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1. INTRODUCTION

1.1 Background Information

The project Sustainable Management of the Usangu Wetlands and its Catchment (SMUWC) is a project for the Government of Tanzania, funded by the United Kingdom (UK) Government's Department for International Development. The project was conceived in response to perceived reductions in water flows in the Great Ruaha river in the dry season. In particular, low flows from the Great Ruaha to the Mtera/Kidatu hydropower schemes were blamed for power shortages in the mid-1990's. The continuous reduction of water flowing through the Ruaha National Parks was also a concern. Competition for water between cultivators and pastoralists, and amongst irrigators was also said to be leading to increased conflicts and sometimes violence. The general concern also was on the diminution and degradation of the wetlands, leading to loss of a valuable natural resource **(**SMUWC Inception Report, 1999).

The development of a sustainable management of the Usangu wetland and its catchment depends on the clear understanding of the past and present situation of the area. In the Usangu wetland and its catchment, farmers practice both irrigated and rainfed agriculture. Most of the farm households, however, depend on rainfed agriculture and the farming system is characterised by small land holdings, low input (except labour), low productivity and low household income. Furthermore, the low production level is achieved in an environmentally unsustainable way. This is because increases in production to match the population increase, have usually been realized by expansion of agricultural land as opposed to intensification (Qaraeen, 1997).

Farmers in the high potential highland areas (normally densely populated, with reliable rainfall) now intensify production or move to marginal lands. Often they employ traditional farming practices that produce short-term benefits and lead to continued depletion of organic matter. Continuous cultivation coupled with the slash and burn system that is usually practised, leads to loss of bio-diversity. This has adversely affected supply of food, fuel wood, fodder and timber and more importantly, water (Dumea, 1997). In the lowland, which is characterised by low and unreliable rainfall, rainfed agriculture is mostly applied to upland crops in areas where irrigation is not suitable or not developed. Traditional and improved irrigation systems are common in paddy-cultivated areas, and off-season production of crops.

The Sustainable Management of the Usangu Wetland and its Catchment (SMUWC) project was initiated in 1998. One of the project objectives is to increase knowledge and understanding of the technical and physical processes underlying natural resource availability and use in the project area. The project is investigating the nature and causes of recent changes in natural resource availability. The knowledge developed will assist the Government of Tanzania and key stakeholders in the development of a sustainable environmental management strategy. This will also enable local communities to develop and implement their own strategies for sustainable management of natural resources (SMUWC Interim Report, 1999).

The project has already developed a body of knowledge on a number of hypotheses developed during the implementation. These include hydrological processes in the sub-catchments and irrigation demands. Studies have been conducted to understand the farming systems under irrigated agriculture and the pastoralists systems. This study addresses the farming systems issues in rainfed agriculture.

1.2 The farming systems study

The existing farming systems in the study area are a result of interaction between their exogenous, natural, economic and cultural circumstances of their own priorities and resource capabilities. A farming system is defined as a unique and reasonably stable management of farming enterprises that the household manages and practices in response to physical, biological and socio-economic environments, in accordance with the household goals, preferences and resources (Shanner et al, 1992). The farming system analysis gives a detailed description of the farmers' circumstances and current production systems. A clear definition of priority problems limiting the farmers in meeting household objectives and productivity of available resources is established. The farming systems study also creates an understanding of the interdependencies of the components under the control of the farm household and on the interaction of their components with physical, biological and socio-economic factors beyond the household control.

In watershed management the central theme is the recognition of linkages of upland and downstream areas by land use factors and the processes within the drainage (Msolla, 1997). It is therefore important to create a clear understanding of the farming practices used in the area, reasons as to why these practices have been adopted and their impact on land and water conservation and the community. This will give more insight of the problems associated with use of land resources in the area.

1.3 Objectives of the study

1.3.1 Main objective

The overall objective of the study is to provide a clear description of the farming systems in the rainfed agriculture of the Usangu wetland and its catchment. This will provide information needed towards the development of a strategy for the sustainable utilisation of the natural resources in the catchment for the maintenance and improvement of rural livelihoods.

1.3.2 Specific objectives

i) To identify all major farming systems components and describe their roles and interactions
ii) To identify types of crops grown, cultivation practices and perceived problems that limit optimum productivity in the study area
iii) To study the integration of livestock in the farming systems described
iv) To establish other sources of income (forests products – lumbering, charcoal making, firewood collection, beekeeping, handicrafts, etc)
v) To establish the relative importance of different activities for household survival/income
vi) To investigate changes over time (20 years ago, 40 years ago) in cropped area, crop type, yields, etc.

2. METHODOLOGY

A combination of data collection methods was used in this study. This include the following:

2.1 Review of secondary information

A review of the secondary information and data from the project documents and other existing literature from previous studies was carried out. This enabled the researcher to gather relevant information about the Usangu wetland and its catchment in general.

2.2 Reconnaissance survey

A reconnaissance survey was conducted in the study area to become acquainted, in particular, with the farming systems, geographical characteristics and the size (magnitude) of the project area. During the reconnaissance survey, information and data from the district, division, ward and village levels were collected to give an insight on the current status on the demographic situation, current production enterprises, constraints and opportunities of the farming community in the different agro-ecological zones. Six districts in the project area, namely Mbarali, Mbeya, Makete, Njombe, Mufindi and Iringa, were visited as per Terms of Reference (Appendix I). Participants' observations, key informants' consultations and group discussions using a checklist (Appendix III) were used as tools for information gathering.

2.2.1 Key informant interviews

During the reconnaissance survey, interviews with key informants (Appendix VI) in the district, division, ward and village levels enabled the researcher to collect important information regarding the crops grown, farming practices and major events and changes that occurred in the past years.

2.2.2 Dialogue with farmers

Dialogue with groups of farmers in some villages was carried out in order to collect qualitative information on the farming systems observed by the researcher in the transect drive through the study area. The dialogue particularly focused on the major farm enterprises farmers are engaged on, major changes, events over time and trends in productivity for various crops.

2.2.3 Participant's observation

Direct observation of land use was made from the standing crop, and other associations for crops that were still in the field, and for livestock grazing lands. The extent of soil fertility and crop allocation on various lands depending on altitude and soil structure and fertility was also observed. Valley bottom cultivation locally known as "vinyungu" and dry season irrigation practices were observed in relation to farmers' off-season engagement.

2.2.4 Areas visited during the reconnaissance survey

The following villages were visited during the reconnaissance survey:

(i) Mbarali district
a) Madibira ward - Nyamakuyu village
b) Mawindi ward – Mawindi and Manienga villages
c) Mahongole ward – Mahongole village
d) Chimala ward – Igumbilo village
e) Utengule ward – Utengule Usangu, Luhanga and Simike villages

(ii) Mbeya district
a) Tembela ward: Simambwe village
b) Ulenje ward: Nyalwela and Ulenje villages. The two wards are located in the subcatchment where Patagwa and Mwambali rivers originate to join the Gwiri River downstream.

(iii) Makete district
a) Matamba wards: Igenge and Magoye villages situated in the Numbe subcatchment that feeds the Chimala river.
b) Njombe district: Wanging'ombe division and particularly Malangali village located in the Balali subcatchment that feeds the Mbarali river.

(iv) *Mufindi district*: Malangali division: Mwilavila village

(v) *Iringa district*: Ifunda ward – Lumuli village that lies in the Lyandembera catchment.

(vi) *Njombe District*: Mlangali and Mambegu villages.

2.3 The formal survey

2.3.1 Selection of study villages

The study villages were selected to represent different Agro Ecological Zones (AEZs) found in the study area. Initially 20 villages were selected for the formal survey, but only 19 villages were involved in the formal survey. Saja village in Wanging'ombe division was dropped because the village chairman and Village Executive Officer were not present to facilitate farmers' selection on the day planned. It was also found that the village lies in the same agro-ecological zones with Idumulavanu in Mufindi district.

The studied villages were Lumuli in Iringa district; Maduma and Idumulavanu in Mufindi district; Imalilo, Itunduma and Malangali in Njombe district; Nyamakuyu, Ikoga, Nyeregete, Itamba, Mhwela and Simike in Mbarali district; Kimani, Ng'onde and Igenge in Makete district and Kikondo, Galijembe, Ulenje and Iyawaya in Mbeya district (Appendix V). An itinerary for formal survey (Appendix II) was implemented.

2.3.2 Farmer selection

A procedure for random sampling of respondents was employed using existing village household lists prepared by the Child Survival and Development Programme (CSPD). In villages where a household list was not available, a taxpayer list was used. In areas where women were exempted from tax paying, efforts were made to get a household list, to make sure that women headed household were represented. On average, 10 farmers were selected in each village for the interviews.

2.3.3 Questionnaire survey

The formal questionnaire survey was carried out in all villages selected. The questionnaire was first pre-tested in Ifiga and Ilongo villages in Mbeya district. Necessary corrections were made before the main survey started. The formal survey enabled quantification of some important information gathered during the informal survey. The questionnaire was administered on an individual household basis. Farmer's interviews took place at their homesteads to facilitate observation by researchers and to build rapport with the farmers interviewed. It also helped to get data on livestock because farmers were very reluctant to admit that they had livestock for fear of taxes. Where possible, husband and wife participated in responding to questions asked to the main respondent.

A total of 187 farm-households were interviewed in the project area. Of these, 104 (56%) were men and 83 (44%) were women farmers. The distribution per district is shown on the table below.

Table 2.1 Composition of farmers interviewed by district

District	Men	Percentage (%)	Women	Percentage (%)	Total	Percentage (%)
Iringa	4	3.8	5	6.0	9	4.8
Mufindi	9	8.7	12	14.5	21	11.2
Njombe	12	11.5	17	20.5	29	15.5
Mbarali	42	40.4	17	20.5	59	31.6
Makete	14	13.5	14	16.9	28	15.0
Mbeya	23	22.1	18	21.6	41	21.9
Total	104	55.6	83	44.4	187	100

2.3.4 Data analysis

Data from the formal questionnaire was analysed using the Statistical Package for Social Science (SPSS). Pre-coding of the questionnaire enabled data entry in the field.

3. THE STUDY AREA

3.1 Biophysical environment and infrastructure

3.1.1 Location and land area

The Usangu wetland and its catchment covers an area of about 21 000 km^2, with 60% of the area lying in Mbeya region and the remaining 40% lying in Iringa region. Administratively, the project area involves seven districts namely: Mbarali, Mbeya Rural and Chunya districts in Mbeya region; Iringa Rural, Mufindi, Njombe and Makete districts in Iringa region. The administrative areas and the relative breakdown (coverage) are given in table 3.1 below.

The farming systems study was carried out both in the highlands and lowlands of the project area. The major rain fed cultivated areas studied include the area south and south east of Mbeya, along the southern watershed between Mbeya and Matamba, Matamba area, the Njombe area south to the Usangu plains, the northern-eastern highlands (Makambako-Iringa); and the southern Usangu plains from the Chunya escarpment to Madibira. The area falls within six districts of Mbarali, Mbeya Rural, Makete, Njombe, Mufindi, and Iringa Rural.

Table 3.1 Administrative areas and breakdown of the Usangu catchment

Region	District	% of the Catchment
Mbeya (60%)	Mbarali	54.69
	Mbeya Rural	3.17
	Chunya	2.30
Iringa (40%)	Iringa Rural	5.35
	Mufindi	11.27
	Njombe	15.22
	Makete	7.98

Source: SMUWC-Interim report, 1999

3.1.2 The people

The Usangu Catchment is occupied by a number of ethnic groups. In Mbeya district, the major ethnic groups are Wasafwa, Wakinga and Wanyakyusa, while in Chunya there are Wakimbu, Wasafwa, Nyakyusa. Pastoralists groups from the northern regions including Wasukuma, Wataturu, and Wagogo are also found in Chunya district. In Mbarali District there are more diverse ethnic groups due to the immigration of people for various reasons. The natives are the Wasangu. There are also Wabena and Hehe who moved from Iringa region (Njombe and Iringa districts) in search of employment on large farms and later decided to settle in the plains to cultivate paddy. Another group is the Nyakyusa from Kyela, Rungwe and Ileje. Wasukuma, Maasais, Barbaig, Taturu and Gogos form the group of pastoralists who moved to the plains in search of grazing pastures for their livestock. Many opted to settle, especially the Sukumas who are engaged in crop production as well. Another group is that of Baluchis who came to Usangu as early 1940's, and engaged themselves in paddy cultivation and business. In Iringa and Mufindi districts, the major ethnic group is the Wahehe and in Njombe district are the Wabena and Wakinga. In Makete district (Matamba area) majority are Wawanji and Wakinga.

The multi-ethnicity in the area has an implication for the farming practices as one group may adopt some different aspects of cultivation from the other. A case in point is the use of water harvesting (water bunds) techniques in the cultivation of rice, introduced in the area by Baluchis and now a common practice in the whole of Usangu.

3.1.3 Physiography, climate and soils

The physiography of Usangu wetland and its catchment is viewed from the agro-ecological zones classification of Samki and Harrop (1982) as reported by URT/EEC (1986a) for Iringa Region, that is, Makete, Iringa, Njombe and Mufindi districts. In Mbeya Region the classification described by Samki and Harrop (1982) and reviewed by Mussei et al (1999) is adopted. Based on this, six main agro-ecological zones are identified – AEZ 3, 8, 11, 14, 16 and 18. These are shown in figure 3.1.

(a) Agro-ecological zones in Iringa Region

In Iringa Region the Usangu wetland and its catchment falls within three main agro-ecological zones, that is, AEZ 3, AEZ8 and AEZ 14. The areas are further divided into land units as described in the Iringa agro-ecological zonation by URT/EEC (1986a) as follows:

Agro-ecological zone 3

(i) **The Njombe Plateau** falls in the AEZ 3, land unit 3iii. It covers most of the Igosi ward, the southern part of Imalinyi ward and the area west of Wangama ward. The plateau is mostly undulating with some parts of rolling to hilly. Flat top slopes occur commonly with broad bottomlands. The plateau becomes more dissected in topography on transition towards the Kipengere ranges. The mean altitude increases from 1 800 m in the eastern parts of the unit to 2 200 m in the western and southern parts, and likewise the climate becomes wetter. The mean annual rainfall is 1 200 mm. The soils are highly leached red clays of low fertility, mainly with humic topsoils influenced by volcanic ash at the almost flat or gently sloping hilltops. On the steeper slopes of unit 3iiib, the soils are often shallow and stony.

(ii) **The Gofio plateau** lies in the AEZ 3 land unit 3iv. It constitutes the northern extension of the Kipengere Mountains, with the eastern and southern boundaries sharply marked by a steep escarpment, while the elongated ridges with decreasing elevations from 2 700 m to 1 800 m a.s.l. stretch in the western and northern direction. The topography is undulating to rolling on the plateau, and the area is accessible and sparsely populated only on its western and southern borders. The greater part remains inaccessible and uninhabited. The soils are shallow, stony and rocky, and have often humic/volcanic ash topsoils.

The Gofio plateau belongs to the most humid areas of Iringa regions, and the mean annual rainfall is 1 500 mm. Short grasses of low nutritive value cover the ridges and the Gofio plateau. Humid forests occupy the valleys as the most common vegetation. Scattered cultivation of crops such as wheat, potatoes and green peas occurs on the borders of the plateau.

(iii) **The Kipengere Range** lies in land unit 3v extends in a roughly northwest/southeast direction from the Kitulo plateau to the Gofio plateau. It refers to a chain of hills, which rises abruptly from 2 000 m to 2 600/2 900 m. The land unit is uninhabited, having a very poor accessibility. The hilltops have generally flatter slopes, with gradients of 2-8%, while the hill slopes are very steep, with gradients mostly over 30%. The drainage system is

narrow in-filled. The soils are shallow, mostly stony and rocky on the steep slopes, and slightly deeper on the gentler hill tops and lower slopes. The humic topsoil influenced by volcanic ash is common also on the steep slopes.

The most common vegetation is short to medium grassland with low nutritional value and humid forests in the valleys. Scattered cultivation occurs on the gentler and more accessible lower slopes.

(iv) **The Matamba-Ikuwo basins** lie in land unit 3vi. These are two plains located in the northern part of Makete District and separated by the Numbe valley and the northward extension of the Kipengere range. Both plateaux are bordered in the south, west and east of the plains by the surrounding Kipengere ranges; and in the north and northeast by the steep Chimala escarpment. The altitudes decreases from 2 300 m at the foot slopes of the Kipengere ranges to 2 000 m near the Chimala escarpment. The topography is undulating to rolling with a more dissected landscape in some places.

The mean annual rainfall is 1 200 mm, and the unit is also the warmest inside AEZ 3 with mean annual temperature of 18.7^0C, reflecting the transition to the drier AEZ 14. The dominant soils are red leached clays, often with humic topsoil, influenced by volcanic ash and pumice. The soil fertility is moderate to fairly high. The area is mostly cultivated, where maize, wheat, peas and potatoes grow and it has the remnants of upland forest.

(v) **The Kitulo plateau** lies in land Unit 3vii, bounded on the east by the Kipengere ranges and on the west by the crest of the Livingstone Mountains. The area is undulating over the greater parts of the plateau and the altitude ranges from 2 200 to 2 900 m. The unit is the coldest and wettest of AEZ 3. The mean annual rainfall is 1 600 mm exceeding largely the annual evapotranspiration that is 800 mm.

The soils are derived from volcanic ash overlying pumice material, with thick and black humic topsoil. The growing period is very long, with duration of 280 days. The mean temperature is 10.8^0C, minimum temperatures occur between months of May and October at 4.1^0C. Frost may occur during the driest months of June to August. The dominant vegetation is short grassland of low nutritional value, which is mostly used for sheep and cattle grazing. Scattered cultivation of pyrethrum, barley, round potatoes and wheat occurs.

