

that depends solely on wild grasses as practiced in the area is far from ideal, for, while animals can be fed well during the rainy season when grasses are abundant, they are extremely underfed during the dry season when grasses deteriorate both qualitatively and quantitatively. During the dry season, the cattle raised by the Masai tribes are literally in a state of starvation. Two serious problems that call for proper solution in the future are shortage of roughage during the dry season and the Masai people's unwillingness to sell their cattle.

(ii) Livestock Sanitation

One of the major factors preventing an appreciable increase in the number of domestic animals is low livestock sanitation standards. The government has been trying to prevent the outbreak and spread of infectious animal diseases through vaccination, application of parasiticides, and guidance. Given an absolute shortage of veterinary surgeons and technical experts well versed in stock farming, a lack of mobility of these human resources, and a shortage of medical supplies for sanitation, these government efforts are not proving very effective. The generally low level of knowledge and understanding about the problem on the part of farmers also results in a considerable loss of livestock resources.

Major diseases that seriously affect livestock production include the following (those bearing asterisks are especially important):

* Anthrax
* Foot and mouth disease
* Black leg
* Pasteurellosis
* Contagious pleuropneumonia of cattle
* Bovine trichomoniasis
* Trypanosomiasis
* Piroplasmosis of cattle
* New Castle disease
* East coast fever
* Tuberculosis
* Rinde pest

(iii) Feed Crops

It is safe to say that feed crops are seldom cultivated by ordinary farm households. Instead, they are cultivated on a pilot farm run by the government and on farms run by public agencies or corporations. Farm households raising dairy cattle are more interested in pasturing. Feed grasses that are often found in the neighborhoods of farm houses include the following:

Guatemala grass (Tripsacum laxum)

Rhode grass (Chloris gayana)

Napier grass (Elephant) (Pennisetum purpureum)

Guinea grass (Panicum maximum)

Setaria spendia

(iv) Beekeeping

Although beekeeping is under the jurisdiction of the Wildlife Division of the Ministry of Natural Resources and Tourism, it is considered together with livestock farming in this report.

Bees are kept more in the Pare, Moshi and Rombo districts than in the Hai District. Though it is difficult to grasp the exact number of beekeepers and beehives, they are estimated as follows:

(Table - 32)

	Hai	Moshi	Rombo	Pare	Total
1974					
No. of bee-keepers	-	624	281	14,085	14,990
No. of modern beehives	-	40	21	62	123
No. of local beehives	-	3,600	700	226,550	230,910
1975					
No. of modern beehives	14	52	79	62	207
No. of local beehives	n.a.	2,683	580	98,454	101,617

Most of the honey and wax produced are domestically consumed either as a subsitute for sugar or as a brewing material or sold on the local market. The amounts thus consumed or sold, however, are not clear. The rest is collected at 1 to 3 collection centers in each district and then shipped to Handeni Plant (H.H.P.) in the Tanga Region. Approximately 18,000 kg of the product is sold in this way at a total price of 90,000 shillings. Since the price paid by H.H.P. to beekeepers is 4 to 5 shillings per kilogram as compared to the local price of between 8 and 10 shillings per kilogram, beekeepers are reluctant to ship their product to H.H.P. The honey thus collected is then refined at H.H.P. together with that collected from Arusha, Morogoro, and other adjacent regions, and the refined honey is sold within the country by N.M.C. or exported abroad by GAPEX. The same can be said of wax. Problems confronting beekeeping in this region are: (1) plants which produce nector are getting scarce as crop cultivation advances; (2) repeated droughts in recent years have reduced the amount of nector; (3) there is a shortage of officers for technical extension programs and vehicles and equipment for use by such officers; (4) there is a lack of interest in beekeeping on the part of young people; (5) honey is stolen by human beings and animals; and (6) insecticides and other agricultural chemicals are having harmful effects on beekeeping.

The following are vital prerequisites to the promotion of beekeeping in this region: (1) reinforcement of extension services, that is to say, increasing the number of extension service officers and the number of demonstration centers and (2) increasing the number of good colonies by building beekeeping centers, preferably in collaboration with neighboring regions.

