A REVIEW OF STUDIES OF THE FARMING SYSTEMS OF THE SOUTHERN HIGHLANDS OF TANZANIA, 1970-1990

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ABSTRACT

The Uyole Agricultural Centre (UAC) was established as a research and training institute in 1970, in order to promote rural development in the Southern Highlands of Tanzania. The challenge for UAC was to develop agricultural research and development strategies appropriate to the Southern Highlands region. The approach adopted was first to conduct farm management studies and collect basic information which could be used in the preparation of a sound agricultural research programme. Several of these types of studies were done and several crop/livestock commodity programmes were started on-station. This paper reviews these studies on the farming systems of the Southern Highlands and describes the main production practices of, and constraints facing, smallholder farmers in the region.

INTRODUCTION

In the 1960s there was a general lack of appropriate agricultural research and development approaches for small resource-poor farm households. Efforts had been made in the field of applied agricultural research to develop technologies for smallholder families, but the results in terms of successful innovations were not limited. The challenge for Uyole Agricultural Centre (UAC) agricultural research system was to develop research approaches for resource-poor farmers who had not benefited very much from previous research.

The conventional research approach is the transfer of technology, in which priorities are determined by scientists, who generate the technology in research field plots and in the laboratories at the research stations, to be transferred through the extension system to farmers. As a result resource-poor farmers have been slow or unable to adopt many of the recommendation flowing from agricultural research stations (Chambers *et al.*, 1989). In the Southern Highlands, where large numbers of small scale farmers have yet to adopt improved technology and have limited resources at their disposal, UAC recognized that a priority for researchers was to gain a better understanding of smallholder farming systems, and a smallholders' practice constraints and problems.

To achieve this, a series of farm management studies and farming systems research surveys was carried out by UAC between 1970 and 1971 (Table 1).

This paper reviews the main findings of the surveys of the farming systems in the Southern Highlands and describes the main production practices of, and constraints facing, the smallholder farmers in the region in the 1970s and 1980s.

THE SOUTHERN HIGHLANDS

The Southern Highlands of Tanzania, consisting of the four regions Mbeya, Rukwa, Iringa and Ruvuma, cover an area of 249,347 km^2 and have an estimated population of 4,163,414, of which over 90% is engaged in agriculture. As might be expected with such a huge land mass, there is a tremendous diversity in the agro-ecological environment. Researchers have used two main approaches in dividing the area into small units or rural development zones. One involves an assessment of the

physical resources, in which climate, soils and topography mainly determine the division into zones (Rombulow-Pearce and Kamasho, 1982). The other involves an assessment of the existing farming systems, including traditional factors, such as food preferences and social customs, as well as the technology used and economic factors, such as access to markets and inputs (Croon, 1982). Croon (1982) points out that the physical resources approach focuses on the potential for various types of agricultural production, whilst the agro-economic/existing farming systems approach focuses on the existing systems as a basis for grouping farmers and agricultural areas.

Using the second approach, the major farming systems of the Southern Highlands can be grouped as follows:

- Maize based
- Cassava based
- Pyrethrum based
- Rice, cocoa based
- Coffee, tea and banana based
- Coffee and maize based
- Livestock (cattle) based
- Finger millet and maize based
- Tobacco based
- Cotton based
- Cashewnut and maize based
- Maize and beans based
- Tea based

Within these major groupings there were a wide range of subsistence crop and animal enterprises which may be undertaken either for food or cash or both. Maize is grown almost everywhere in the Southern Highlands, albeit in small amounts in some areas, and is the major staple food for smallholder farmers. Rice is the second most common staple food and is eaten by most people. This paper therefore concentrates primarily on studies of the maize-based farming systems of the Southern Highlands, but also mentions the rice based system. Few of the surveys described here explicitly examined the role of livestock in the farming systems; in general, livestock were surveyed separately, and are therefore discussed separately in this paper.