Agroecological zone 8

(vi) **Rocky Mountains** (AEZ 8v) comprise of rocky areas and have an elevation of 1 100 to 1800 m a.s.l. Rainfall is 750 to 900 mm annually; and evapotranspiration is 1 500 mm. *Commiphora* and *Combretum* species are common in the lower more arid parts. Miombo occurs in the higher elevations. The soils are shallow and stony. These areas are recommended for extensive grazing due to low rainfall and the rocky nature of land.

Agroecological zone 14

(vii) **The Mufindi Plateau** lies in the AEZ 14i, and it is mostly undulating with slopes of 2-8%, with scattered steeper areas with slopes of 8-16% with in-filled drainage lines. The altitude ranges between 1 600-2 000 m. The annual precipitation is 950 mm, with growing period of 175 days starting from end of November. The soils are uniform yellow highly leached clays,

although red clays also occur. The fertility of this unit is lower than in most parts of Iringa region due to the high degree of chemical leaching and the absence of humic or dark topsoil. Most organic matter has already mineralised due to the relatively dry and warm conditions. Vegetation is wooded grassland and grassland. There are scattered trees and clumps of *Terminalia,* but *Parinari* and *Uapaca* are typical species. Most of the area is cultivated, although there is are still large areas under grassland of low nutritive value.

(viii) **The Northern Ubena Plateau,** AEZ 14ii, is a small unit that covers the main Makambako-Njombe road. It is mostly undulating, scattered areas with hilly land slopes and gully erosion. The altitude ranges between 1600-2000 m and the annual precipitation is 950 mm. The vegetation comprises of miombo woodland and wooded grassland. The area is highly populated and mostly cultivated. The soils are mostly highly leached yellow clays with low fertility with small inclusions of more fertile red clays.

(ix) **The Kidugala Plateau** lies in AEZ 14iii located between the Gofio Plateau escarpment and northern border of Njombe Plateau. The common land form is undulating to rolling plateau with a broad bottomland and in-filled drainage system. The landscape decreases in elevation in a northeasterly direction from more than 2 000 m around Wangama to 1 500 m in the Kidugala area. Extensive undulating grasslands, characterised by short shrubs of miombo, mikusu (*Combretum species*), *Uapaca kirkiana* and Misaulwa (*Parinari species*), typify the zone. *Hyparrhenia species* dominate the natural grasses. The soils are red clays, sometimes with a sandy topsoil, with moderate fertility. The unit is mostly cultivated and it is suitable for maize, beans, sunflower, wheat and potatoes.

(x) **The Lower Mufindi Plateau** (Malangali-Saja-Wanging'ombe stretch) is a transition to the Usangu flats and it lies in AEZ 14iv. The lower Mufindi Plateau is mostly flat to undulating land. The mean elevation decreases from 1500 m in the west to 1 200 m in the east. In the undulating to rolling landscape, the dominant soils are red and yellow leached sands with very poor fertility, sometimes associated with red and yellow loams with sandy topsoil. Shallow and stony soils are common in the eroded areas. Large areas in this zone are affected by severe sheet and gully erosion, with an incised drainage. The vegetation is wooded grassland with *Combretum* thicket on sandy soils and miombo woodlands in some places. Cultivation is common in the area.

(xi) **Usangu Flats border** (Chimala-Mbuyuni-Igawa) is located on the northern side of Makete and Njombe districts along the boundary with Mbeya region. It lies in the AEZ 14v and is also a transitional zone to the flat and dry Usangu plains. The landform is mostly rolling, hilly with an incised drainage system. The elevation decreases from 1 500 m in the south to 1 000m in the north. The area receives little rainfall, an average of 900 mm per annum. The soils are predominantly shallow or moderately deep red clays, mostly stony with poor fertility. The dominant vegetation is Miombo and *Acacia* woodland with grasses of low nutritional value.

(xii) **Chimala scarp, Numbe Mountains and Northern Gofio Plateau** is a small unit located in Makete district that lies in AEZ 14vi. It differs from the preceding unit in elevation and landform as it is steeply dissected and there is mountainous area in the north bordering the Matamba-Ikuwo basins. The main elevation decreases from 1 800 m to 1 300 masl, and the unit is almost uninhabited and suffers from very poor access possibilities. On the shallow, rocky and stony soils, in the western parts miombo woodland is very common, while grassland or wooded grassland is more common on the Gofio Plateau border. The area is suitable for afforestation and grazing.

Figure3.1 Agro-ecological map of the Usangu wetland and its catchment

(b) Agro-ecological zones in Mbeya region

The area of the Usangu catchment that falls in Mbeya region is divided into four main AEZs namely zone AEZ 3, AEZ 14, AEZ 16 and AEZ 18 (Samki & Harrop, 1982) and are hereby summarised.

(xiii) **Uporoto Highlands** lie in the AEZ 3il (Samki and Harrop, 1982). The area comprise of steeply dissected mountains with gentle slopes and down valleys, and a hilly plateau with broad convex interfluves. The altitude ranges from 1 500 m to 2 500 masl, and the rainfall is between 1 000-2 000 mm per annum. The area comprises deep brown sandy clay loams (Mollic, Andosol, Vitric, Haplic Andosol). More than 90% of the area is under cultivation. Remnants exist of natural forests consisting of *Hagenia sterculea* and bamboo with scattered *Ficus* tree species. The common natural grasses in the area are Kikuyu grass. As you move down towards Mbeya stepped plains, grass species dominating the area are *Themeda* and *Hyparrhenia*. Scattered *Acacia kigalia* and *Erythrina* tree species constitute the natural vegetation.

(xiv) **The Mbeya Stepped Plains** lie in the AEZ 3io (Samki & Harrop, 1982). It consists of a gently undulating lava plateau, which has been partly buried by undulating and rolling lava flows. There are also alluvial and debris fans beneath the surrounding hills. The resulting soils are brownish to deep red clay loams of low fertility and highly prone to soil erosion (Haplic Andosols). Altitude ranges between 1 200 m to 1 900 m above sea level. The rainfall decrease from 1 500 mm, in areas bordering Uporoto Mountains to 600 mm towards Shamwengo. Miombo woodlands consisting of *Brachystegia* and *Combretum* tree species as well as scattered *Acacia* are common. *Hyparrhenia* grass species are also common.

(xv) **Rocky Mountains East of Madibira** fall under AEZ 8v (Samki and Harrop, 1982). These are mostly steep, with altitude ranging from 1 000 m to 1 800 masl and mean annual rainfall is 750-900 mm. The soils are rocky and shallow (Cambic arenosol) and sandy with highly sodic and relatively clay rich hardpan in the upper soils towards Mapogoro plains. The vegetation is mainly of *Acacia kirkii*, *A. stuhlmanii*, *Commiphora*, with bushes of *Cynodon* short grassland or barren land. The land is much eroded in the higher elevations leaving rocky out crop.

(xvi) **The Chunya Dissected Plateau** (AEZ 11i) is an undulating and rolling plateau with altitude ranging from 1 200 m to 1 800 masl. Mean annual rainfall is 700-1 300 mm, and the growing season extends from December to April. The soils are shallow, stony sand (Cambic Arenosols). Vegetation is mainly *Brachystegia julbernardia* woodland, bush land or bushed grassland with scattered cultivation. Above 1 700 m, scattered *Parinari curatellifolia* trees occur on the gentler slopes, which are often chosen for cultivation.

(xvii) **The Chunya Plains** lie in AEZ 11ii that is a gently undulating plain with inselbergs. The altitude ranges between 1 000 m-1 500 masl with the mean annual rainfall of 750-900 mm. The soils are deep sands, sandy clay over sandy loam (Albic Arenosol, Fine sodic, Eutric Gleysol). The growing season starts from December to April; and mainly grazing is practised. Miombo woodlands and *Hyparrhenia* species dominate.

(xviii) **The Middle Ruaha Valley** lies in the AEZ16i (Samki & Harrop 1982). It is mostly flat with riverine plains, surrounded by foot slopes of hills and mountains. The altitude ranges between 1 000 m – 1 500 masl and mean annual rainfall is 550 mm. The soils are young, fertile and alluvial, characterised by dark brown to yellow brown loams that are calcareous and saline (Calcic Cambisol, Eutric). The land use is basically grazing of beef and small

ruminants, with scattered cultivation of sorghum, rice and groundnuts by pastoralists. The growing period is between December and March (Mussei, et al, 1999).

(xix) **The Usangu Plains** lie in the AEZ 18 (Samki and Harrop, 1982). They consist of lacustrine plains with fans, bajada and piedmonts. The altitude ranges from 1 000m to 1 050 masl in general, rising to 1 200 masl in the west in the vicinity of Ruiwa. The soils are mainly dark grey clays and the prismatic cracking clays; and are generally slightly sodic. They can be very sodic on levees or raised ground as are indicated by *A. kirkii* or *A. stuhlmanii*. The young alluvial fans and bajada are moderately fertile and are favourably affected by ground water. On the piedmonts above Rujewa, moderately deep reddish profiles with dark moderately fertile topsoils have developed over a mixture of acid and basic rocks. Near Madibira, the soils are moderately deep and coarse in texture in the vicinity of granites. The beach sands are deep course quartz that may be moderately shallow, overlying a hardpan or poorly drained soils. The mean annual rainfall is 600 mm decreasing north eastwards. The growing season is four months from December to March.

3.1.4 Infrastructure

The two highways, Dar-es-salaam-Tunduma and Uyole-Kasumulu, and the Tanzania-Zambia Railway line, pass in the project area. The rural road network is good although the road condition in most of the districts is not good. Most of the villages visited have all-weather feeder roads. The road connecting Matamba division from the District Headquarters is not passable during the wet season, making it very difficult for farmers to get administrative support. Farmers in Matamba division sometimes have to walk long distances to Chimala for hospital services, market their crops and buy other household items. Bicycles are very common and many people use them to transport their produce to the marketing centre.

There is at least one primary school in each village. There are secondary schools in almost every ward either owned/managed by religious institutions or the Tanzania Parent's Association. There are also health centres in most of the wards, though they are poorly equipped with personnel as well as medical facilities.

Water supply status is moderate to good, as some of the villages have piped water distributed by the Water Project funded by DANIDA. In other areas, they have shallow wells. However, other villages like Malangali and Imalilo depend on streams and traditional wells.

There are organised open markets in almost all wards for marketing of crops as well as livestock. Dipping facilities are found in some villages, but most of them are not functional due to problems of availability of acaricides. Appendix VIII summarises some infrastructural facilities existing in the surveyed villages.

A number of donor-funded projects are operating in the area. In Iringa, Hifadhi ya Mazingira (HIMA), a DANIDA/GOT supported project is operating in all three districts. There was also support of the Southern Highlands Dairy Development Project, a Swiss Government funded project, which is currently phasing out. Heifer Project International (HPI) is also supporting dairy farmers. Most of these projects are operating in Iringa Region and the highlands areas of Mbeya.

3.1.5 Village leadership, social groups and institutions

Village leadership is in the hands of village governments, headed by village chairmen. The Village Executive Officers assist the Chairmen on day-to-day activities. The village government comprises also various committees and there are also sub-village leaders.

3.2 Households composition and characteristics

3.2.1 Household size and composition

The mean household size of the respondents is 6 with a minimum of 1 person and maximum of 33 (standard deviation=4.42). Highest numbers were recorded in Mbarali, Iringa and Mufindi districts due to polygamy and extended family ties. Extended family ties were more pronounced amongst the pastoralists, especially the Wasukuma. Sometimes it was very difficult to define a household in the Sukuma context, because sons continued to stay in the parent's homesteads and were counted as one household.

Table 3.2 Household size and composition in the study area

Farming System	Household size			Household Composition			No. of Household members involved in Agriculture (Range)
	Min.	Max.	Mean	Female (mean)	Male (mean)	Children (below 16)	
Potato based (FS1)	1	8	3.73	2.00	2.18	2.10	2.09 (1-3)
Maize-Potato (FS2)	1	11	4.91	2.57	2.48	2.45	2.51 (1-7)
Maize-Beans (FS3)	1	7	4.95	2.40	2.35	2.45	2.35 (1-5)
Maize based (FS4)	1	23	6.19	3.12	2.83	3.55	2.4 (1-9)
Rice Pastoralist (FS5)	1	33	6.81	3.29	3.21	3.41	3.47 (1-11)
Total	1	33	5.90	2.94	2.82	3.10	2.79

Source: Questionnaire survey, 2000

The average number of female and male members of the household is 2.94 and 2.82 respectively. The number of children under 16 years old is on average 3.1 (standard deviation = 3.08). The number of people engaged in agriculture ranged from 1 in singles to 11 in large households, with an average of 2.79 (std. 1.89). Table 3.2 summarises the household size and composition of the interviewees in the different farming systems identified in the study area.

3.2.2 Age and marital status

The average age of the household elders is 39 years, minimum age was 18 years and maximum was 76 years old. The average age of men was 41.6 years while the average age of women was 36.5 years.

About ninety (89.8) percent of respondents were married, 4% were single, 5.9% widows, while 1.1% divorced and 1.2% temporarily separated from their spouses. About 80.7% of the respondents are Christians, Moslems are 3.2% and traditionalists are 16.0%.

3.2.3 Education level

As shown in table 3.3, about 50 percent have complete primary education, 27.8 percent attended primary education but did not complete standard seven. Few (3.2 percent) attended secondary level education, but half of them did not finish school due to various reasons. Some parents could not continue paying school fees for their children, and mostly the girls dropped out to get married.

Table 3.3 Proportion of respondents by types and level of education

Level of Education	Frequency (n=187)	Percentage
No formal education	34	18.1
Adult education	7	3.8
Complete primary education	88	47.1
Incomplete primary education	52	27.8
Secondary education	3	1.6
Incomplete secondary education	3	1.6

Source: Questionnaire survey, 2000.

3.2.4 Ethnic composition

Looking at the ethnic composition in the project area (table 3.4), it was found out that, in Iringa and Mufindi the major ethic groups are Wahehe (88.9% and 76.2% respectively) and Wabena (11.1% and 23.8% respectively). In Njombe, Wabena are the majority and few Wakinga (96.6% and 3.4% respectively). In Makete, Wawanji are the majority (71.4%) especially in the highlands, with few Wabena and Wakinga (10.7% each). Wasangu are found in the lowland areas of Kimani (7.1%). In Mbeya district, majority are Wasafwa (85.4%), with few Wakingas (9.8%) especially in the Uporoto Mountains, and Wanyakyusa (4.9%). In Mbarali, as stated earlier, there are more diverse ethnic groups. It was found that Wasangu who are the natives forms about 23.7%, followed by Nyakyusa (20.3%). Another big groups are the Wahehe (16.9%), especially in Madibira area, and Wasukuma (11.9%). Others are Wabena and Wakinga (6.8% respectively), Wasafwa, Wawanji and Wagogo (3.4% respectively), Wandali and Walambya (1.7% respectively).

Table 3.4 Ethnic groups composition by district (% of respondents)

Tribe	Iringa	Mufindi	Njombe	Makete	Mbeya	Mbarali
Wahehe	88.9	76.2				16.9
Wabena	11.1	23.8	96.6	10.7		6.8
Wakinga			3.4	10.7	9.8	6.8
Wawanji				71.4		3.4
Wasangu				7.1		23.7
Wasafwa					85.4	3.4
Wanyakyusa					4.9	20.3
Wasukuma						11.9

Source: Questionnaire survey, 2000.

3.2.5 Source of income for rural livelihood

The major source of household income is agriculture and livestock. About 94.7% of the farmers ranked agriculture as their first income source, and 38% indicated livestock as their second source. Agriculture formed the main occupation of rural people, where 100% are engaged in crop production. Eighty six percent (86%) of farmers keep different types of livestock. Farmers are also engaged in off-farm activities as discussed in Chapter 8.

3.2.6 Land ownership, acreage and distribution

On average, farmers manage 5 different agricultural plots. ranging between 1 and 25. The highest number of agricultural plots was recorded in maize-potato farming system. This is due to land fragmentation in the highlands. In the maize-potato growing areas, particularly Mbeya District, husbands and wives customarily own farm plots. Therefore land is divided into smaller plots and allocated between parents, sons and daughters soon after the latter are able to work. Daughters maintain their plots even after they are married. Coupled with population pressure, this system of land allocation has resulted into increased land fragmentation such that the size of the plots is currently very small. Husbands may also allocate some land to their wives so that there is guarantee of food for their household and excess for sale. In the rice-pastoral farming system number of plots are few but the acreage are large. In most of the villages, men own land (65%), while 25% of the farmers indicated that both husbands and wives owned land. Only 10% of women owned land in the project area. Farmers have an average of 8.5 acres, with a minimum of 0.5 and a maximum of 261 acres. Table 3.5 shows the average number of farm plots and acreage per farming system.

Table 3.5 Average number of farm plots and acreage per farming system

Farming Systems Zones	No. of respondents	Number of Agricultural Plots			Acreage		
		Ave.	Min.	Max.	Ave.	Min.	Max.
1. Potato-based	12	5.4	4	7	6.1	2.5	10.5
2. Maize-Potato	35	8.6	2	25	7.9	0.75	80.0
3. Maize-Beans	20	8.0	1	24	4.9	1.0	10.5
4. Maize-based	52	3.7	1	20	4.9	1.0	15.0
5. Rice-Pastoralism	68	3.1	1	10	13.2	0.5	261.0
Project area	187	4.9	1	25	8.5	0.5	261.0

Source: Questionnaire survey, 2000

Large land holdings were recorded in Mbarali and especially amongst the agro-pastoralist households who have opened large land areas for crop production. There is a difference between genders in land ownership. Men headed households have more land, the average is 10.45 acres, ranging from 0.5 to 261. Women headed household have on the average 6.14 acres ranging between 0.75 to 80 acres.