(3) Government Facilities Relating to Stock Farming

In this region there are three government facilities for experimentation and research relating to stock farming: the Livestock Research and Training Center, the Marong Pig Unit, and the Agriculture Research and Training Institute.

Livestock Research and Training Center

The center is located in West Kilimanjaro on an extensive area of 1,532 ha. It is the only stock farming experimentation and research institution in the region which is engaged in breed selection of cattle, goats and sheep for milking as well as for meat production and in experimentation with pasturing grasses. The foreign breeds used in breed selection are as follows:

Cattle	Dairy cattle	Friesian, Sahiwal, Broun-Swiss, Jersey and S. Devon (a mix of Devon and Jersey)
	Beef cattle	Angus, Sharalais, Limosusin, Heretord, Bron, and T.S.Z. (a mix of Tanzania-Shorthorn and Zebu)
Goats		Toggen-Burg Saanen, Kamorine, Galla anglo-nobian
Sheep		B.H.P. (black head perisan)

Approximately 30 different grass varieties are being studied in order to improve pasturage. However, the shortage of experts is a very serious problem. Also urgently needed is expansion and reinforcement of a livestock research and experimentation center.

Marong Pig Unit This is the only swinery within the region. It specializes in the breeding of young pigs and distribution of superior pigs to villages. Though the exact number of pigs distributed is unknown, it is estimated to be somewhere between 300 and 500 a year.

A hybrid of Large White and Land-Race is being produced here. A considerable increase in the recent years in the number of pigs raised in the Rombo and Pare districts owes much to the activities of this swinery. The swinery also functions as a pivotal base for promotion of pig raising in the region.

Agricultural Research and Training Institute, located in Lyamungu, is under direct government control. The activities of the institute are roughly two: research and training. A substation in Tengeru

houses the pasture and livestock section and engages in experiments relating to raising. The substation also offers training to field officers. (Tengeru is in Arusha Region, and the substation there serves as a training center for the northern parts of the country, including the Kilimanjaro Region.)

A total of 161 officers are in charge of stock farming in the region. The breakdown by district is as follows:

(Table - 33)

	Hai	Moshi	Rombo	Pare	Total
V.O.	-	1	-	-	1
F.O.	1	4	2	-	7
V.F.O.	-	-	-	1	1
V.F.A.	-	-	-	15	15
V.F. Aux.	-	-	-	29	29
A.F.O.	6	17	9	-	32
F.A.	25	33	18	-	76
Totals	32	55	29	45	161

It should be pointed out immediately that the number of officers active in the first line is far less than satisfactory. What is more, there are only 5 land rovers and 12 motorcycles for use by these officers, which is too few for adequate mobility. In order to improve efficiency of extension services and organize channels for dissemination and introduction of new techniques, it is of vital importance to increase the number of experts and establish proper extension service programs.

(4) Production and Consumption of Livestock Products

There are in this region vast plots of land available for livestock raising, and a sufficiently large number of domestic animals on the basis of which to breed many more. In spite of these favorable conditions, however, livestock products account for only 0.4% of total agricultural production. This is due partly to the fact that stock raising is more of a side business for many farm households and also to the fact that farmers usually regard smaller animals as a means of food self-sufficiency and cattle as assets. Because of these factors, livestock production is increasing very slowly if at all. The following table summarizes the breakdown of livestock production in 1975.

(Table - 34)

	Hai	Moshi	Rombo	Pare	Totals
Meat (kg)	852,492	1,177,166	710,440	664,479	3,404,514
Chicken (kg)	32,837	80,000	-	8,820	121,657
Milk (1,000 l)					69,000
Eggs (dozen)	41,800	100,000	12,628	49,910	204,347

Source: Statistics of Regional Government, 1975

Cattle, goats, sheep and pigs are all included under the category "meat." Assuming that 3,526 tons of meat and chicken produced in the region in a year were consumed entirely within the region, per-capita meat consumption in the region would be about 4.3 kg a year, or 11.7 g a day. Annual production of milk is 69 million liters.

The following is a comparison with the 1968 FAO statistics on animal protein intake.