Table 1. Major farming systems studies undertaken in the Southern Highlands, 1970-1991

	Study
1971	The Southern Highlands socio-economic study
1971	Paddy in Usangu
1974	Pyrethrum in the Southern Highlands - Mbeya and Njombe Districts
1976	Potato production ad part of the farming system - Njombe and Makete
1980	An interdisciplinary farming systems approach to planning an adaptive research programme for farmers of the Ufipa Plateau
1981	Agro-economic zoning of Mbeya Region on the basis of farming systems
1982	The basis for planning an adaptive research program on rice for small farmers - Kyela and Usangu
1983	Agro-economic zoning of Ruvuma Region on the basis of farming systems
1982	Development of the farming systems in Mbeya
1989	The role of cassava in the farming systems of Lake Nyasa coastal strip - Mbinga, Ruvuma Region
1990	Diagnostic survey report of the Uporoto-Umalila highlands
1990	Women in irrigated agriculture Phase I. Agricultural production in the Mswiswi Traditional Irrigation Scheme, Mbeya Region
1991	Analysis of the coffee-based farming system in the Matengo Highlands - Mbinga District
1984	Maize Production in Tanzania's Southern Highlands: current status and recommendations for the future

MAIZE BASED FARMING SYSTEMS

According to Bakke *et al.* (1971) maize is grown all over the Southern Highlands at all altitudes, in small scale production enterprises. It is produced mainly for home consumption, and mainly local varieties were used. Jespersen (1970) reported that hybrid maize was introduced in Njombe District as a smallholder crop in 1968 and estimated that 2,180 hectares were cultivated with the variety H611B. As most people preferred maize to wheat, the introduction of higher yielding maize varieties was expected to replace wheat production. The new hybrid varieties recommended were: UCA for medium to lower altitude areas; Ilonga Composite for very low areas; H613B, H613 and H611B for areas at an altitude of 1650-2100 m, with a five to six month growing season; and H632 and H622 for areas at an altitude of 1200-1500 m, with a short rainy season.

Ulvund and Mkindi (1976) observed that finger millet was the dominant crop on the Ufipa Plateau at the time of their survey. Maize was a relatively new crop in the area and was third in importance after beans. Four years later, Collinson *et al.* (1980) found that the Ufipa Plateau farming system was based on both finger millet and maize, with maize overtaking finger millet as a base for *ugali*, the main staple food dish in the Southern Highlands. This is a trend that has occurred almost everywhere in the Southern Highlands, with traditional coarse cereal grains being replaced by maize. The development of improved high yielding varieties tailored to different climates and altitudes has been a considerable stimulus to the adoption of maize production as a major activity by smallholders, both for food and cash. The Southern Highlands now accounts for nearly 90% of the total amount of maize purchased for Tanzania's national food security granary reserves.

Ufipa Plateau

In 1976 the average cropped area per households on the Ufipa Plateau was 3.6 ha (Ulvund and Mkindi, 1976), with finger-millet (1.8 ha), beans (1.0 ha), maize (0.6 ha) and groundnuts (0.06 ha) as the principal crops.

Most of the maize fields on the Ufipa Plateau are prepared between November and January using one pass with oxen and plough to produce a flat seedbed. Tractors and hand hoes are also used. Virgin or fallow land is cultivated at the end of the previous season in March, April or May, with a final ploughing once the first rains have started (usually November).

Maize planting occurs from September to February, with 32% of the farmers surveyed planting in November, 39% in December and 18% in January (Collinson *et al.*, 1980). Row planting (45%), usually by dropping the seeds after the plough, and broadcasting (52%) were the dominant methods of planting. At the time of the survey three local maize varieties were in use: Mofat, with flat grain and a four month maturity period; Kalimwa, a short plant with small cobs and grains, early maturing; and Namesa, with mixed grain colours (red, black and white) and reported to be resistant to maize grain weevils in store. The recommended improved maize varieties for Ufipa Plateau are: H622, UCA, H614, Kilima and TMV1, with recommended planting dates of December - January.

Most farmers started to weed their maize plants three to four or more weeks after emergence, using hand hoes. The dry maize was harvested in the cobs and taken home, shelled and kept in bags or traditional grain stores (*vihenge*), either for food or for sale.