About 79 percent of the farmers acquired their land through inheritance. Fourteen percent (14%) of the farmers were allocated land by village governments and 7% got land through hiring or bought land. About 36% of farmers hire land from other individuals. Hiring of land is very common in Mbarali (28.8%), Makete (35.7%) and Mbeya (46.3%) districts. Land is hired for the production of cash crops like paddy and potatoes. Also many farmers hired land in the valley bottoms locally known as “vinyungu” for the production of high value crops like green maize, tomatoes and vegetables.

It was also found out that farmers have moved back to their land, locally known as "malungulu", due to a shortage of land in areas where they were moved to during the villagization programme of 1974. Farmers keeping livestock also had to walk long distances in search of grazing lands; thus they decided to go back to their "malungulu". This has increased the number of village hamlets, and some of them are allocated more than 10 km from the village centre, creating problems to children attending school, as was the case in Maduma and Malangali villages in Mufindi and Njombe districts respectively.

About 48% of the respondents have land in the valley bottoms locally known as "vinyungu". In Iringa district 100% of farmers have land in the "vinyungu". The utilisation of bottom valley 'vinyungu' under different farming systems is shown on table 3.6 below.

Table 3.6 Percentage of respondents having farms on valley bottoms, sloping and flat lands

Farming System	Having farms on Valley bottom land (vinyungu)	Having Farms on Sloping Land	Having Farms on Flat land
Potato-based (FS 1)	0	90.9	27.3
Maize-Potato (FS 2)	34.3	100.0	40.0
Maize-Beans (FS 3)	50.0	85.0	75.0
Maize-based (FS 4)	79.2	69.8	69.3
Rice-Pastoralist (FS 5)	36.8	5.9	91.2
Project (study) area	47.6	55.1	70.1

Source: Questionnaire survey, 2000.

This indicates that, valley bottom cultivation is very common in almost all farming systems, except in the potato-based farming system and some parts of Uporoto (maize-potato farming system), where it is very hilly and valley bottoms are narrow. Cultivation in the 'vinyungu' is done as an income generation activity, but to a large extent it supplements the low production in the main season. In the rice-pastoralist farming system most farmers cultivate along river-banks when they have access to water. Apparently due to shortage of water in the past two seasons, most farmers could not cultivate their vinyungu. Some farmers have to hire from neighbouring farmers or villages. Otherwise vinyungu cultivation is very important for food security as well as income generation.

Fifty five percent (55.1%) of the farmers indicated having land on steep slopes, while 70.1% have their farms on the flat land. Except for few farmers in areas where there is intervention by projects like HIMA in Matamba, EEC in Galijembe, and ARI Uyole in Iyawaya, farmers did not use any conservation methods to protect land from erosion. Most farmers in the highlands construct diverging channels to allow water flow out of their fields. During group discussions with farmers, it was revealed that farmers did not practice land conservation, claiming that contour construction, for example, is laborious. Other claimed that contours reduced areas for cultivation.

4. DESCRIPTION OF THE FARMING SYSTEMS

Rainfed agriculture is mainly subsistence and is practiced by all households in the study area. It is the most important source of living. The different farming systems found in the project area can be explained by the variation in physical and biological circumstances and by variation in economic and social realities. Natural circumstances influence farmer's decisions on the type of crops to be grown. Altitude and rainfall impose restrictions on growing seasons and create uncertainties in farming. Differences in soils and topography are other factors of major importance in crop production. External socio-economic circumstances including farmer's access to inputs, produce markets, prices, availability of consumer goods, credits and extension services also influence their decisions.

Resource constraints in terms of labour, cash and capital limit farmers capacity to make substantial changes in their farming systems. Also large and rapidly expanding villages have resulted in local land shortages. In areas where farmers cultivate with oxen and land is not limiting, increases in production are a result of increases in acreage as opposed to intensification. Most of the potential farmland is under continuous cultivation. In areas where there is land pressure, cultivation is now spreading to steeper slopes with serious erosion susceptibility.

The farming system in the rainfed agriculture is very dynamic and in most cases crops and crop mixtures grown reflect the dietary preferences and the market opportunities of the farmers and risk avoiding strategies. The highlands and plateau have good soils, reliable and plentiful rainfall and are of high agricultural potential for smallholder farmers.

In the highlands and medium plateau, crops grown include maize, beans, round potatoes, green peas, sweet potatoes, wheat, pyrethrum, coffee, sunflower, finger millet, vegetables and fruits. In some areas, sugarcane is becoming an important cash crop and its production is on the increase in villages bordering Usangu plains. In the lowlands, the main crops produced are maize, cowpeas, pigeon peas, groundnuts, millets, sorghum, sweet potatoes and cassava. Paddy is mostly grown under irrigation either in traditional or improved schemes. Table 4.1 shows percentage of farmers growing different types of crops in the farming systems studied.

Livestock is practised both in the highlands and lowlands, where cattle, small ruminants, and non-ruminants are kept in varying degrees. There is high population of ruminants in the lowlands, and in the highlands dairying and pig production is common.

The farming systems (FS) are classified based on AEZs and other socio-economic factors. Although the soils, climate and altitude define the land-use pattern within any AEZ, different farming systems occur along side each other, sometimes correlated with infrastructure (figure 4.1). The farming system zonation is summarised in Appendix VII and detailed information is given in the proceeding sections.

Figure 4.1. Farming systems map.

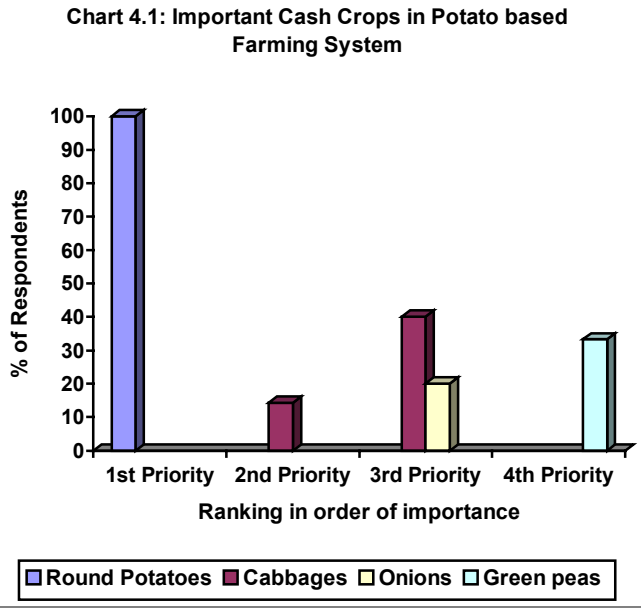
Table 4.1 Types of crops grown by farmers in different farming systems (percentage of respondents growing the crops)

Crop	FS1	FS2	FS3	FS4	FS5	Total
Maize	-	97.1	100.0	98.1	100.0	98.4
Beans	-	77.1	95.0	98.1	36.8	67.9
Wheat	-	100.0	50.0	9.4	-	31.0
Paddy	-	-	-	-	60.3	21.9
Pyrethrum	18.2	62.9	20.0	-	-	15.1
Finger millet	-	-	5.0	13.2	7.4	7.0
Sorghum	-	-	65.0	11.3	17.6	7.0
Round potatoes	100.0	88.6	68.8	32.1	-	38.3
Sweet Potatoes	-	14.3	55.0	43.4	30.9	32.1
Sunflower	-	5.7	5.0	79.2	1.5	24.6
Sugarcane	-	5.7	5.0	7.7	4.4	4.8
Cowpeas	-	-	-	30.2	22.1	16.6
Tomatoes	-	20.0	70.0	28.3	8.8	22.5
Cabbages	27.3	17.1	20.0	18.9	-	12.3
Onions	9.1	22.9	30.0	9.4	2.9	11.8
Green peas	54.5	64.7	60.0	5.7	-	23.1
Coffee	-	37.1	35.0	-	-	10.7
Bananas	-	20.6	30.0	1.9	4.4	9.1
Fruits	-	42.9	10.0	1.9	1.5	10.2
Groundnuts	-	-	20.0	13.2	38.2	19.8
Vegetables (leafy)	9.1	11.4	30.0	9.4	10.3	12.3

Note: FS1=Potatoes based. FS; FS2=Maize-Potatoes FS; FS3=Maize-beans FS; FS4=Maize based FS; FS5=Rice-Pastoralism.

4.1 Potato-based farming system (FS1)

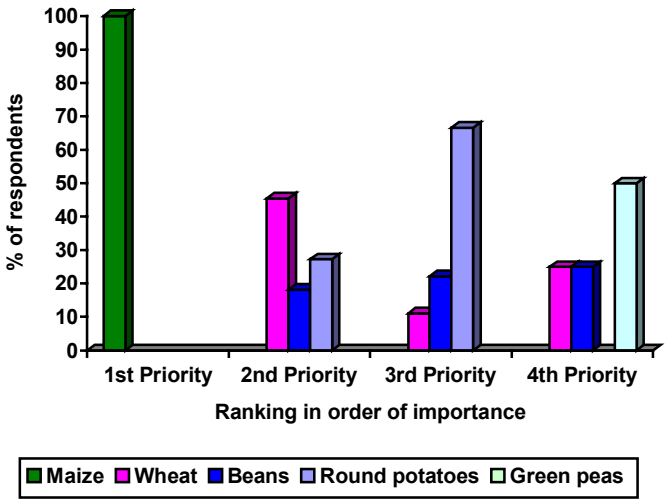
The potato based FS lies in the high areas of Kikondo in Kitulo plateau in AEZ 3. The altitude ranges from 2000 to 2900 m and has a montane temperate farming system. The soils are rather variable but the altitude and temperatures are of overriding importance. The dominant vegetation is short grassland of low nutritive value, which is mostly used for grazing. There are remnants of the natural forests consisting of *Hagenia sterculea* and bamboos with scattered *Ficus* species. Kikuyu grass is the common natural grass in the area. Bamboo is used primarily as a building material and especially for roofing.



The soils are mostly dark in colour with free pumice gravel. Rainfall is generally high and the

mean annual rainfall is 1 600 mm. The growing period is consequently very long, with duration of 280 days. The mean temperature is 10.8^0C, and frost can occur in the driest months of June, July and August. Climatically the area is suitable for pyrethrum, and it used to be a major cash crop before 1991. Round potatoes replaced it (chart 4.1) due to marketing problems experienced after the collapse of co-operative unions, which were sole buyer of pyrethrum flowers.

Chart 4.2: Important Food crops in Potato-based farming system



Good markets in Dar-es-salaam and neighbouring countries such as Malawi and Zambia also motivated farmers to expand potato production. Potatoes are grown as the main cash and food crop. Although the area under potato production is on the increase, poor road conditions leading to low prices are discouraging farmers. With liberalisation of marketing of cash crops in recent years, some farmers have started to replant pyrethrum. The pace of growing pyrethrum is, however, very slow because the prices offered in the last two seasons were not very attractive and the farmers still lack confidence on the market opportunities. It was reported that farmers are discouraged to grow pyrethrum in this area, as it takes too long to harvest (6 months), as compared to potatoes (3 months). In addition, during the wet season drying of pyrethrum is laborious and there are a lot of post harvest losses.

Wheat, green peas and maize are grown mainly for food (chart 4.2). However, the growing season is too long in this zone, therefore farmers cultivate these crops in the neighbouring villages that are located at lower altitudes. Farm size is on average 6.1 acres per household, ranging between 2.5 to 10.5 acres (table 3.5). Area under cultivation of round potatoes, which is a major cash crop, is on average 2.68 acres per household ranging from 1.0-5.0 acres. Use of chemical fertilisers in round potato production is medium, where most farmers apply 2 bags of 50 kg each of Triple Super Phosphate (TSP) plus 1 bag (50 kg) of Calcium Ammonium Nitrate (CAN 26% N) mix in one acre, as basal application. The recommended rates for potatoes in these areas are 3 bags of TSP plus 3 bags of Urea (46% N) per acre. Top dressing is not common, and use of organic manure was not mentioned. Cultivation is done by hand hoe, and use of donkeys for haulage is on the increase. Labour is one of the constraints in crop production, but terrain limits mechanisation especially for land preparation, weeding and harvesting. Farmers use hired labour and labour parties for the activities.

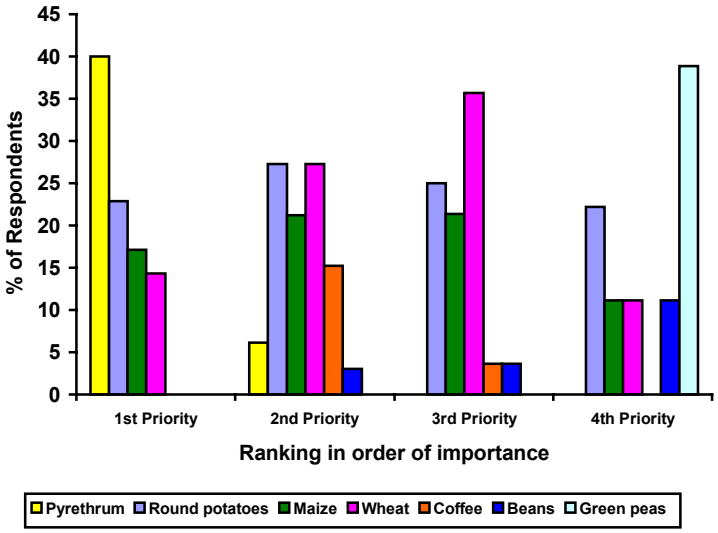
On average, yield for crops grown in potato based farming systems are very low. The average yield for round potatoes is 5 409 kg/acre, while the potential yield ranges from 17 tons to 30 tons depending on the variety and fertiliser use. The average yields for other crops recorded are cabbage (2 533 kg/acre); green peas (196.7 kg/acre) and onions (200 kg/acre).

About 72.7 percent of farmers interviewed reported that they keep various types of livestock, including cattle, sheep, and donkeys. Local Zebus and sheep are common, although the population of sheep has declined due to high mortality rates caused by diseases. Pig production is also very common. Livestock keeping is mostly extensive where animals are kept far from homesteads, and one member of the family goes there once a day to check in case of sick animals. Under this system animals are not milked. The average number of animals kept, by category, are presented in table 6.1.

4.2. Maize-potato farming system (FS2)

The maize-potato (MP) farming system is found in the high altitude areas of Uporoto particularly Tembela and Matamba divisions, and some parts of Njombe plateau. Mussei et al (1999) referred to this as farming system zone 4 (FS 4). The soils are mostly highly leached. The area comprises of deep brown sandy clay loams (Mollic Andosol, Vitric, Haplic Andosols) in Uporoto Mountains. In the Njombe plateau the soils are highly leached red clays of low fertility, mainly with humic topsoils influenced by volcanic ash on the almost flat or gently sloping hilltops.

Chart 4.3: Important Cash crops in Maize Potatoes Farming System

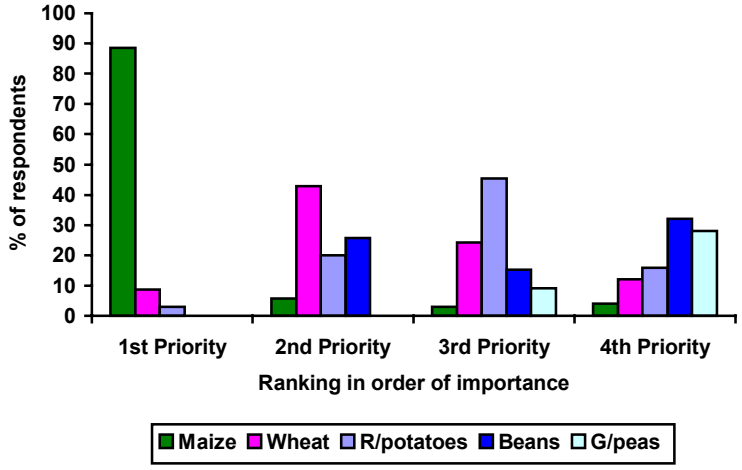


Remnants of natural forest consisting of *Hagenia sterculea* and Bamboo, Kikuyu grass at higher elevation and *Hyparrhenia* grass is dominating in the lower altitude. More than 75 percent of land is under continuous cultivation. Land fragmentation is common and access to more land for expansion is difficult. The growing period is rather long extending from August to July the following year, thus inter-cropping or double cropping is very common.

Agriculture is both for subsistence and cash income. The predominant crop is maize followed by potatoes and pyrethrum, wheat, beans and peas (table 4.1). Round potatoes, pyrethrum and maize are the major cash crops, while maize is the major food crop, followed by wheat and round potatoes, beans and green peas. Low prices offered by private buyers and poor road condition to villages in this farming system are becoming major hindering factors to increased production.

In this area pyrethrum used to be a major cash crop, but market problems caused farmers to abandon the crop in favour of round potatoes. Unlike in Kikondo area, farmers interviewed at Igenge, Ulenje and Nyalwela villages claimed that there is increased demand of pyrethrum seeds this season as many farmers are increasingly gaining confidence in the private sector involved in the buying of pyrethrum flowers in the villages. Charts 4.3 and 4.4 summarises the ranking by respondents on the importance of different crops grown. Pyrethrum is ranked as first priority as a cash crop, followed by round potatoes and maize. Maize is ranked as first priority food crop followed by wheat, round potatoes, beans and green peas.

Chart 4.4: Important Food Crops in Maize-Potato Farming System.



Vegetables like cabbages, onions and tomatoes are becoming important cash crop earners where communication is good such as Njombe, Tembela and Uyole areas that have access to market areas of Mbeya town and Dar-es-salaam. Other crops include high altitude sorghum and finger millet, although the production of finger millet has declined as areas under forest used for slash and burn system are diminishing. Sorghum and finger millet are basically used for brewing. Temperate fruits, mostly peaches are common around the homesteads in this area. Bamboo for wine production is also an important cash crop in some areas. All cultivation is done by hand hoe, as hilly terrain limits mechanisation.