(Table - 35)

	Per-capita animal protein intake per day
Average for Africa	10.8 g
Average for the world	24.0 g
Average for the Kilimanjaro Region	11.7 g

The following figures were offered by the Moshi District Office:

(Table - 36)

	Average weight	Weight of meat with bones	Yield
Cattle (Zebu)	225 kg	112.5-135 kg	50%
Goats	45 kg	16 kg	35%
Pigs	90 kg	68 kg	76%
Chickens	1.5 kg		

Cattle are slaughtered at age 4 or 5, and improved breeds of cattle at age of 2 or 3 or more.

Production of milk is becoming increasingly important as a means of improving nutrition. Most of the milk is produced with indigenous breeds or with select breeds produced by crossing foreign breeds with indigenous breeds, which have a poor milk yielding capacity of only 2-3 liters a day per head. Milk thus produced is usually consumed by the producer or sold at an open-air market.

N.A.F.C.O. and D.A.F.C.O., which are both public corporations in the region, are engaged in the production of milk at a total of 12 farms (9 N.A.F.C.O. farms and 3 D.A.F.C.O. farms), mainly in West Kilimanjaro. The situation and activities of N.A.F.C.O. and D.A.F.C.O. are as summarized in the following three tables. The production figures are for a one-year period in 1975 and 1976 and have been taken from statistics of the Regional Development Livestock Division.

Production and Consumption of Milk (liters)

(Table - 37)

	NAFCO	DAFCO	Total
To factories	386,015	380,150	766,165
For local sale	83,192	262,259	345,451
For calves	106,667	95,069	201,736
Totals	575,874	737,478	1,313,352

Number of Milking Cows (Table - 38)

	NAFCO		DAFCO	Total	
	Dairy	Beef	Dairy	Daily	Beef
Cows	515	57	533	1,048	57
Heifers	1,022	83	621	1,637	83
Calves (fem.)	140	36	130	270	36
Calves (male)	72	9	75	147	9
Breeding bulls	34	2	29	63	2
Fatting	343	22	208	551	22
Totals	2,126	209	1,587	3,713	209

Land Utilization (hectares)

(Table - 39)

	NAFCO	DAFCO	Total
Crops	6,508	583	7,092
Natural pasture	7,301	2,536	9,837
Pasture	34	188	222
After use	1,382	212	1,594
Totals	15,225	3,520	18,745

Each cow produces an average of 1,257 liters of milk per year, or 3.5 liters a day (359 days). The production figure per hectare of pasture is 174.3 liters. Given the fact that on some of these farms, where pasture can accommodate 2.6 cows per hectare, maximum milk production reached 1,900 liters per head per year, or 5.2 liters per day, there is some possibility for increasing the general level of production still further. These farms play the part of leaders, selling strains and giving advice on dairy farming techniques.

(5) Stock Farming Bottlenecks

While it should be possible to further develop the livestock industry in the region, the degree of success will depend largely upon how well water is secured and made use of. The following are also bottlenecks, however:

(i) Concentrated feed is short in supply as it competes with food crops for human consumption. Also, natural pasture, which affords the main roughage, becomes too poor to support livestock in the dry season, thereby retarding the growth of grazed animals and increasing their mortality rate.

(ii) Cattle of Zebu breed and smaller domestic animals of indigenous breeds, though suited to the climatic conditions of the region, grow slowly and are small in size, yielding little meat.

(iii) The farming operations of an ordinary farm household are small and mainly for the purpose of self-sufficiency. Their technical and financial capacities are also very limited. They are not interested in improving techniques and methods and are caused economic lossess by chronic diseases. In other words, they are not organized in a pattern suitable for pursuing economic efficiency. Also, owing to the insufficient staff and facilities of extension services, the dissemination of livestock production techniques is far from satisfaction.

(iv) The low level of income does not encourage consumption of livestock products. Consequently, producers have little incentive to increase production. Also, the lack or inadequacy of distribution facilities such as abattoirs and meat markets and of related transportation facilities such as a road network providing access to consumer markets and refrigerating plants is another reason for small demand for livestock products and little commercialization of operations.