Seedbed preparation for finger millet started with forest or bush clearance, followed by ploughing or hoeing before the heavy rains of December. Planting was carried out from December to February, the most frequent planting time being January. Finger millet trials at UAC have shown that the middle of December is the ideal planting time, suggesting that by planting late most farmers were losing yield. The seeds were broadcast by hand and covered either by hoe, trampling by cattle, or sweeping with tree branches pulled by oxen. Farmers used very high seed rates (17 kg ha^{-1} sample mean) compared with the recommended rate of 5-10 kg ha^{-1}. Wild finger millet (*Eleusine indica*), which in early stages is difficult to distinguish from finger millet is a serious weed problem. Farmers weeded only once by hand using a hoe and often too late. The finger millet was harvested by cutting off the heads with small knives, threshed by beating with sticks, and winnowed by hand using baskets and/or *nyungo*.

Land preparation for beans was done before the onset of the rains for intercropped beans planted in November and December, and between February and April for beans planted as mono-crops. The mono-cropped beans were usually planted between March and April in random planting patterns. Weeding appeared to be a major problem, since the most commonly used tool, a big hoe, caused much damage to the plants when weeding was late. Harvesting of the early planted beans took place between February and March, and of the mono-cropped beans in June and July. Whole plants were uprooted and threshed in the field. The grain was used for both sale and family consumption.

The farming system of the Ufipa Plateau has undergone rapid change as a result of the increasing use of oxen, fertilizers, and improved maize varieties. With a favourable climate and altitude, the Plateau has a good potential for maize production (yields of up to 3.5 t ha^{-1} have been obtained in experimental trials).

The average size of the household was 6.5 (Ulvund and Mkindi, 1976). The average labour input on the farm was 2,520 hours per year per household; 24% contributed by the husband, 35% by the wife or wives, 33% by the children, 7% by hired labour, and 1% by relatives and friends. The labour input to different farm operations is shown in Table 2.

The major production constraints facing farmers on the plateau were: decreasing soil fertility as a result of continuous cultivation of land around the villages; uncertain rainfall in March in some years; and labour constraints in the November-January land preparation period.

Table 2. Labour inputs to farm operations on Ufipa Plateau

	Time ($h\ ha^{-1}$)		Total Labour input (%)
Soil preparation	623	Finger millet	46
Planting	289	Beans	11
Weeding	368	Maize	7
Harvesting	621	Maize/beans	9
Total	1 901	Finger millet/maize	2
		Other crops	7
		Livestock	19

Source: Ulvund and Mkindi, 1976.

Songea District

The mean farm size for smallholder farmers in Songea District is estimated to be 2 ha. Maize, the most important crop, occupies 1.2 ha, rice 0.1 ha and finger millet, beans and sunflower about 0.05 ha each with a number of other crops being grown (ASSP, 1991).

There are few cattle in Songea: only one head of cattle per five farm families, all confined to the areas close to major population centres. Chickens, goats, and pigs are the livestock most frequently kept (Table 3).

Land cultivation is mostly done by hand hoe between August and January, with a peak in November and December. The common type of seedbed used for maize is ridges. The maize is planted in November and December. The 1991 survey (ASSP, 1991) showed that 51% of farmers used unnamed local seed, 7% H614 and 4% UCA. The plant population was near to the recommended density. The varieties recommended by UAC for Songea District are H614, UCA, H6302, TMV1, H632 and Kilima.

The weeding and crops extended from December to April and was done by hand hoe. Generally, sulphate of ammonia was applied to maize, rice and tobacco crops, and urea and calcium ammonium nitrate to maize. Use of triple superphosphate, compost and manure was rare.

The main months of harvest are from May to August for most crops and the mode of transport is on the head. Most crops are stored in the cob or on the ear, but a significant proportion of shelled grain is also stored. Maize production per smallholder varies considerably. The mean yield of

approximately 1400 kg (16 bags) suggest a small surplus above domestic demand. Crop yields are shown in Table 4.

The survey (ASSP, 1991) indicated a mean family size of 5.0. Almost everyone (males and female) worked full time on the farm.

The main constraint to crop production in Songea District is the low-resource system of farming. The traditional hand-hoe and cutlass are the predominant farm tools, animal traction is virtually unknown and tractor use is non-existent. Means of transport are limited mainly to bicycles. The capacity to move inputs and produce by means other than human carriage is therefore extremely limited.