Average farm size is 7.9 acres per household, and allocation of land to a particular crop depends very much on its importance as a cash or food crop. On average, farmers cultivate 2 acres of maize; 1.24 acres of round potatoes; 1.1 acres of beans, 1.2 acres of wheat, 1.1 acres of pyrethrum and 0.9 acres of green peas. Sometimes these crops are mixed, and it is common to find mixtures of maize with round potatoes and peas or wheat with peas. Pyrethrum is grown as a mono-crop. Few farmers buy seeds, while the majority select own seeds from previous crop. Varieties of maize grown include H6302 and H614.

Use of chemical fertiliser is common for cash crops and farmers are using TSP or DAP for basal application and UREA or CAN for top dressing. On average 36.3 kg/acre is applied at planting and 30 kg/acre is applied as top dressing in maize. In round potatoes 51.4 kg and 33.1 kg per acre are applied during planting and top dressed respectively. Use of organic manure was reported, but rates are very low (270 kg/acre). The recommended rates for maize and round potatoes are 2 bags of TSP per acre and 7 bags of Urea per acre for Njombe plateau and Uyole plains respectively. Average yield in kg per acre for crops grown in this farming system as reported by respondents are very low as follows: maize (522.9); round potatoes (1,696.9), beans (140.7); wheat (295.6), onion (468.6) and tomatoes (1011.4). Farmers mentioned soil fertility and labour as major constraints. There is also high diseases and pest pressure in this farming system as compared to potato-based farming system. Many farmers in the MP-FS reported use of pesticides in control of diseases and pests.

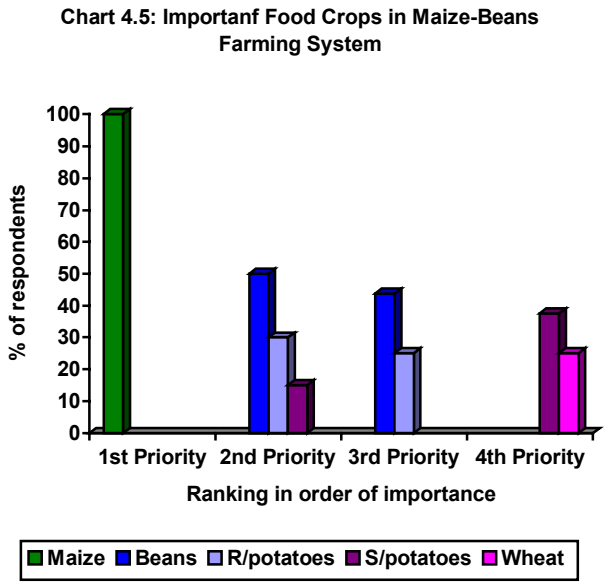
Over 80 percent of farmers indicated problems of labour shortage in the FS for various crop operations; out of which 42.4 percent hired labour for especially land preparation. Other activities such as planting, weeding and harvesting, though experienced labour shortage, there are few farmers that indicated hiring labour.

About 88.6 percent of farmers interviewed keep livestock in the MP farming system. The livestock kept include cattle, goats, sheep, pigs, guinea pigs, rabbits and poultry (table 6.1). The number of dairy animals under smallholder is increasing as a result of intervention by projects and NGOs like

Southern Highlands Dairy Development Programme, HPI, and CARITAS Tanzania. Most of these animals are managed under the extensive system of grazing (60.9%), while dairy animals are either zero grazed (8.7%) or tethered (30.4%). Milk marketing is a common problem in these areas, despite the efforts by some projects to mobilise groups cum associations to promote group marketing. Milk processing is only limited to fermentation into sour milk. There is low use of draft power in this zone (8.6% of respondents) because of the terrain that limit mechanisation; moreover donkeys are used for haulage.

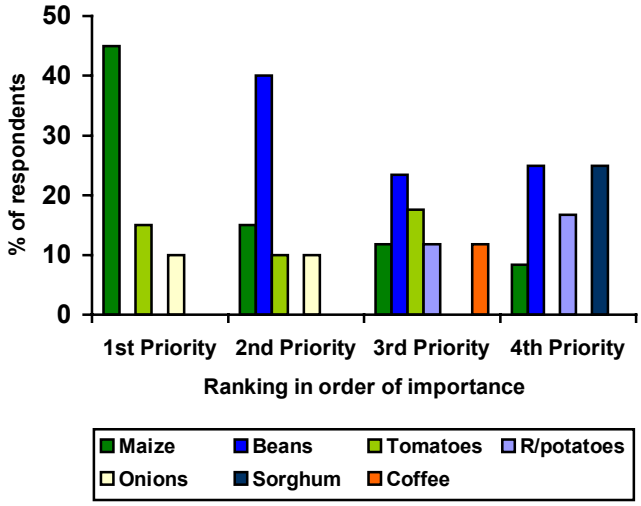
4.3. Maize-Beans Farming System (FS3)

The maize-beans (MB) FS is predominantly practised in the middle altitude. The FS is common in the Uyole plains and it extends to Inyala area. It is also found in some parts of the highlands such as the Njombe plateau, where it is located in the foot-slopes of the mountains. The soils are mostly highly leached red clays with low fertility. In the Mbeya stepped plains soils are brownish and deep red clay loam of low fertility. These soils are prone to erosion. Miombo woodland and *Hyparrhenia* grasses are the dominating natural vegetation. Rainfall decreases from 1 500 mm in higher altitudes, to 600 mm in the lower altitudes. The growing period is between December and June. The main crops grown are maize, beans, tomatoes, onion, wheat, round potatoes, sweet potatoes, sunflower, sorghum and finger millet. Their importance as food and cash crops is shown by the percentage of respondents (charts 4.5 and 4.6). The cropping system is either mono-crop or mixed. Cultivation is on small to medium farms. Farmers cultivate on average 2.8 acres of maize, 2.1 acres of beans, 0.8 acres of pyrethrum, and 0.5 acres of round potatoes and wheat respectively. Other crops are groundnuts (1.7 acres); onion (1.0 acres); sorghum (0.6 acres); sunflower (0.5 acres) and finger millet (0.5 acres).



There is high use of draft power (52.6% of respondents) for land preparation. All other operations are done by hand. However, farmers who owned oxen are only 20%. Other farmers using oxen either borrowed (10%) or hired from fellow farmers (70%). Use of fertilisers is relatively low, and is mainly used in maize and round potato fields. Interviewed farmers who indicated use of fertilisers in maize, apply on average 30.6 kg/acre as basal application, and 52.9 kg/acre for top dressing. The recommended rates for maize is 50 kg/acre of TSP or DAP and 100 kg/acre of CAN for basal and top-dressing respectively. Most farmers reported use of own selected seeds from previous crop, and reasons given are that prices of seeds are high and quality of seeds is poor as experienced in the last two seasons.

Chart 4.6: Important Cash Crops in Maize-Beans Farming System

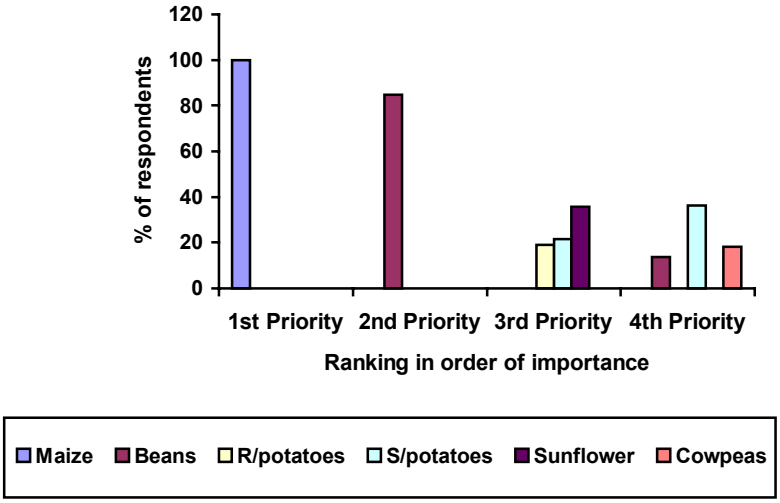


About 95 percent of respondents keep livestock in this farming system. Thirty nine percent (38.9%) keep cattle for draught power, milk production and supply of manure. More than 88.9 percent keep chicken and 61.1 percent keep goats. About 16.7%, 11.1%, and 16.7% also keep pigs, guinea pigs and rabbits respectively. Table 6.1 shows the average number of livestock kept in the FS. Livestock keeping is mostly extensive, except for pigs and guinea pigs that are raised in-door. Farmers interviewed indicated that feed resources are adequate.

4.4. Maize-based farming system (FS4)

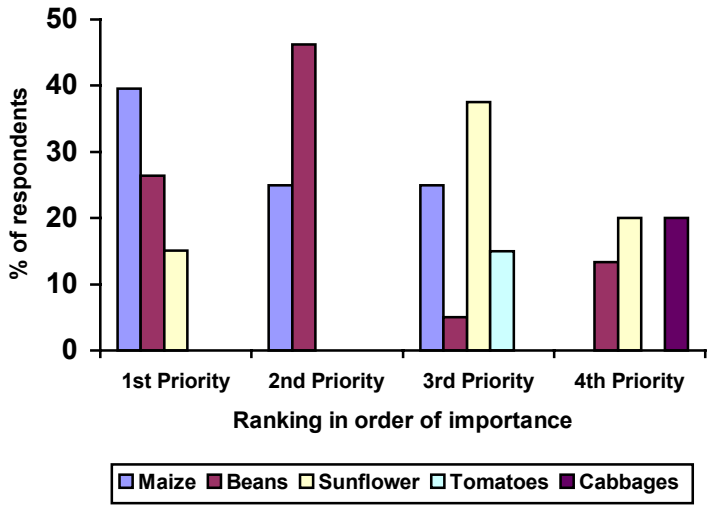
The maize-based (M) FS covers areas of Mufindi and Kidugala plateau, Northern Ubena plateau (Makambako-Njombe road), lower Mufindi plateau (Malangali-Saja-Wanging'ombe stretch) and Usangu Flats border (Chimala-Mbuyuni-Igawa area). The altitude ranges between 1 200 - 2 000 m. The annual precipitation varies between 900 mm to 1 000 mm, and the growing period is 175 days starting from end of November. The soils are uniform yellow highly leached clays, and red clay soils with moderate fertility sometimes having a sandy topsoil. In the Usangu Flats border, soils are predominantly shallow or moderately deep red clays, mostly stony with poor fertility.

Chart 4.7: Important Food Crops in Maize based Farming System



The dominant vegetation is Miombo and *Acacia* woodland with grasses of low nutritional value. Extensive undulating grasslands characterised by short shrubs of miombo, mikusu (*Combretum* species), *Uapaca kirkiana* and Misaulwa (*Parinari* species) typify the zone. *Hyparrhenia* and *Cynodon* species dominate the natural grasses. Most of the area is cultivated, although there is still a large area under grassland.

Chart 4.8: Important Cash Crops in Maize-based Farming System

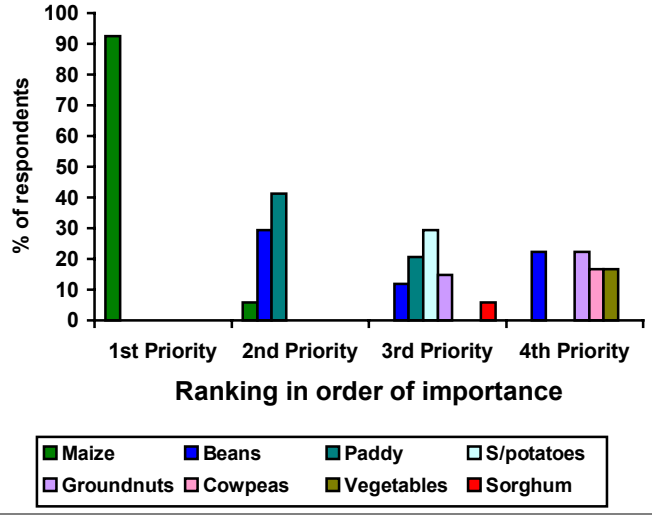


The basic FS does not vary significantly throughout the system, concentrating mainly on maize production followed by oilseeds such as sunflower and groundnuts. Other crops of importance are beans, cowpeas, pigeon peas, sorghum, sweet potatoes, cassava, wheat, tomatoes, onion, vegetables and bamboo. Charts 4.7 and 4.8 summarise the importance of food and cash crops as indicated by respondents. Maize is sometimes planted under *Acacia* trees, a practice commonly seen along Chimala-Mbuyuni and Madibira areas. Soils under *Acacia* trees are fertile and moist favouring growth.

In this area, farmers use oxen (73.6%), mostly for ploughing and transportation. Weeding and ridging implements are not very common despite the fact that these farm operations seem to be an important bottleneck in increasing productivity. Use of chemical fertilisers is very low, due to low incomes leading to low capital investment in crop production. Very few farmers use chemical fertilisers, but farm yard manure is used by many farmers who keep livestock. On average farmers use fertilisers in maize at rates of 26.2 kg/acre of TSP and 30.9 kg/acre of CAN for basal and top-dressing respectively. Farmers mostly use own selected seeds.

About 94 percent of respondents keep livestock. Animals kept include cattle, goats, sheep, pigs and poultry. Fifty percent of respondents keep cattle while 84.3% keep poultry. Few farmers keep goats, sheep and donkeys. Like in other FSs, livestock are extensively grazed in rangelands, and farmers reported that feed resources are adequate.

Chart 4.9: Important Food Crops in Rice-Pastoral Farming System



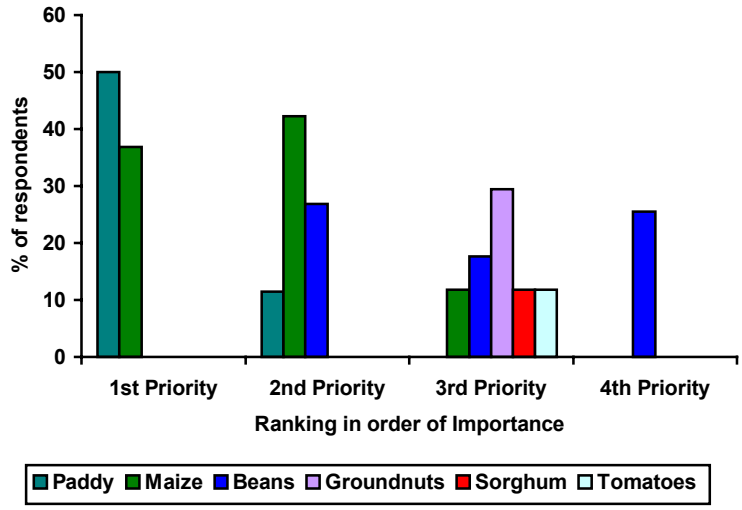
4.5 Rice-Pastoral Farming System (FS5)

The Rice-Pastoral (RP) FS occupies the Usangu plains (AEZ 18) and is characterised by cultivation of paddy, and is referred to as FS 10 by Mussei et al (1999). Under this system, the concept of land use planning along the catena is very well developed and crops are located to land components according to their capabilities (Hatibu

& Shetto, 1997). Soils are mainly dark grey clays and are generally slightly sodic. The young alluvial fans are moderately fertile. The mean annual rainfall is 600 mm that tends to decrease north-eastwards. The growing season is short as compared to other FS zones, that is, four months starting from December. The Acacia woodlands dominate the natural vegetation, with *Hyparrhenia* and *Cynodon* species in the grasslands.

Rainfed agriculture is practiced mainly with upland crops like maize, sorghum, cassava, sweet potatoes, groundnuts, cowpeas, beans, onion, pumpkins, sunflower, sugarcane and green-grams. Farmers grow maize because it is the most preferred staple food, but they do not use fertilisers, claiming that the land is still fertile. Charts 4.9 and 4.10 indicate the percentage of respondents showing the importance of different crops grown in the rice-pastoral farming system. It shows that paddy is mostly grown as a cash crop than a food crop. This may have implication of the food security because paddy receives more attention in terms of resources allocation especially labour than maize, the main food crop. Extensive inter-cropping is practiced, and the yield of maize is low due to moisture stress and poor management.

Chart 4.10: Important Cash Crops in Rice-Pastoral Farming Systems



Cotton was a promising cash crop but its production stopped in 1998 season as a result of quarantine imposed by the government due to out break of American Red bollworm. Paddy is produced in water bunds, as a strategy for water management. However, unreliable rainfall is a major constraint as experienced in the past two years, where land under paddy cultivation was abandoned in most villages visited, because of little rains received in the area.

Production of other rainfed crops is suffering from conflicts in terms of resource allocation such as labour because all crops are grown at the same time. Labour has been mentioned as an important constraint in rainfed crop production and there is always competition with rice production in this FS. Labour saving technologies are limited to the use of oxen for land preparation and haulage. None of the farmers interviewed reported use of oxen for other farm operations like weeding or ridging. Division of labour within family members, dovetailing activities and hired labour are some of the strategies used to cope with labour constraint. Use of labour parties or 'njanwa' is not common for activities such as weeding. Reasons given include the fact that at the very time every farm family is trying to 'rescue' their crop, therefore not willing to work in labour parties. Some farmers indicated that with 'njanwa' the family is required to prepare food or brew alcohol for fellow farmers to drink after the work. Unfortunately it coincides with time of food shortage, and thus farmers cannot afford it. Some farmers indicated also that operation like weeding needs care, which is not guaranteed with hired labour or labour parties.

Improved crop husbandry like planting in recommended spacing is not practised. Ridging is common for maize and groundnuts. Sorghum is planted on flat seedbeds and mostly is broadcast. Farmers select own seeds from previous crop, and most common maize varieties grown include Katumbili, Katumani and Mwendambio. Few farmers purchase seeds and Cargil 4141 is preferred due to its early maturity. Sorghum varieties grown are known by different names in different places, but in Ikoga farmers mentioned Piligi (an early maturing variety), Mawilu (late maturing variety but high yielder). Other sorghum varieties are Gumi and Msale believed to originate from the northern region or Kenya.

Farmers cultivate large land areas. On average farmers own 13.2 acres, ranging from 0.5 to 261 acres. Large land holdings are reported amongst the agro-pastoralists groups who opened large areas to cater for large families. Land scarcity was reported at Kimani where farmers hired land for especially paddy cultivation. Yield for crops grown is generally low because of poor crop husbandry in almost all crops grown in addition to other problems mentioned above. Mean yield for paddy is 1228 kg/acre; for maize is 572 kg/acre; groundnut (225 kg/acre); sorghum (415.8 kg/acre); sweet potatoes (1482 kg/acre); cowpeas (67 kg/acre); finger millet (252 kg/acre).

More than 77 percent keep livestock. Large groups of ruminants, sheep and goats are mainly kept by agro-pastoralists, especially the Sukumas, Maasais and other ethnic groups from the northern regions (table 6.1). Increased theft incidences by pastoralists have reduced the number of animals kept by small farmers in the Usangu area. Most farmers (88.7%) keep chicken, but numbers are reduced by high incidences of diseases like Newcastle and coccidiosis.

4.6. Pastoral farming system

The pastoral (P) FS covers the area north of the Usangu plains known as Middle Ruaha valley. In this system the principal production enterprise is livestock. The system is characterised by stock keeping that is sometimes supplemented by a little crop production (mainly sorghum and millet). There is very low off-take of animals but with high sales of milk and gee in exchange for food grains. The output levels are low and there is limited commercialisation (Hatibu & Shetto, 1997). This area was not visited during the study.

4.7 Tobacco-pastoral farming system

The tobacco-pastoral (TP) farming system lies in the northwest parts of the project area in Chunya district. Most farmers grow flue-cured tobacco as their main cash crop. Bee keeping is a traditional activity in the farming system. The majority of farmers keep large herds of cattle. The climate, soils and poor road communications are a serious constraint to development in this system. The area was not visited during the survey.

4.8. Maize - potato - tea farming system

The maize-potato-tea (MPT) farming system covers the central Njombe area. Main crops grown in this FS are maize, potatoes and tea. Other crops include wheat, peas, temperate fruits, beans, barley, pyrethrum, sunflower and coffee. The livestock kept include cattle, goats, sheep, pigs and poultry. Forests are a common component of the system and are dominated by wattle trees. The FS was not visited during the formal survey.

4.9. Changes in the farming systems

As discussed earlier, the existing farming systems are a result of interaction between the exogenous, natural, economic and cultural circumstances of farmers and their own priorities and resource capabilities. Farm households manage and practice production roles in response to physical, biological and socio-economic environments, and in accordance with the household goals, preferences and resources. In rural areas many activities are geared towards ensuring enough household food supply and earn cash to meet other household obligations. Observation shows that the farming systems found in the study area are very dynamic. Discussion with farmers reveals that household preferences on the type of crops to be grown for food and cash earning and level of productivity have been changing over time. The changes may be in terms of changes in cropping patterns, crop-livestock interactions, and particularly changes towards a market economy.

In the maize-beans and maize based farming systems where maize is a main staple food, farmers indicated that finger millet used to be the main staple food. Finger millet was produced under a slash and burn system. Increase in population resulted in opening up of more land for production of food crops. This reduced areas under forestry to support this type of farming system. After the introduction of maize improved technologies under the maize improvement programme of the 1970s, maize replaced finger millet. Promotion of use of fertilisers that were highly subsidised made it more profitable to produce maize at that time and there was a ready market for the crop. Therefore maize became a major food crop as well as a cash crop. In addition, the availability of input credit facilities in the rural areas at the time of maize improvement programme increased the adoption of improved practices. Increase in maize production in the southern highlands, hence nicknamed 'the big four' or 'the grain basket of the country'.

Recent campaigns by the government and other pressure groups to stop deforestation have also contributed to reduced number of farmers producing finger millet and area under cultivation. Only 7 percent of farmers indicated that they grow finger millet. The number might be higher as many farmers feared to state that they grow finger millet due to by-laws on deforestation. In Idumulavanu, for example, farmers needed a permit to clear a new farm, and that is where they plant finger millet. Farmers also reported that finger millet post-harvest processing is very laborious and thus discouraging them especially young farmers.

In the rice-pastoral farming systems we observed that land that is currently under maize could be converted to rice production when water is available, thus changing cropping patterns. For example, in Itamba village farmers are producing maize on land that was formally under rice cultivation. The river that was providing water to these farms had shifted its course during the *el nino* rains, leaving about 2 000 acres without water for rice production. Farmers who want to continue cultivating rice have to walk long distances to other villages like Kimani to hire land. This creates more competition of resources available especially family labour. There are many similar examples in villages in this FS like Simike and Mhwela villages.

There is persistence of growing maize in marginal areas due to food preferences as it was observed in the high altitudes. These areas have long growing season causing maize to occupy land for almost 10 months.

Improvements in the infrastructure to markets in major towns has recently increased production of horticultural crops. Most of the horticultural crops are produced in the off-season, under irrigation. Land that used to lay idle after harvesting allowing cattle to graze is immediately cleared for horticultural crops as observed in Iyawaya village. This has also created competition on resource allocation in terms of labour for off-farm activities and water.

It was also observed that in the potato based FS and maize-potato FS, round potato replaced pyrethrum when there was a problem of marketing the crop. This shows that farmers are responding to market opportunities whenever possible.

The migration of agro-pastoralists in the Usangu plains also has an influence on the type of farming systems. They introduced keeping of large herds of animals, creating more demand on grazing lands. Pastoralists from the Sukuma ethnic group also promoted cultivation of crops like sorghum, groundnuts and sweet potatoes causing opening up of more land.

Changes in government policies may also influence changes in the farming systems. The recent quarantine caused farmers to drop cultivation of cotton that was a promising cash crop in the Usangu plains.

Introduction of dairy animals under zero grazing also makes a lot of changes in resource allocation especially labour. Women get more involved in dairy management as observed in maize-potatoes and maize-beans farming systems. In same FSs land fragmentation and utilisation of marginal lands due to population pressure caused farmers to cultivate high value crops like tomatoes and onions. Due to land shortage in these areas, time for fallowing that was practised for soil conservation and fertility improvement is reduced from 5-10 years to 1-3 years.

5.0. CROP PRODUCTION

5.1. Types of crops grown

The major crops grown in the Usangu wetland and its catchment are maize, beans, paddy, wheat, round potatoes, sweet potatoes, sunflower, groundnuts, cowpeas, finger millet, and vegetables like pumpkin leaves, spinach, cabbages, green peas, onions, and tomatoes. The choice and intensity of a crop grown depends very much on the agro-ecological zone and the farming system. The main food and cash crops in different farming systems and land allocation is presented in table 5.1. It is apparent that maize is an important crop in the farming systems as it is a food and cash crop. The importance of maize varies from one farming system to another.

(a) Maize

Maize is grown in almost all AEZs except the Kitulo Plateau. Both wet season and dry season planting are practiced. The latter is planted on valley bottom locally known as "vinyungu". About 98% of the respondents grow maize in the main season.

The main season for maize production is the wet season that starts in November. In higher altitudes like Uporoto Mountains planting is done in August using residual moisture. Sixty eight percent of the farmers interviewed grew maize mixed with other crops. In the medium and low altitudes, maize is mixed with other crops such as beans, cowpeas, sunflower, sorghum, groundnuts and pumpkins. In high altitude areas of Uporoto maize is mixed with round potatoes and green peas. The average acreage under maize is 3.89 acres ranging between 0.5 and 42.0 acres. In the Usangu plains, maize is grown on land that is not suitable for rice. Maize cultivation in Usangu is mainly done on ridges. The intensity of cultivation appears to be directly related to the distance from the settlements, with land near the village being more intensely cropped than the land further away.

Low soil fertility and declining moisture, especially in the last two seasons, mainly account for low production. Use of chemical fertilisers in maize production is also very low. Only 16.8% of farmers reported using TSP or DAP during planting, 23.8% use organic fertiliser mainly farm yard manure and compost for planting. Moreover the fertiliser rates applied are well below the recommended ones as discussed earlier in chapter 4. In the lowland farmers do not use fertilisers claiming that their soils are still fertile.

About 83% of farmers select seeds from the previous crop. Most of them indicated that they continued selecting from the Hybrid seeds planted in the 1970s during the maize improvement programme. Few farmers (11%) buy new seeds from either stockists in villages or open markets. Others get seed from fellow farmers when they see that it has performed better. Varieties grown in high and medium altitude include H 6302, H 614, TMV2, CG4141. In the lowland, composite were preferred most and *Katumani*, *Kilima*, *Staha*, UCA, CG4142 and 4141 were mentioned in many villages. Local varieties used were mostly from the reselected seeds and farmers prefer *Katumbili* and *Mwendambio* because they mature early. Important criteria for selection of varieties are high yielding, early maturity and milling quality.

Table 5.1 Average acreage under crop production in different farming systems (range)

Crop	FS1	FS2	FS3	FS4	FS5	Total
Maize	-	1.99 (0.5-6.0)	2.8 (0.5-7.0)	3.5 (0.5-10)	3.8 (0.5-42.0)	3.16 (0.5-42)
Beans	-	1.08 (0.1-6.0)	2.1 (0.25-7.0)	2.5 (0.25-8.0)	1.8 (0.25-13.0)	1.96 (0.1-13.0)
Wheat	-	1.2 (0.25-3.0)	0.5 (0.25-1.0)	0.5 ((0.25-1.0)	-	0.95 (0.25-3.0)
Paddy	-	-	-	-	4.1 (0.5-21.5)	4.1 (0.5-21.5)
Pyrethrum	1.13 (.75-1.5)	1.14 (0.25-5.0)	0.8 (0.25-1.0)	-	-	1.09 (0.25-5.0)
Finger millet	-	-	0.5	0.2 (0.2-0.5)	0.6 (0.25-1.0)	0.37 (0.21.0)
Sorghum	-	-	0.6 (0.25-2.0)	2.4 (0.5-4.0)	26.5 (1.0-240)	10.99 (0.25-240)
Round potatoes	2.68 (1.00-5.00)	1.24 (0.25-7.0)	0.5 (0.25-1.0)	0.8 (0.13-6.0)	-	1.25 (0.13-7.0)
Sweet Potatoes	-	0.3 (0.25-0.5)	0.3 (0.25-1.25)	0.3 (0.2-1.0)	0.8 (0.2-6.0)	0.48 (0.13-6.0)
Sunflower	-	0.25	0.5	2.1 (0.2-6.0)	1.5	2.01 (0.13-6.0)
Sugarcane	-	-	-	1.4 (0.24-3.0)	2.7 (0.13-9.0)	2/02 (0.13-9.0)
Cowpeas	-	-	-	1.9 (0.25-7.0)	1.7 (0.2-6.0)	1.81 (0.13-7.0)
Tomatoes	-	0.26 (0.1-0.5)	0.3 (0.1-0.5)	0.4 (0.1-2.0)	0.28 (0.2-0.5)	0.3 (0.1-2.0)
Cabbages	0.33 (0.25-0.5)	0.18 (0.1-0.25)	0.4 (0.1-1.0)	0.3 (0.1-1.0)	-	0.3 (0.1-1.0)
Onions	0.5	0.28 (0.1-0.5)	1.0 (0.5-2.0)	0.24 (0.2-0.3)	0.25	0.44 (0.2-2.0)
Green peas	0.68 (0.1-2.0)	0.89 (0.2-3.0)	0.5 (0.25-2.0)	0.5 (0.25-1.0)	-	0.7 (0.1-3.0)
Coffee	-	0.6 (0.25-1.5)	0.3 (0.25-0.5)	-	-	0.46 (0.25-1.5)
Bananas	-	0.3 (0.1-0.5)	0.2 (0.1-0.25)	-	3.8 (0.5-9.0)	1.44 (0.1-9.0)
Fruits	-	0.23 (0.2-0.25)	-	-	-	0.23 (0.2-0.25)
Groundnuts	-	-	1.7 (0.25-5.0)	1.4 (0.25-3.0)	2.2 (0.25-13.0)	2.01 (0.25-13.0)
Vegetables (leafy)	0.25	0.33 (0.25-0.5)	0.2 (0.1-0.25)	-	0.5 (0.25-1.0)	0.35 (0.1-2.0)

Harvesting time for maize varies depending on the AEZ. In the medium and low lands maize planted in November-December is harvested starting June to August. At higher altitude maize takes 10 to 12 months to harvest, as is the case in potato-based farming system. The average production of maize is 543 kg per acre, ranging from 50kg to 2 500 kg (Std. deviation is 383.9). This variation is mainly attributed to location, soil fertility, and amount of rainfall and husbandry practices. In the high and medium plateau where maize is grown for food as well as a cash crop, improved husbandry is practised. This includes planting in recommended spacing, use of fertilisers, plant protection and weeding twice. The pest of economic importance is stalk borer, and most farmers control it by using natural botanicals such as 'utupa' (Tephrosia species) and 'Lidupala' (*Neurotanania species*, a legume found in the bush lands).

On average, fifty percent of the maize produced is left for household consumption and the rest is sold to earn income. Maize is sold to private buyers, and the price ranging from 4 000/ per bag of 100 kg at harvesting time to 10 000/- in February when there is scarcity. However, most farmers sell their maize immediately after harvesting to earn money for other household needs such as medical expenses, school fees and clothing.

Many farmers indicated that they produce maize in the dry seasons (*vinyungu)* under irrigation to supplement the low production of maize in the main season.

(b) Beans

Beans is a second crop grown by many farmers in the study area. About 129 (68%) of the respondents are producing beans as a food crop as well as for cash. On average, 1.9 acres per household is under beans. There are three seasons for bean production. Beans planted in November/December are grown in mixtures with maize. The second season is February/March where beans are planted as a mono-crop. A third season is under the vinyungu system and in the lowlands where beans are grown under irrigation that is planted in July/August. The majority of farmers in Usangu plains produce beans in the third season. Use of fertilisers is very low. In many cases beans are fertilised when planted with maize or where it is planted in the second season in places like Njombe, Makete and Mbeya where beans is mostly produced as a cash crop.

Bean varieties grown in the area are mostly local varieties including Kablanketi, Mwasipenjele, Nyamhanga, Masusu and Msafiri. There are also improved varieties that were released at the Uyole Agricultural Research Institute such as Kabanima and Uyole 84. Currently three new varieties namely Uyole 94, Uyole 96 and Uyole 98 were tested on-farm especially in Wanging'ombe area. Farmers' assessment of these varieties is still on going.

Average production is 154 kg/acre, ranging from 20kg/acre to 1 000 kg/acre (std. Deviation = 170.6). Low production is caused by use of local varieties and low soil fertility in the highlands. In the lowlands, low soil moisture is the major constraint and sometimes the crop fails completely in bad years. Pests also caused decline in bean production especially in the second and third season. Disease is a problem in the first season due to high moisture.

(c) Wheat

Wheat is mainly grown in Njombe, Makete and Mbeya districts, and in some areas in Iringa and Mufindi districts. About 31% of farmers plant wheat in the study area, and the average area under production is 1 acre, ranging from 0.25 to 3 acres. In Makete, wheat is produced mainly as food crop as well as cash crop, while in Mbeya most farmers produced it for cash. Use of fertiliser is very low, only 3.6% of farmers indicated using fertilisers during planting of wheat.

A number of varieties are grown in the area and it is common to find the same variety identified by different names from one place to another. The local varieties mentioned by farmers include Magunila, Kadala-kasupi, Madihani and Sikalino. Improved variety found in farmers' fields, in Matamba division especially, is Juhudi that was released at Uyole in 1980s. Wheat production is also very low, with an average of 276.9 kg/acre, ranging from 60 kg/acre to 334 kg/acre. The potential yields recorded in Galijembe in Mbeya district under farmers' condition are 1 000 kg/acre (ARI Uyole Progress Report, 2000). Low soil fertility, late planting and diseases account for poor production in most of the areas visited.

(d) Paddy

Although the crop is not produced under rain-fed agriculture, it is very important in the rural livelihoods of Usangu people. Paddy is produced in the Usangu plains and is under irrigation. Both traditional and improved irrigation systems are used. The crop is produced mainly as a cash crop; where about 80% percent of the farmers in Mbarali district (the main producer) indicated that it is their first important cash crop. Average acreage under paddy production is 4 acres per household, ranging between 0.5 to 21.5 acres. The average production of paddy is 1 228.1 kg/acre.

Most farmers are not using improved crop husbandry practices, such as planting at the recommended spacing and use of inputs. Farmers using recommended spacing and high yielding varieties at Igomelo village recorded higher yields of up to 34 bag/acre. Varieties commonly planted by farmers are Supa, Subarimati, India rangi, Faya, Mahia, Pijo and Zambia. Supa is the mostly preferred variety due to its grain quality and differential price, but it is low yielding. As with other crops, use of fertilisers is very low, only 2.4% of farmers indicated using fertilisers during planting and top dressing. The majority of the farmers claimed that land under paddy is still fertile. The major problem causing low production, as reported by farmers, is inadequate water for irrigation. In some villages like Itamba, Simike, Luhanga, Utengule and Mhwela farmers could not produce paddy this season because of water problems. Some farmers associated this with poor designs of improved irrigation channel that denied them water that used to flow in rivers. However, current research found out that the main problem is expansion of area under production outside the designed irrigation schemes by the people surrounding the project (Machibya, 2000: personal communication).