Table 3. Number of livestock in Songea District (total number of farm families surveyed, 83)

	No.
Cattle	18
Goats	282
Pigs	62
Sheep	32
Chickens	776

Source: ASSP, 1991.

Table 4. Mean yield (kg ha^{-1}) of the main crops in Songea District (number of farm families surveyed, 83)

	Yield
Maize	1 185
Rice	2 003
Finger millet	618
Beans	464
Sunflower	1 709
Tobacco	1 121

Mbeya District

The average farm size in Mbeya District is about 2 ha. The main crops are maize (1.1 ha), rice (0.3 ha), beans (0.2 ha), coffee and potato (0.1 ha each), finger millet and peas (0.05 ha each) with small areas of pyrethrum, groundnuts and other crops also being grown.

There are more cattle in Mbeya District than in Songea, 1.75 head of cattle per family overall. The total numbers of different types of stock kept by the 152 farm households in the survey were: chicken (905), cattle (266), goats (240), pigs (69) and sheep (47).

In the highland areas, most land preparation is done by hoe between June and September. At lower altitudes both ox-ploughs and tractors are used, especially in the maize and rice fields.

Planting is done between June and August in the highlands and in November and December at lower altitudes. Farmers use the maize hybrids H614, H6302 and H632 but they also use local seeds for late planting. Most maize is sown in rows on the flat. The seeding rate corresponds to the recommended density.

Weeding is done throughout October in winter planted crops in the highlands, and until March at lower altitudes in most of the main crops. The hand hoe is the commonest tool used; a few farmers use the herbicides germplasm and gramoxone. Inorganic fertilizers (triple superphosphate, urea and calcium ammonium nitrate) are applied to enhance soil fertility, although in the highland areas the soils are inherently fertile.

Most of the crops are harvested between May and August. Food grain crops are processed by beating with a stick in a sack or on a clean floor or a mat. The cleaned produce is carried home on the head and stored in locally made wattle and daub granaries. Many pesticides are used to protect stored crops, including Kynakil, Actellic super, DDT and Didimac. Crop yields are shown in Table 5.

The mean family size in Mbeya District is 5. Many men have two or more wives who live in separate homesteads and own farms. Both men and women work full time on their farms. Hired labour is limited.

The main constraint limiting the production of maize in the highlands is the dominance of hand hoe cultivation and the limited transport available to take produce to market outlets. In the lower altitude areas, the scarcity of tractor and oxen draft power, lack of money, and high costs and unavailability of inputs are the principal constraints to increased agricultural production.

Njombe District

The average farm size in Njombe District is 2 ha. The main crops are maize (1.6 ha), green vegetable and wheat (1.1 ha each), and potatoes and field beans (0.3 ha, each).

The total number of cattle owned is quite high, with 1.8 head of cattle owned per family overall. The main stock kept on the surveyed farms were fowl (785), goats and sheep (193), cattle (146) and pigs (61).

The land is cultivated between August and January, with the majority cultivated in November. Cultivation in all villages is principally by hoe although ox ploughs and tractors are used by some farmers, ox ploughs especially in Makambako Division.

Sowing extends from November to January and is all done by hand on the flat in rows. The most commonly used maize varieties include H6302, H614, H632, H625 and an unnamed local variety.

First and second weedings extend from December to March. Weeding is done mainly by hand hoe although a few farmers use herbicide at the second weeding (gesaprim). Many farmers use manure and inorganic fertilizers (calcium nitrate), urea and triple superphosphate, and NPK compound on tea.

The maize is harvested between July and September and carried home on the head or by sledge and stored in wattle and daub granaries. Shelled grain stored in sacks is protected with Kynakil or Actellic against maize weevils. Crop yields are shown in Table 6.

The mean household size in Njombe District is 5. Both men and women work full time on their farms.

The principal constraints to increased maize production are lack of money, the high cost and unavailability of fertilizers, lack of knowledge about improved production practices and lack of timeliness in the provision of inputs.

Table 5. Mean yield (kg ha^{-1}) of the main crops in Mbeya District (number of farm families surveyed, 152)

	Yield
Maize	1 041
Rice	2 923
Beans	335
Coffee	486
Potato	3 997
Finger millet	306
Peas	445
Pyrethrum	849
Groundnut	889

Source: ASSP, 1991.