Labour and bird scaring are also important production constraints in paddy cultivation.

(e) Pyrethrum

Pyrethrum is produced in Njombe, Mbeya and Makete districts. The crop as mentioned earlier, used to be an important cash crop before 1990 when the Cooperatives Union responsible for marketing was operating. Currently, with market liberalisation, the area under pyrethrum is increasing though at a slow pace. About 15% of the farmers interviewed grow pyrethrum. More farmers growing pyrethrum were found in Mbeya district (60.7%), followed by Makete (21.4%) and Njombe is 17%.

Harvesting of pyrethrum flower is done by hand and dried on mats or special areas prepared for the purpose. Average production of pyrethrum is 136 kg/acre, ranging from 30 to 350 kg/acre. No use of chemical fertiliser was recorded during interviews. Farmers in Imalilo villages informed that they grow pyrethrum in their old farms (malungulu) where it is fertile.

(f) Ground potatoes

This is an important cash crop in the Kitulo Plateau, Njombe Plateau and Uporoto Mountains. On average, acreage under round potato production is 1.2 acres, ranging between 0.13 to 7.0 acres. In Iringa, Mufindi and some parts of Mbeya, round potatoes is mixed with maize, green peas or wheat; and in this farming system, yields are very low. In Kikondo and Njombe plateau where potato is mostly grown as cash crop, the cropping system is mono-crop and the production is high. It ranges from 30 bags to 60 bags/acre (weight of one bag is between 110 to 130kg). The average production in the project area is 2 000 kg/acre (about 16 bags/acre).

Use of chemical fertilisers is common in Njombe and Mbeya. Mostly farmers apply basal fertilisers and the most common is Triple Super Phosphate, NPK and Di-Ammonium Phosphate (DAP). Farmers in Kikondo reported that they use three bags of fertilisers, a mixture of TSP and CAN at a ration of 2:1 at planting, and top dressing with Urea at a rate of one bag per acre.

The most important problems indicated by farmers are soil fertility and diseases, and the use of pesticides in Mbeya and Njombe is high. Diseases of economic importance are potato blight and bacterial wilt. Potato blight is controlled using fungicides and most farmers apply them. The control of bacterial wilt is mostly by cultural practices like crop rotation, but most farmers are not aware of the problem. The disease, if not controlled can spread very fast and may threaten production of potato in the area (Gondwe, 2000 in ARI Uyole progress report).

(g) Vegetable crops

Many farmers, especially young farmers, produce vegetables in the rain-fed as well as in the *vinyungu* or under irrigation during dry season. Tomatoes are grown by 22.5% of the farmers interviewed, and are an important cash crop especially in areas with good access to markets in towns. Most of the farmers, however, depend on the Dar-es-salaam markets.

Farmers produce tomatoes on small plots, average is 0.3 acres and it ranges between 0.1 to 2 acres. Large plots were found in Njombe, especially Itunduma/Mtwango and Mbeya areas, enjoying good access to roads which makes marketing easy. Average production is 2 500 kg/acre. It was difficult for most farmers to estimate their production per acre as most of them produce in very small plots. Also very few kept records of number of buckets harvested as the crop is sold in small quantities. During the reconnaissance survey, some key producers (through discussion) claimed that some farmers could produce up to 1 000 buckets each of 20kg, which was estimated to about 40 000 kg/acre.

Other vegetable crops produced are cabbages mostly in Mbeya and Makete districts where it is mainly produced as cash crop. Onions is another important cash crop produced in Mbeya, Mbarali and Makete districts. Green peas are also an important cash crop in the Uporoto villages as they have access to market links through the Kasumulu-Mbeya-Dar-es-salaam road. Women mostly grow the crop in small plots mixed with potatoes, maize or wheat. In villages surrounding Kipengere ranges and in Matamba, green peas are mostly grown for food, prepared as relish.

(h) Other crops

Other crops include sunflower, sorghum, cowpeas, finger millet, sweet potatoes, sugarcane, groundnuts, bananas, coffee, and fruits.

Sunflower is an important cash crop in Malangali-Wangingombe-Saja areas. Farmers grow sunflower in mixtures. On average farmers produce 175.8 kg/acre, ranging between 100 to 1 200 kg/acre. When sold as seeds, farmers get very low prices (Tsh. 6 400/- per bag), but they fetch good

returns when sold as processed oil as commonly done by farmers around Makambako town. It was found out that farmers get 16 000/- to 20 000/- per bag when sunflower is processed into oil that gives about 25 litres of vegetable oil.

Sweet potatoes are usually grown in small plots, solely by women. The farm field sizes vary between 0.1 to 1 acres. Wasukuma in Usangu recorded higher acreage up to 12 acres, thus bringing the average of 2.5 acres per household. It is mostly grown after land preparation and sowing of other crops is finished, indicating labour competition and increasing workload of women. The crop is mainly grown on the more sandy soils, and it is an important food security crop utilised during food scarcity in March. The Sukuma women dry potatoes for storage as *matobolwa* or *michembe*. The yield varies from 50 to 2 000 kg/acre.

Groundnuts are also becoming an important cash crop in the Lower Mufindi Plateau and Usangu plains in areas of Madibira division. Discussion with farmers at Idumulavanu and Saja villages revealed that it is becoming second to maize as a cash crop. The crop is grown on sandy soils, sometimes mixed with maize or sorghum. Average production is however low, 292 kg/acre, ranging from 50 kg/acre to 1 000 kg/acre.

Sorghum is grown in Njombe and Mbarali districts. In Njombe it is mostly grown for brewing, while in Mbarali it is an important food crop especially amongst the Wasukuma ethnic group. Average acreage is 11 acres, ranging between 0.25 to 240 acres (highest acreage recorded in Mbarali by Wasukuma). Production is also very low ranging between 20kg/acre to 2 500 kg/acre (mean production is 360.3 kg/acre).

Coffee is an important cash crop in the highlands, but only 9% percent of farmers interviewed grow coffee. Average acreage is 0.5 acres, and production is very low ranging between 20 to 200 kg/acre. The crop is mostly mixed with bananas or Grevillia.

Many farmers grow some fruit trees especially around their homesteads. In the highland, peaches and avocado are common, while in the lowlands mangoes were found. Farmers although appreciated the produce from fruit trees, it was very difficult to estimate production as mostly, fruits are consumed at home.

In most of the villages visited bamboo farming was common for production of bamboo wine. The wine is mostly harvested starting from December at the on set of the rains up to May. In some places where the crop is grown in the wetter parts, harvesting may continue up to August. Bamboo wine makes an important source of income in many households near the main road for the markets in Mbeya, Makambako, Mufindi, and Iringa towns. Farmers in Matamba division in Makete district reported that they might also transport bamboo wine to Chimala where they market it to businessmen from Mbeya town. HIMA (1994) reported that up to 17% of farmers in Makete engage in bamboo wine business and it contributes about 19% of average cash earning per annum in the household.

5.2. Crop production operations and cropping calendar

5.2.1 Land preparation and ploughing

Land preparation involves slashing and burning of forest, in case of new land, or clearing and burning of crop residues. Ploughing is mostly done by hand hoe and oxen. On average 54.1 percent of farmers indicated use of draft animals for land preparation. The use of draught animals is more pronounced in the maize-beans FS, maize FS and rice-pastoral FS (table 5.2). Use of tractors was

reported in Mbarali district. Land preparation and ploughing for different crops is done at different time depending on the cropping calendar as shown in figures 5.1 to 5.5.

Table 5.2 Percentage of farmers using draft animals in different farm operations by farming system

	Potato FS	Maize-Potato FS	Maize-Beans FS	Maize FS	Rice-Pastoral FS	Total
Draft animal use (%)	11.1	8.6	52.6	73.6	69.2	54.1
Ownership of draft animals (%)	100	33.3	20	50.0	37.8	43.4
Hired draft animals (%)		66.7	70.0	32.5	57.8	48.5
Borrow draft animals (%)			10.0	12.5	4.4	8.1
ACTIVITIES USING DRAFT POWER						
Land preparation (%)		15.0	71.4	86.7	93.6	73.3
Weeding (%)				17.8	4.3	7.6
Puddling (%)					27.3	11.4
Ridging (%)				22.2		7.6
Haulage (%)	20.0		7.1	31.1	44.7	28.2

Source: Questionnaire survey, 2000

Where tillage is done by hand hoe, farmers prefer planting on ridges as they claimed that it was easier to prepare land and weed on ridges. Flat seedbeds are common when oxen are used for ploughing as tillage is mainly done by using the single furrow mouldboard plough. In the potato based FS farmers owned and used donkeys for haulage only.

In the highlands, crop residues are ploughed under to improve soil fertility, while in lowland farmers burn crop residues to avoid pest infestation of their crops.

5.2.2 Sowing

There is great variation in planting time for various crops. This is influenced more by the agro-ecological zone and labour availability. Planting time for various crops in the farming systems identified is indicated in the cropping calendar (figs. 5.1-5.5). Sowing is done by hand either randomly or in furrows behind the plough when oxen are used in ploughing. Broadcasting of small cereals like wheat and sorghum is also common.

5.2.3 Weeding

Weeding is invariably done by hand hoes in all farming system zones. Weeding using draft animals is not common with the exception of the Mtwango/Makambako area where the mouldboard plough is used (table 5.2).

Frequency of weeding depends on the importance of a crop. In maize and round potatoes it is usually done twice. Cash crops mostly receive more attention in terms of management. For example, farmers producing paddy reported that the crop is given priority in terms of labour allocation during peak time.

5.2.4 Soil fertility management

The productivity of the soils very much depends not only on the physiography of land but also on its nutrient supplying power. Crop production is directly related to the level of both macro and micronutrient elements. The levels of these nutrients are in turn influenced by both landforms, inputs (e.g. crop residues, inorganic and organic fertilisers, etc), cropping system and agronomic practices (Msaky, 1998). Soils in the highland areas are acidic in nature, low in nitrogen and phosphorus and other micronutrients to support crop production. Farmers have for a long time adopted various ways of managing soil fertility such as fallowing, incorporation of crop residues, ridging, composting, crop rotation, agro-forestry, and use of organic manures. Table 5.3 below summarises response of farmers on various soil fertility improvement methods used by farmers other than application of fertilisers.

With increased population, suitable land for crop production has been continuously cultivated. Fallowing though still practised, the time for fallowing has been reduced from 5-10 years to 1-3 years, and in many cases farmers reported only one year of fallowing.

Farmers practice inter-cropping, but in most cases is used as a risk aversion strategy rather than soil fertility improvement strategy. Farmers are intercropping in order to ensure that they produce many crops in a small piece of land.

Table 5.3 Use of soil fertility improvement methods by farming systems (in % of respondents)

Method	Potato FS	Maize-potato FS	Maize-Beans FS	Maize FS	Rice-pastoralist FS	Total
Fallowing	81.8	60.0	45.0	28.3	33.8	41.2
Nitrogen fixing plants		8.6	5.0	7.5	16.2	10.2
Intercropping	9.1	20.0	65.0	66.0	17.6	36.4
Marejea				5.7		1.6
Burying crop resdues		22.9	20.0	30.2	1.5	15.5
Crop rotation		45.7	70.0	18.9	13.2	26.2

Source: Questionnaire survey, 2000

Agro-forestry in Mbarali district was observed in relation to incorporation of Acacia trees in the farming system. This was very common in Madibira, in the lower Mufindi plateau, especially in the border to Usangu and Chimala-Mbuyuni areas. Soils under the Acacia tree are reported to be very fertile, hence these trees are retained on the farm to fertilise the land.

The use of fertilisers, both organic and inorganic, was mentioned in all farming system zones except the rice–pastoralism farming system zone where farmers reported that land is still fertile (see table 5.4).

Use of fertiliser was reported mostly for crops produced as cash crops such as maize, round potatoes, beans and horticultural crops such as tomatoes. Farmers did not report use of fertilisers in other crops. Use of organic fertiliser is becoming popular in areas where there is project intervention such as HIMA, and CONCERN. Farmers however reported that use of manure is limited to farms around homesteads because of transportation problems.

Table 5.4 Average amount of fertiliser used in maize, beans and round potatoes

	FS1	FS2	FS3	FS4	FS5
MAIZE					
Basal Application (kg/acre)	0	36.3	30.6	26.2	0
Top dressing (kg/acre)	0	29.5	52.9	30.9	0
Organic manure (kg/acre)	0	270.3	310.0	360	0
BEANS					
Basal Application (kg/acre)	0	29.2	41.6	31.1	0
Top dressing (kg/acre)	0	0	0	0	0
Organic manure (kg/acre)	0	0	0	0	0
ROUND POTATOES					
Basal Application (kg/acre)	143.0	51.4	45.0	50.0	-
Top dressing (kg/acre)	16.7	33.1	53.8	50.0	-
Organic manure (kg/acre)	0	383.3	0	500.0	-

Note: Amount are kilograms of TSP, CAN (26%N), DAP, Urea applied per acre.

5.2.5 Crop protection

Practices of controlling crop pests and diseases are reported mostly in the highlands and medium plateau. Stalk borer, aphids, bean beetle and army-worms were mostly mentioned. Natural botanical materials such as Utupa (Tephrosia species) and Lidupala (Neurotanania species) are commonly used in controlling stalk borer in maize.

5.2.6 Harvesting and storage

Harvesting of all crops is done manually, and farmers harvest crops as they mature in the farm. In most cases, harvesting is done using family labour. Hiring of labour or labour parties may be used in case of crops such as round potatoes that have to be harvested in one day.

Cash crops are normally sold immediately after harvesting; therefore it is mostly food crops that are stored for a long time. Farmers in the study area use traditional storage structures locally known as 'vihenge'. These are built outside the homestead and they are of different capacity ranging from 3 to 10 bags of maize. Some households may have more than one structure depending on the harvest and size of the household. In some areas especially where there is influence of township, farmers are discouraged to store their grains in such structures because of incidences of theft. Sometimes farmers are storing their produce in gunny bags. The most common storage pest is the grain weevils (*Sitophilus species*) and sometimes the large grain borer was found. Farmers are advised to mix

shelled maize with Actellic Super Dust as a way of controlling LGB. However most farmers are reluctant to shell their maize, claiming that it is easy to misuse the grain.

5.2.7 Land conservation practices

Soil degradation in most cases was expressed in terms of declining soils fertility. Soil erosion though evidenced in some parts was not revealed as a major problem contributing to declining soil fertility. Few farmers consciously practiced soil erosion control methods, except in areas where there is awareness through projects such as HIMA and CONCERN (table 5.5).

Table 5.5. Use of erosion control methods in the farms by farming system (% of respondents)

Method	Potato FS	Maize-Potato FS	Maize-Beans FS	Maize FS	Rice-Pastoralist FS	Total
Ridging	18.2	20.0	25.0	32.7	21.2	24.5
Contours	27.3	57.1	55.0	21.2	3.0	25.5
Perennial grass planted on contours		14.3	15.0	1.9		4.9
Crop straw barriers			5.0	9.6		3.3
Fallowing	54.5	48.6	25.0	26.9	12.1	27.2
Tree planting		5.7	10.0	15.4	1.5	7.1
Intercropping		20.0	50.0	53.8	6.1	26.6
Agro-forestry	9.1	14.3	10.0		13.6	9.2

Source: Questionnaire survey, 2000

The construction ditches to drain out excess water in the fields is a common practice in areas where they cultivation on very steep slopes. Use of ridges is also common in high and medium plateau. Contour farming is rarely practised and in most cases is influenced by project interventions.

5.2.8. Cropping Seasons and Calendar

There is great diversity in terms of time of operations for various crop productions in the project area due to variation in agro-ecological zones. The cropping season runs throughout the year. In some areas land preparation starts immediately after harvesting, as growing seasons are very long especially in the high altitudes. With increased use of 'vinyungu' or irrigation to supplement crop production for household food security as well as cash, most farmers are involved in agriculture for twelve months. Crop calendars for crops grown in different farming systems are shown in figures 5.1 to 5.5. Most farmers indicated that December to March is the labour peak period, where land preparation, planting and weeding is done. In maize-bean FS and maize FS harvesting coincides with land preparation in the valley bottom, thus is another time with high labour demands.

Figure 5.1 Seasonal calendar: potato-pyrethrum based farming system

Crop	1	2	3	4	5	6	7	8	9	10	11	12
R/potatoes					LP	LP	LP	LP				
					PL	PL	PL	PL		WD	WD	WD
	WD											HV
	HV	HV										
Cabbage	LP	LP										
	PL	PL	WD			HV	HV					
G/peas		LP	LP									
		PL	PL			HV	HV					

Note: LP = Land preparation; PL = planting; WD = weeding; HV = harvesting.

Figure 5.2 Seasonal calendar: maize-potato based farming system

CROP	1	2	3	4	5	6	7	8	9	10	11	12
Maize									LP	LP	LP	LP
											PL	PL
	WD	WD	WD				HV	HV	HV	HV		
Beans: first crop									LP	LP	LP	LP
											PL	PL
	WD	WD		HV	HV	HV						
second crop		LP	LP									
			PL	WD		HV	HV					
R/potatoes								LP	LP	LP	LP	
								PL	PL	PL	PL	
	WD	WD		HV	HV	HV	HV					
Wheat	LP	LP	LP	LP								
	PL	PL	PL	PL			HV	HV	HV			
Pyrethrum												LP
	PL	PL	PL	PL	PL							
			WD	WD	WD	WD						
				HV	HV	HV	HV	HV	HV			
G/peas	LP	LP										
	PL	PL			HV							
Maize (off- season)								LP	LP			
								PL	PL		WD	WD
						HV	HV					
Vegetables								LP				
								PL	PL	WD	HV	

Note: LP = Land preparation; PL = planting; WD = weeding; HV = harvesting.

Figure 5.3 Seasonal calendar: maize – beans farming system

CROPS	1	2	3	4	5	6	7	8	9	10	11	12
Maize								LP	LP	LP	LP	
											PL	PL
	WD	WD	WD				HV	HV	HV			
Beans									LP	LP	LP	LP
											PL	PL
	PL	PL										
	WD	WD	HV	HV	HV							
Wheat		LP	LP									
		PL	PL	PL			HV	HV				
Pyrethrum									LP	LP		
	PL	PL	WD			HV	HV	HV	HV	HV		
Sorghum									LP	LP	LP	
											PL	PL
	WD	WD	WD					HV				
R/potatoes									LP	LP	LP	LP
											PL	PL
	PL											
	WD	WD	WD					HV	HV			
S/potatoes	LP	LP	LP	LP	LP							
			PL	PL	PL				HV	HV	HV	HV
S/flower										LP	LP	
											PL	PL
	WD	WD	WD					HV	HV			
Coffee										LP	LP	LP
												PL
	PL	PL										
	WD	WD						HV	HV	HV		

Note: LP = Land preparation; PL = planting; WD = weeding; HV = harvesting.

Figure 5.4 Seasonal calendar: maize - based farming system

CROPS	1	2	3	4	5	6	7	8	9	10	11	12
Maize										LP	LP	LP
											PL	PL
	WD	WD	WD		HV	HV	HV	HV				
Beans										LP	LP	LP
											PL	PL
	WD	WD	HV	HV	HV							
S/flower										LP	LP	LP
											PL	PL
	LP	LP										
		WD	WD		HV	HV						
S/potatoes											LP	LP
											PL	PL
	WD	WD	WD		HV	HV	HV	HV	HV	HV		
S/cane						LP	PL	PL				
							HV	HV				
Tomatoes							LP	PL		HV	HV	
Onions							LP	PL	WD	HV		
G/nuts												LP
	PL	WD			HV							
R/potatoes		LP										
		PL		WD		HV						
F/millet									LP	LP	LP	
											PL	PL
		WD	WD		HV							

Note: LP = Land preparation; PL = planting; WD = weeding; HV = harvesting.

Figure 5.5 Seasonal calendar: rice based farming system

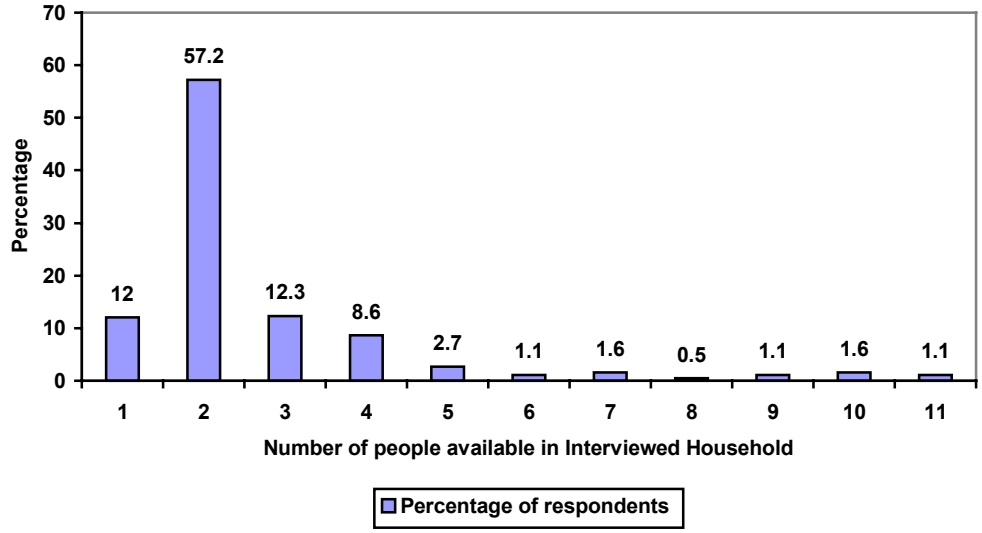
CROP	1	2	3	4	5	6	7	8	9	10	11	12
Maize											LP	LP
												PL
	PL											
	WD	WD	WD			HV	HV					
Beans: First crop												LP
	LP	PL	WD									
			HV	HV								
Second crop				LP	LP		WD	HV	HV			
					PL	PL						
Paddy											LP	LP
	PL	PL	PL									
			WD	WD		HV	HV					
Sorghum												LP
												PL
	WD				HV							
Sweet potatoes	LP	LP	LP									
	PL	PL	PL							HV	HV	HV
	HV	HV	HV	HV	HV							
Cowpeas												LP
												PL
	PL	WD	WD		HV	HV						
Groundnuts											LP	PL
	PL											
	WD	WD	WD		HV	HV						

Note: LP = Land preparation; PL = planting; WD = weeding; HV = harvesting.

5.3 Labour use and division in crop production

Family labour that is regularly available for crop production is on average 2 people as reported by 57.2 percent of respondents. The number ranges from 1 to 11 as shown in the chart 5.1 below.

Chart 5.1: Regular Family labour working in the farms



Households with more people working on the farm were recorded amongst the pastoralists in Mbarali district, and Iringa and Mufindi due to polygamy and extended family relationship.

Table 5.6 Household members' involvement in crop production operations (% of respondents)

Activity	Responsible member of the family			
	Men	Women	Both adults	Children
Land preparation	16.9	14.8	63.4	6.5
Ploughing	11.4	10.3	73.4	4.8
Puddling	25.5	6.4	66.0	2.1
Planting/transplanting	5.0	21.0	68.5	11.0
Weeding	5.5	15.9	73.6	4.9
Spraying	37.5	9.1	51.1	2.2
Harvesting	6.0	13.1	76.0	4.9
Transportation	7.6	12.0	74.5	6.0

Both men and women almost on equal basis participate in crop production in the study area as shown in the table 5.6. Farmers' response on involvement of household members revealed that in men headed household both adults participate in all farm operations. In female-headed household women do all the activities. Where there are children they also participate in some operations when out of school. Despite the involvement of both men and women in all field activities, the men are more involved in puddling and spraying, while women participated in weeding, harvesting and

transportation. The women are also involved in other reproductive chores such as fetching water and fire wood collection.

5.4. Crop production trends

The study reviewed trends of production for major crops produced in the Usangu wetland and its catchment. Farmers interviewed reported that there is a general trend of decline in crop production in all farming systems visited. Table 5.7 below summarises the response from farmers.

Table 5.7 Percentage of farmers indicating declining in production of major crops by farming system

Crop	FS1	FS2	FS3	FS4	FS5	Total
Maize		80.0	70.0	75.5	97.1	84.1
Beans		69.6	70.0	86.5	100	83.5
Wheat		80.0	50.0	100.0		76.6
Paddy					100.0	100.0
R/potatoes	80.0	74.2	50.0	55.6		69.0
S/potatoes		50.0	71.4	72.2	94.1	78.3
Finger millet				80.0	80.0	80.0
Sunflower				80.0		72.7
Sorghum			62.5	100.0	100.0	85.7
Tomatoes		80.0	41.7	75.0	100.0	67.6
Onion		100.0	33.3	100.0	100.0	75.0

Source: Questionnaire survey, 2000

The decline in crop production is associated with many reasons, but the main reasons are: (i) decline in soil fertility, (ii) unreliable rainfall, (iii) diseases and pests and (iv) frost damage (table 5.8). In the case of pyrethrum, farmers reported that production is increasing because the area under production is also increasing as many farmers are replanting the crop after improvement in the market situation. An increase was also reported for sugarcane especially in villages bordering Usangu plains like Lower Mufindi plateau as many farmers are opening up new farms. New crops like sugarcane are replacing maize that used to be a cash crop in these areas. Groundnut production is also on the increase.

5.5. Crop production constraints

During group discussion farmers mentioned a number of problems. These are:

(i) Labour availability
(ii) Declining soils fertility
(iii) Unreliable rainfall
(iv) Marketing of produce
(v) Fertiliser availability
(vi) High fertiliser prices
(vii) Pesticides availability
(viii) High pesticides prices
(ix) Extension services

Some of these problems have been highlighted in the previous sections. Farmers ranked the problems in order of importance as discussed hereunder.

Table 5.8 Percentage of farmers indicating reason for the decline in production of major crops by farming system

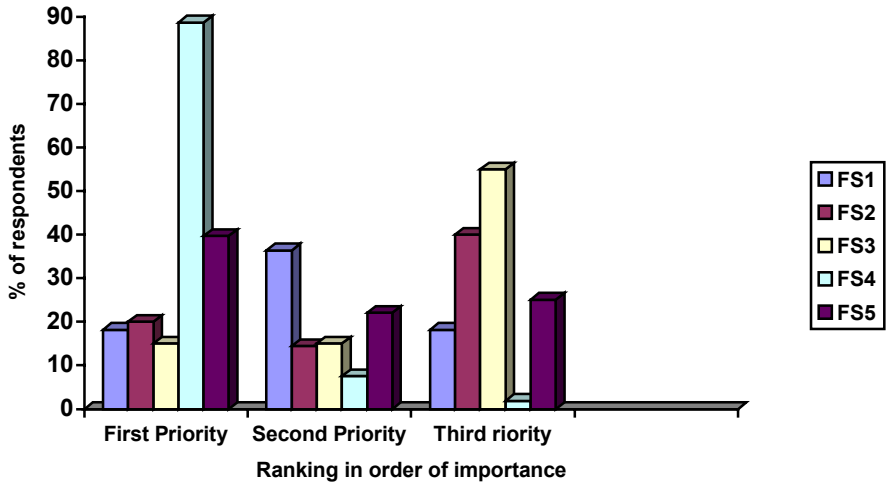
Crop	Reason for the decline	FS1	FS2	FS3	FS4	FS5	Total
Maize	Decline in soil fertility		60.0	78.6	70.5	11.9	43.9
	Unreliable rainfall		26.7	21.4	25.0	85.1	51.0
	Diseases and pests		3.3			1.5	1.3
	Frost damage		3.3				
Beans	Decline in soil fertility		52.9	64.3	47.8		38.8
	Unreliable rainfall		29.4	28.6	26.1	96.2	44.7
	Diseases and pests		5.9		23.9		11.7
	Frost damage		5.9	7.1			1.9
Wheat	Decline in soil fertility		62.1	50.0	100.0		64.9
	Unreliable rainfall		17.2	50.0			18.9
	Diseases and pests		6.9				5.4
	Frost damage		3.4				2.7
Paddy	Decline in soil fertility					12.5	12.5
	Unreliable rainfall					87.5	87.5
	Diseases and pests						
	Frost damage						
R/potatoes	Decline in soil fertility	37.5	64.0	25.0	80.0		57.1
	Unreliable rainfall	25.0	20.0	50.0			21.4
	Diseases and pests		12.0	25.0			9.5
	Frost damage	25.0			20.0		7.1

Source: Questionnaire survey, 2000.

5.5.1. Labour availability

Cultivation of various crops for food and cash needs, coupled with dependence on the hand hoe, resulted in labour shortage at peak period in most of the farming systems. Many farmers especially for priority crops like maize, beans and paddy experience labour shortage. Chart 5.2 summarises the response of farmers on the extent of labour problem in different farming systems.

Chart 5.2: Extent of Labour problem in different farming systems



In FS1, 2, and 3 labour was mentioned as an important limitation but there was also high use of labour parties than in FS 4 and 5. Farmers in the latter zones claimed that labour parties, or locally known as "Mgowe" in Iringa, Njombe, Mbarali and Makete or "Nyanwa" in Mbeya, are becoming less popular and farmers are not responding when invited. There are many reasons given on this state of affair. Some farmers claimed that due to unreliable rainfall, the growing season is short. Therefore, there is a tendency of farmers rushing in their fields to ensure that they perform the operations in time. Those with big families have advantage of coping with the situation. A few farmers can afford hired labour and the majority end up in late completion of farm operations.

It was also noted that the time of peak labour demand coincides with payment of school fees. It was also reported that at this time of the year many people suffer from diseases such as malaria, hence reducing the work force and more money is spent on hospital bills. Some operations like weeding needed great care. In some areas it was found out that during this time of labour peak, many families have also food shortage, and hence sell their labour to earn food in kind or in cash. As a result they attend late to their farms. Labour shortage is experienced in areas where there are many crop enterprises like maize-potato FSs and maize-beans FSs.

Crop operations that use hired labour most are land preparation and weeding. This reflects inadequacy in mechanisation in the study area, despite the indication of high use of draft animals (54.1%) in land preparation in the study area. Tables 5.9a and 5.9b show the extent of labour shortage and hire and activities that use hired labour by crops.

Table 5.9a Extent of labour shortage and hire of labour for different crops by district (% of respondents)

Crop	Labour Shortage/hire	Potato FS	Maize-Potato FS	Maize-Beans FS	Maize FS	Rice-Pastoral FS	Total
Maize	LS	70.0	88.6	100.0	86.8	76.1	83.8
	LH	50	44.4	57.9	36.7	40.3	42.2
Beans	LS	25.0	63.6	84.2	79.2	52.5	70.2
	LH	100.0	16.7	62.5	35.4	31.6	36.9

Wheat	LS	71.4	81.8	57.1	66.7		76.0
	LH	33.3	21.4	20.0			22.0
Paddy	LS					85.4	85.4
	LH					65.8	65.8
Pyrethrum	LS		76.2	50.0			73.9
	LH		11.1				11.5
R/potatoes	LS	90.9	75.0	57.1	23.1		64.4
	LH	81.8	32.0	40.0	11.1		40.0
S/potatoes	LS		33.3	42.9	33.3	38.5	36.2
	LH			20.0	11.8	12.5	12.1
Sunflower	LS		100.0		65.8	100.0	65.9
	LH				33.3		30.6
Tomatoes	LS			46.2	36.4	25.0	33.3
	LH			50.0	22.2	50.0	34.8

Note: LS = Labour shortage; LH = Labour hired

Table 5.9b Crops and activities that use hired labour (% of respondents)

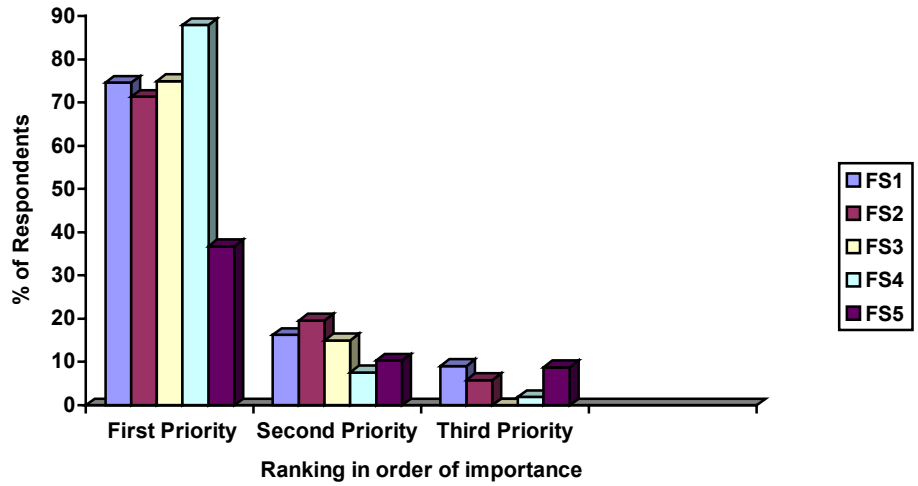
Crop	Activity	Potato FS	Maize-Potato FS	Maize-Beans FS	Maize FS	Rice-Pastoral FS	Total
Maize	Land preparation	75.0	80.0	30.8	5.6	19.2	32.9
	Planting		6.7				1.3
	Weeding		6.7	69.2	88.9	80.8	61.8
	Harvesting	25.0	6.7		5.6		3.9
Beans	Land preparation	50.0	100	30.0	23.5	16.7	31.6
	Weeding			60.0	76.5	83.3	63.2
	Harvesting	50.0		10.0			5.3
R/potatoes	Land preparation	22.2	37.5	50.0			30.0
	Planting	33.3	12.5				20.0
	Weeding		25.0	50.0			20.0
	Harvesting	44.4	25.0				30.0
Wheat	Land preparation		83.3	100.0			66.7
	Weeding		16.7				11.1
	Harvesting						22.2
Paddy	Land preparation					12.5	12.5
	Puddling					33.3	33.3
	Transplanting					12.5	12.5
	Weeding					33.3	33.3

Source: Questionnaire survey, 2000

5.5.2 Declining soil fertility

Low productivity due to declining soil fertility is another problem, which was frequently mentioned. The problem is felt more in the high and medium altitude and particularly in areas where soils are fragile, and prone to soil erosion like lower Mufindi plateau. Chart 5.3 below depicts the picture as per farmers' response. Generally the problem of declining soil fertility as first priority cuts across all the farming system.