Table 6. Mean yield (kg ha^{-1}) of the main crops in Njombe District (number of farm families surveyed, 80)

	Yield
Maize	1 055
Green vegetable	195
Wheat	55
Field beans	92
Potatoes	460

RICE BASED FARMING SYSTEMS

The main areas where rice is grown as a major crop both for food and cash are: the Usangu Plains, the Kyela Plains, the Kamsamba-Msangano Rukwa Valley, the Pawaga Division in Iringa, the Lake Tanganyika shores, the Lake Nyasa coastal strip in Mbinga District, and the Tunduru Flats. With the exception of Usangu and Pawaga, where rice is grown under both rain-fed and irrigated conditions, the farmers plant rain-fed rice. In the Usangu Plains there are three large scale rice farms belonging to the National Agricultural Food Company (Mbarali, Madibira, and Kapunga), which use intensive irrigation systems. The Baluchi farmers in Rujewa have started their own rice irrigation schemes. Recently smallholder irrigation schemes have been developed at Kimani, Majengo-Igurusi and Mswiswi. In 1971, Jespersen reported that the total marketed production of paddy in Tanzania was

69,445 t, of which 32% came from Mbeya Region, the majority (70%, 15,506 t) from the Usangu Plains. Mbeya has consistently taken the lead for rice production in the Southern Highlands, followed by Rukwa and Ruvuma (Table 7).

The data in Table 7 refer only to marketed output passing through official channels, and do not take account of the substantial volume of unofficial marketing and family consumption. There are further large areas of land with potential for rice production under both rain-fed and irrigated conditions in Usangu and Pawaga, and under rain-fed conditions elsewhere. The Southern Highlands could therefore produce a very substantial proportion of Tanzania's national requirements for rice.

Table 7. Paddy production in the four regions of the Southern Highlands, 1985/86-1990/91

	Mbeya		Ruvuma		Rukwa		Iringa	
	(ha)	(t)	(ha)	(t)	(ha)	(t)	(ha)	(t)
1985/86	23 000	37.0	19 000	33.0	900	13.0	1 000	2.0
1986/87	33 600	59.1	23 300	42.2	4 000	9.1	3 100	4.0
1987/88	37 400	57.1	22 000	35.9	7 100	12.6	700	1.0
1988/89	32 500	65.3	24 600	33.4	15 200	34.0	800	1.3
1989/90	28 400	67.2	23 700	34.4	6 600	35.0	800	1.2
1990/91	23 600	58.6	27 200	40.9	14 300	45.4	1 200	3.1

Source: Food Security Unit, Dar es Salaam.

Usangu

The mean farm size in the Mswiswi irrigation scheme is 3.9 ha (Mayona *et al*; 1990), with paddy occupying the biggest land area on the farm (1.46 ha). Other crops grown include maize (0.86 ha), beans (0.45 ha), groundnuts (0.21 ha), sweet potatoes (0.18 ha), onions (0.12 ha) and sugarcane (0.30 ha).

Land cultivation for rice is carried out between October and November. Oxen and tractors are used for the first cultivation. Depending on the availability of water, the paddy nursery is planted in November or December. The second cultivation (levelling and puddling of the soil in a banked field plot) is performed between January and March, entirely by hand hoe, as soon as the ground is soft. The irrigation furrows are subsequently cleaned, and soil clods broken to make a fine seedbed, which is filled with water ready for transplanting the rice seedlings. Rice planting is done immediately after puddling, with nursery seedlings transplanted randomly into the main field. The common varieties grown are Kilombero, Kahogo, Pijo and Faya. Weeding is carried out by hand in January or February (one weeding only). Flooding of the field is also used as a means of controlling weeds. Harvesting is done between May and July with a knife or sickle, and the dried plants are threshed by hand using a stick. The winnowed paddy is stored in bags or *vihenge*.

The first maize crop, grown under irrigation, is cultivated and sown in September or October while the second, rain-fed, crop is planted in December or January. Hand hoes are used for cultivation in both cases. Local varieties are mostly used; few farmers use hybrids because they are not readily available. The farmers weed their maize once by hand hoe and hand-pulling. The crops are harvested in March or April and June or July. Only the outer leaves are removed, leaving the inner leaves with the cobs for storage in the *vihenge* at home. Women and children then shell small amounts as needed for immediate consumption.

Groundnuts are planted as pure stands on ridges from November to February. The local variety, *Baraka* is used. The crop is weeded once within six weeks after planting. Mature plants are up-rooted by hand hoe and stored unshelled. Shelling is done as needed for sale or home use.

Beans grown as a mono-crop are cultivated in March or April and grown under irrigation, either on the flat or on big ridges. Rain-fed beans are normally intercropped with maize at random. Mono-crop beans are weeded by hand hoe only once. The first bean crop is harvested in March or April and the second in July or August.

Since the Jespersen study (Jespersen, 1971) paddy production has more than doubled but the use of agricultural inputs has not increased much. Farmers are satisfied that their land still has natural fertility and that additional fertilizers are not needed to increase yields. Farmers still use local rice varieties because the improved high yielding varieties, such as IR 8, are not considered so palatable. Progress has occurred in the use of ox-drawn ploughs and tractors in place of hand hoes for the first cultivation in rice fields.

Yield estimates for the major crops as estimated by two different studies in the Usangu Plains over the period 1970-1990 are shown in Table 8.

Table 8. Crop yields (kg ha^{-1}) in the Usangu Plains, 1973 and 1990

	1973	1990
Paddy	2 718	2 400 - 4 400
Maize	1 089	300 - 800
Groundnuts	228	500 - 750 unshelled
Beans	233	200 - 500

Source: Jesperson, 1971, and Mayona *et al.*, 1990.

Household size in the Usangu Plains was estimated to be 4.6 by Jespersen (1971), 3.5 by Kirway (1982a) and 2.5 by Mayona *et al.* (1990). Jespersen (1971) reported that work in the paddy fields (transplanting, weeding, bird scaring, threshing and winnowing) was carried out equally by men, women and children. Tasks done by men only were ox-cultivation, puddling and levelling. The labour needed for a range of crop production activities is shown in Table 9.

Table 9. Estimated labour requirements (person-days) in the production of the major crops grown in the Mswiswi irrigation scheme, Usangu

	Paddy	Maize	Beans	Onions	Gdnuts
Cultivation	49.2	41.2	26.0	24.2	37.5
Puddling/harrowing	22.5	-	-	37.5	-
Planting/transplanting	49.2	13.8	9.0	30.0	37.5
Weeding	49.2	22.0	12.5	75.0	37.5
Bird/vermin control	12.5	112.5	-	-	-
Harvesting	65.0	31.7	17.1	30.8	75.0
Total	347.6	221.2	64.6	197.5	187.5

Source: Mayona *et al.*, 1990.

Production constraints

- Reliable water for irrigation was the major limiting factor for improved paddy production and expanded acreage.
- No palatable high yielding paddy varieties are developed for Usangu farmers, local varieties dominate in the farming system.
- The hand hoe is still the predominant tool in agricultural production, with limited use of oxen and training to increase draft farm power and reduce labour peaks.

Kyela

In the rice based farming system in Kyela all farmers grow rice for food and, increasingly, as a cash crop, supplemented with bananas and other fruit trees surrounding the homesteads. Other basic foods such as maize and beans, are either purchased, or exchanged for rice, from outside the district. Numerous minor crop and livestock enterprises are undertaken.

For rice production the majority of farmers use oxen for cultivation while some use tractors and a few use hand hoes. The first ploughing is done in August or September when the land is still soft. The second ploughing starts in November or December for oxen and plough users, when the rains have softened the soil. Those owning or hiring a tractor plough and harrow in December or January. The area cultivated per family is typically about 1.5 ha, about half of which is used for rice production (Kirway, 1982b).

Planting goes on from December until early March. Seeds are broadcast by hand and covered by light harrowing using a tractor driven disc plough or an ox-plough. Some farmers cover the seeds by using hand hoes or by bamboo branches pulled by oxen. The main local rice varieties grown are Kilombero, Mwasungo, Faya and Mwanguru, (an upland rice). Weeding (once only) starts in early-planted rice in December and continues until April, depending on the time of planting. Weeding is mostly done by women by hand-pulling. A few farmers use herbicides to control weeds although herbicides are difficult to obtain in the area. Harvesting is carried out by hand-cutting and takes place from June to August. Threshing and winnowing are carried out entirely by hand, by women. Typical rice yields range from 3-6 bags in bad years to 20-30 bags in good years.

Some farmers used small amounts of fertilizer, 50 kg (one bag) of triple superphosphate broadcast with the seed at planting, and 50 kg of sulphate of ammonia top-dressed after planting (Croon, 1982; Kirway, 1982b). No improved rice varieties have been adopted by farmers to date. Most farmers use either their own oxen, or rented or borrowed oxen, for cultivation and some hire tractors.

Mean family size is 6-7, with four of these able to provide labour for farm work. Farmers use most labour during the period from November to April, for cultivation, planting and weeding of rice fields, and from May to August during harvest time. The main activities of the agricultural calendar are shown in Table 10.

There are three major production constraints in the Kyela area. Climatic variation is the overriding factor accounting for fluctuations in production, with occasional floods submerging crops in the flood plains, and droughts limiting rice production in higher areas. There is a lack of appropriate rice technology for the area (improved weed control methods, palatable high yielding varieties, improved techniques for land preparation, use of fertilizers). A broader look at the whole farming system, with rice as the major resource user, seems desirable. There is a general shortage of draft power in the area, with difficulties in tractor rental for the first cultivation and too few oxen for hire.

Table 10. Monthly cropping calendar for Kyela district

Month	Cultivation	Planting	Weeding	Harvesting
Aug.	Rice			Rice, maize
Sep.	Rice, finger millet, cocoa			Beans
Oct.	Finger millet, cocoa			
Nov.	Rice			
Dec.	Rice	Finger millet, rice		
Jan.	Rice, maize, gdnuts	Rice, maize	Rice, finger millet	
Feb.	Rice, sweet potato	Rice, gdnuts	Gnuts, rice	
Mar.	Rice, cassava, sweet potato	Rice	Rice, maize, gdnuts	
Apr.	Cassava	Cassava, cocoa		Maize, gdnuts
May	Cassava, maize, beans	Cassava, cocoa, maize, beans		Maize, gdnuts, rice
Jun.			Beans, maize	Finger millet
Jul.	Sweet potato	Sweet potato		Maize, rice

Source: Croon, 1982.

LIVESTOCK IN SMALLHOLDER FARMING SYSTEMS

Within the various farming systems of the Southern Highlands, livestock play a number of roles. In the maize/beans and rice/sorghum based farming systems, cattle are primarily used for meat and milk production and as a dowry to seal marriages. In addition, they are used to a limited extent for ploughing, transportation of produce from farms to homesteads and market centres, and occasionally as a source of manure for the maintenance of soil fertility, although this practice is not common because it aids weed dispersion. In the coffee, tea and pyrethrum based farming systems of the high altitude areas, cattle have a similar role. Land shortage are quite acute (especially in Rungwe in Mbozi District), and the climate is ideal for dairying, so that either crossbreeds or purebreds are kept in enclosures with stall-feeding.

According to the National Livestock Census (MALD, 1986), the Southern Highlands had a total of 1,812,453 cattle in 1984, including indigenous, improved dairy and improved beef cattle (Table 11), representing 14% of the mainland total. Cattle numbers have increased considerably as a result of the influx of nomadic pastoralists (the Sukuma, Masai, Hadzabe and to a lesser extent the Gogo people) into the Usangu Plains and Lake Rukwa valley. The numbers of improved dairy cattle have also increased as a result of the activities of the Uyole Agricultural Centre, which sold a total of 861 dairy cattle between 1979 and 1990 (Table 12). Other sources of dairy cattle include Kitulo, Iwambi, Dabaga and Ihimbo Dairy Farms as well as Sao Hill Livestock Multiplication Units mainly being used by the Small-scale Dairy Development Project (SSDDP). Missionaries and private farmers in Iringa have also contributed considerably to the distribution of both pure and crossbred dairy cattle. However, the indigenous breed (Tanzanian short horn zebu) is still the most numerous type.

The majority of livestock keepers in the Southern Highlands practice open grazing, with herds of up to 1,000 head of cattle or more. Supplementary feeds are rarely used mainly because farmers know little about them.

Herds are normally kept near the homestead throughout the rainy season, and move to more favourable grazing areas away from the homesteads with the onset of the dry season. Those farmers who practise stall-feeding are amongst the 'elite', having received education, often having their own transport, and owning fewer animals which they are able to provide with supplementary feed purchased from feed mills or from neighbours. Few if any cattle receive the optimum daily nutrient requirement because of the poor quality and limited quantity of forage available, especially during the dry season.

Calves, sheep and goats are usually herded by young children close to the homestead. Pigs and chickens are managed as scavengers, with little or no herding or supplementary feeding. They are usually heavily infested with parasites and the chickens are taken by predators of all sorts.

The cattle diseases of economic importance in the Southern Highlands are liver disease, pink eye disease, mastitis, endoparasites, brucellosis, and foot and mouth disease. In addition, black quarter, anthrax, tick-borne diseases (such as East Coast fever) and ectoparasites also occasionally occur. Tick-borne diseases can be controlled by dipping or spraying with acaricides, but because acaricides are expensive and not readily available only about 10% of pastoralists carry out this treatment. Vaccination and de-worming are rarely carried out for the same reasons. Castration of young male cattle is a fairly common practice; this is carried out by a *burdizzo* if available, otherwise by crushing the teste, often using blunt metal. De-horning is rarely practised.

Occasionally, superior bulls in a village are identified for breeding purposes, but generally breeding is fairly indiscriminate. Selection is practised only in as much as weaker animals are chosen for sale. Reducing stock numbers to avoid overgrazing is viewed as a threat by most pastoralists, and is not practised. Calves are allowed to continue suckling until the mother objects; early weaning to increase the milk available to the farmer is not practised.

The many constraints to the livestock industry in the Southern Highlands include: tick-borne diseases, the limited quantity and poor quality of fodder, lack of availability and high cost of drugs, the poor genetic potential of the indigenous animals, and lack of supplementary feeds at the village level.

Table 11. Total numbers of cattle by region in the Southern Highlands, 1984

	Indigenous	Improved dairy	Improved beef	Total
Iringa	469 622	8 313	2 475	480 410
Mbeya	896 137	4 466	196	900 799
Rukwa	389 963	1 169	1 102	392 234
Ruvuma	36 969	1 380	661	39 010
Mainland	12 269 166	143 410	99 472	12 512 048

Source: MALD, 1986.

Table 12. The increase in dairy cattle in the four regions of the Southern Highlands between 1984 and 1990

	1984	1985	1986	1987	1988	1989	1990	Increase 1984-1990 (%)
Rukwa	1 169	1 317	1 472	1 651	1 850	2 071	2 316	98
Mbeya	4 466	5 014	5 625	6 307	7 006	7 910	8 844	98
Ruvuma	1 380	1 522	1 677	1 846	2 032	-	2 234	62
Iringa	8 312	8 958	9 646	10 380	11 162	11 995	12 872	55

Source: Mbeya Regional Dairy Extension Office.

CONCLUSION

A major difficulty in preparing this paper and in drawing implications for research and policy makers has been the scattered and un-coordinated nature of the various farming systems studies undertaken in the past, and the incomplete nature of recent information. Detailed data on farmers' circumstances, and how they are manifested in current farming systems, are required to identify the technical changes farmers are likely to accept.

The constraint that most limits agricultural production in many of the existing farming systems of the Southern Highlands is farm management - the ability to combine effectively the available resources into systems that are both highly productive, and financially efficient. Although the production of maize and rice has more than doubled in the last twenty years, the use of agricultural inputs (mineral fertilizers manure, compost, improved varieties, mechanization) has not changed much. In Usangu, very few farmers use mineral fertilizers because they believe that the soil is already fertile enough, whereas in Kyela fertilizer use is limited by high prices and limited availability. In both areas, farmers are still growing local poorly yielding varieties, mainly because the high yielding varieties available are not considered as palatable.

Substantial progress has been made in the use of oxen for ploughing. More efforts are required to help farmers with oxen-training and encourage increased oxen use, particularly for carrying out activities other than ploughing, such as planting and weeding, to reduce the dominance of the hand hoe in cultivation.

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