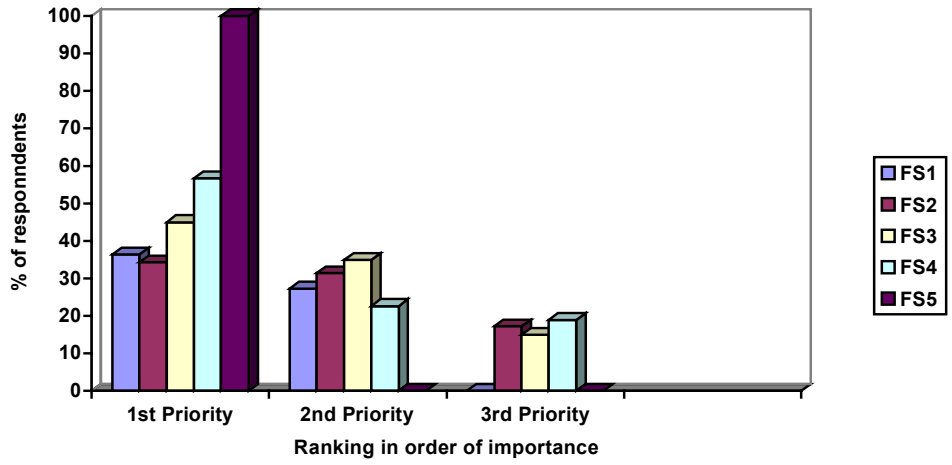
Chart 5.3: Declining Soil fertility as ranked by Farmers in different Farming Systems



5.5.3 Unreliable rainfall

Unreliable rainfall was mentioned as a big problem in varying magnitude. In the highlands sometimes too much rains increase the incidences of diseases, causing low production. This was particularly mentioned in the FS1 and FS2 as a problem in round potatoes production. For the past two years, however, the problem has been late start of rains and the rains stopped early. In the lowlands, the problem is declining moisture content to support growth of crops. The problem also was experienced more in the last two seasons. Farmers with irrigation facilities supplement with dry season production of food crops to ensure food security. Chart 5.4 below shows percentage of farmers responding to unreliable rainfall in order of importance.

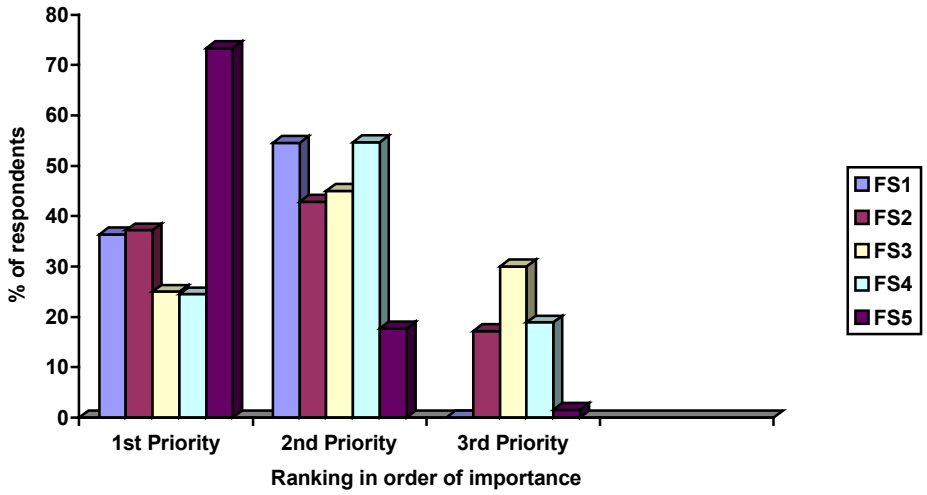
Chart 5.4: Ranking of the Problem of Unreliable Rainfall in order of importance



5.5.4 Marketing of produce

With trade liberalisation, 96.8 percent of farmers indicated that they have access to market. The main problem was therefore, low farm gate prices offered by private buyers. Farmers would like to sell their produce immediately after harvesting, but the prices given at that time are very low compared to cost of production. For example, the price of one bag of paddy sold at harvesting time in June/July ranges from 6 000/- to 8 000/-. The same bag of paddy will sell at 18 000/- to 20 000/- in January/March when there is shortage. Very few farmers could manage to keep their produce that long. One strategy used by farmers who have good access to water is to plant very early and harvest when there is high demand for rice, in March/April. Chart 5.5 give the picture of marketing problems as ranked by respondents in the farming systems studied.

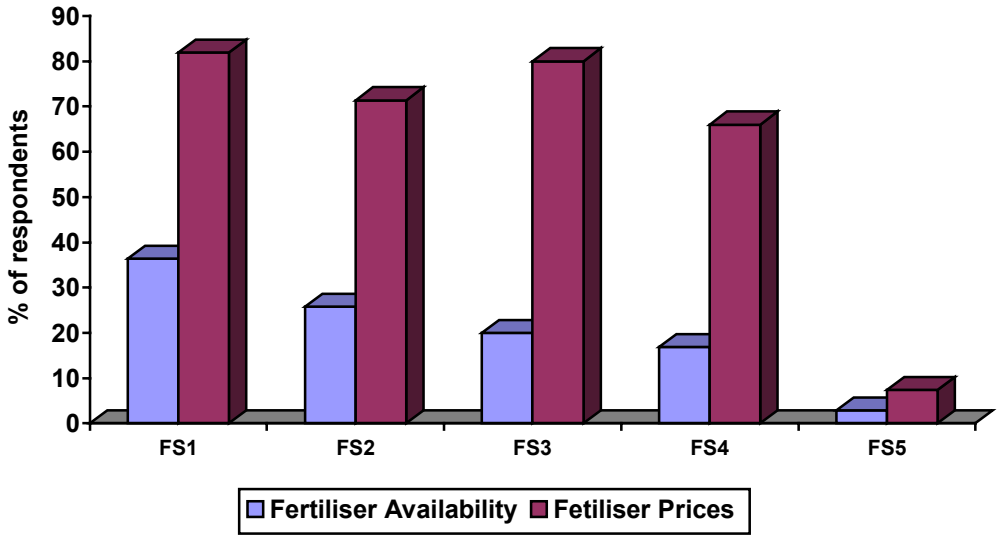
Chart 5.5: Marketing problem as ranked by farmers in different farming systems



5.5.5 Fertiliser availability and fertiliser prices

Farmers related the problem of low productivity with decreased use of fertilisers. Most farmers reported that they no longer use chemical fertilisers because of its non-availability and high prices (see chart 5.6).

Chart 5.6: Farmers response on problems of Fertiliser availability and prices

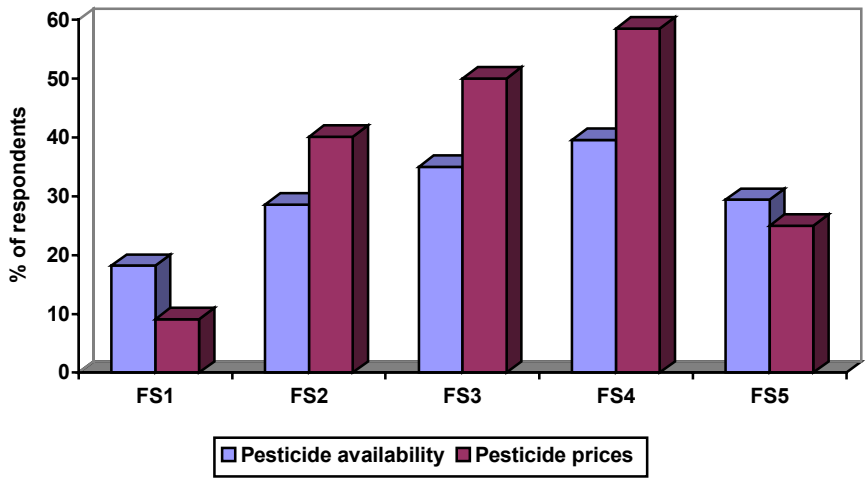


In ranking the two problems farmers felt that the prices of fertilisers were high as indicated in the charts 5.6 above. The problem was reported mainly in the high and medium altitudes due to low soil fertility as discussed in section 5.4.2. Farmers increasingly use organic fertilisers to cope with the problem, although the problem of transportation hinders its extensive use.

5.5.6 Pesticide availability and pesticide prices

The problem of pesticide availability and high prices was mentioned more in horticultural crops and round potatoes. Farmers reported that there is a problem of pests such as aphids in dry season vegetables and beans. As with the case of fertilisers, farmers complained more on pesticides prices and their efficacy. There is a lot of adulteration of chemicals sold especially in open markets where most farmers go to buy their supplies. Chart 5.7 shows the response of farmers in the pesticides

Chart 5.7: Response of Farmers on Problems of Pesticides Availability and prices

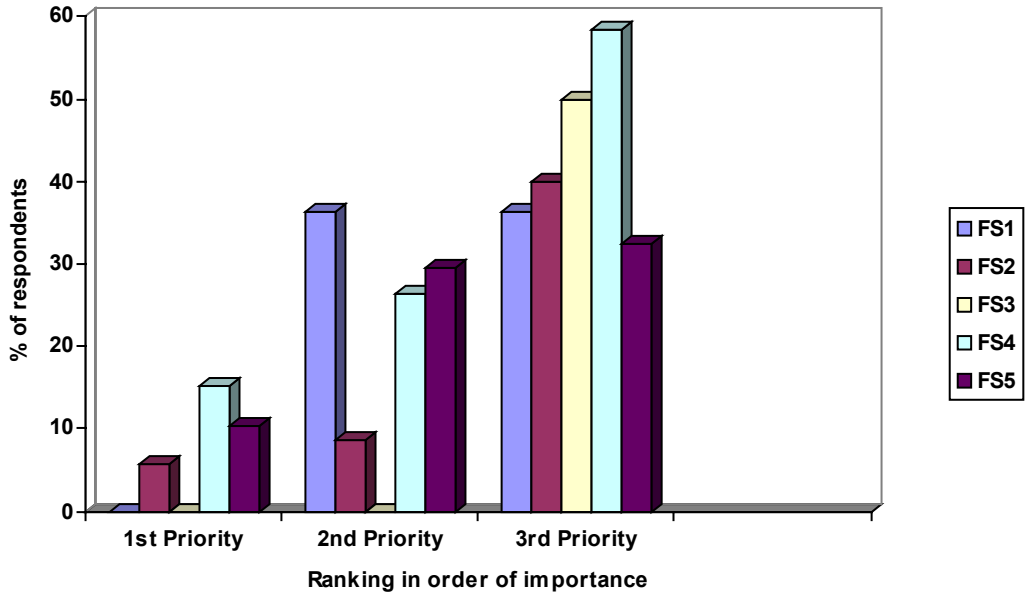


availability and prices. Use of pesticides in potato based farming system is low due to low disease pressure; while in rice-pastoral FS use of inputs is generally low in paddy production.

5.5.7 Extension services

Some farmers related the problem of low production with lack of adequate knowledge on good husbandry practices and new technologies to address production constraints. However, unlike other problems, this was ranked low. Maybe this is due to the fact that there are few extension officers in various fields of rural development especially agriculture and livestock. Farmers learn more from their fellow farmers as one way of knowledge uptake pathways. Although most of the villages visited had Village Extension Officers, most of them serve more than one village, and do not have transport to enable them visit the villages more frequently. This to a large extent reduces their efficiency. Chart 5.8 shows the ranking of extension services in the study area.

Chart 5.8: Ranking of problem of Extension Services by Farmers in the study area



6. LIVESTOCK PRODUCTION

6.1 Livestock types, herd sizes and ownership

Livestock keeping is an important enterprise for the majority of farmers in rural households. Livestock was ranked as a second income source in order of importance of household income generating activities. About 86% of farmers interviewed keep livestock. Types of livestock kept include cattle, goats, sheep, chicken, pigs, donkeys, guinea pigs, rabbits and ducks. Table 7.1 below shows the percentage of farmers keeping different types of animals in different farming systems.

Table 6.1 Number of livestock kept by respondents in different farming systems

Type of Livestock	FS1			FS 2			FS3			FS 4			FS5		
	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max
Cattle	9	7	10	4	1	12	5	1	15	7	1	20	54	1	406
Goats	10	1	15	3	1	7	5	1	10	5	1	12	24	1	100
Sheep	-	-	-	4	2	5	-	-	-	2	2	2	25	2	115
Chicken	5	2	10	6	1	20	10	2	21	12	1	70	13	1	150
Pigs	2	1	4	3	2	4	1	1	1	2	1	9	2	1	3
Donkey	3	2	3	2	2	2	-	-	-	2	2	2	4	1	8
Guinea pigs	8	8	8	9	3	18	5	3	6	11	2	25	4	2	5
Ducks	-	-	-	4	1	8	-	-	-	2	2	2	7	1	26
Rabbits	-	-	-	2	2	2	9	6	12	8	7	8	2	2	2

Source: Questionnaire survey, 2000.

Numbers of cattle reported by farmers vary between 1 to 406 head per household, that of goats vary between 1 to 110, and sheep between 1 and 115. The average is 10 and 19 for goats and sheep respectively. The small stock are kept in small numbers as shown in the table 6.1.

Men mainly own cattle, goats and sheep, while women own the small stock like chicken, ducks and guinea pigs; and to a lesser extent pigs. It was noted that farmers under-reported the numbers of livestock kept in fear of paying more taxes. Big herds of animals were observed in Ikoga and Simike villages in FS5 amongst the agro-pastoralist groups of Wasukuma and Maasais. Cattle population was also reported to be fluctuating and the main reason is cattle movement to distant grazing areas. Other reasons are death from disease outbreaks and theft; and sales of big numbers of animals during times of fodder and water shortage.

6.2 Uses of livestock

Livestock are mainly kept for cash earning, milk and meat supply, draft power, manure, dowry, rituals, prestige and investment. They are also kept for food security and for next generation or inheritance.

(a) Meat and milk supply

Cattle are rarely slaughtered for meat for household consumption except when they are sick or on special occasions. The animals mostly slaughtered are small stock. Goat and chicken meat is preferred most.

Milk production is very low, ranging between 1.0 to 1.5 litres/cow/day from local zebus. This is mostly consumed at home in case of few animals. Farmers with large herds like the agro-pastoralists may have excess milk for sale especially in the wet season. However the marketing of milk is a big problem in the Southern Highlands, because people do not have the habit of drinking milk.

There are few farmers with dairy animals, mainly crossbred cattle and goats in some villages in Makete (Matamba division), Njombe, Mbeya and Mufindi districts. The production of milk of the dairy cattle ranges between 5 to 10 litres. These animals were acquired mostly through projects like the Southern Highlands Dairy Development Project (SHDDP), Heifer International Project (HPI) and CARITAS. Institutions like ARI Uyole, Kitulo Dairy farms and SAO Hills Livestock Multiplication Centre were mentioned as sources of dairy animals.

(b) Cash income

Cattle, goats, chicken and pigs are important for income generation. The respondents reported that it is easier to sell goats and chickens than other stocks like sheep. Sheep play an insignificant role, as most people do not like its meat. Some farmers reported that they sell sheep to fellow farmers for rituals. Women preferred keeping chicken and pigs as an important source of income. These could be sold in events of sickness or payment of school fees for their children.

(c) Draft power and manure

Oxen are very important for crop production almost in all farming systems except Kikondo and Uporoto areas. On average, 54% of the farmers in the study area used draft animals for crop production. Donkeys are mostly used for haulage, and were very common in the Usangu plains, Matamba and Kikondo areas. Oxen are mainly used for land preparation using the mouldboard plough, ridging and for transportation. Weeding by using draught animals is not common with exception of the Mtwango/Makambako area where the mouldboard plough is used (table 7.2). Many farmers were unaware of draught animal weeding technologies. Organic fertilisers especially farm yard manure or kraal manure is used to improve soil fertility.

(d) Dowry, rituals, and food security

Cattle used to be important animals for dowry purposes. With time, this is changing as farmers claimed that due to high monetary value of cattle, people would rather sell the animals and pay dowry in cash. In agro-pastoralists, in particular the Sukuma, payment of dowry in terms of cattle is still very common. When a family has more boys, dowry could be a reason for decreased cattle herd.

Goats and sheep are mostly used for rituals purposes, although this is becoming less important with Christianity and amongst young farmers. Farmers also sell their animals in events of crop failure to buy food, as is the case this season in most agro-pastoralists families.

(e) Investment and inheritance

The role of cattle as a store of wealth in rural livelihood is very significant, and farmers claimed that it is more reliable than other alternatives like banking. Most of the banks are very far from rural

areas, and it becomes very expensive for them to bank. Cattle and goats also play a major role in prestige and inheritance as compared to other stock.

6.3 Livestock management

Livestock are traditionally managed by extensive systems. The most important aspects of management are feeding, watering, housing, milking and disease control are briefly described below. King and Ole-Lengisugi (2000) in their study of Livestock in the Usangu Plains give a more detailed description of livestock management in the pastoralists system.

(i) Feeding

Cattle, goats, sheep and donkeys graze or browse in the rangelands. Rangelands are uncropped areas within designated village lands. The animals are taken to graze during the day and kept in bomas in the night. Only 5.3 and 7.4 percent of respondents practice zero grazing and tethering respectively. Tethering is common in some parts of Matamba and Mbeya districts where grazing lands are scarce as land is continuously under cultivation. Farmers keeping dairy animals mostly practice zero grazing. In Mbarali and Njombe districts about 50% or more of the respondents reported that feeds were inadequate (table 6.2).

Table 6.2 Condition of feed resources in grazing lands as assessed by farmers (% of respondents)

Assessment level	Potato FS	Maize-Potato FS	Maize-Beans FS	Maize FS	Rice-Pastoralist FS	**Total**
Very plenty	33.3	4.3	20.0	25.9	12.0	16.1
Adequate	33.3	34.8	73.3	29.6	44.0	41.9
Scarce	33.3	56.5	6.7	29.0	40.0	35.5
Very scarce	0.0	4.3		14.8	4.0	6.5

Source: Questionnaire survey, 2000

(ii) Watering

Watering of ruminants is done along the streams and rivers in the grazing lands. During the dry season, water is a big problem. This has been a cause for conflicts between pastoralists and crop producers who cultivate in the valley bottoms (*vinyungu*) as witnessed in Simike village. Alternatively livestock keepers dig holes/wells to get water for animals. Women and female children fetch water for animals kept under zero grazing system and non-ruminants. This adds women workload especially during the labour peak period and the dry season when they walk long distances.

(iii) Housing

Cattle, goats, sheep and donkeys are kept in open enclosures (kraals) commonly called *bomas* or 'zizi la ng'ombe'. Sometimes sheep and goats are kept in raised huts. In Imalilo, Matamba and some parts of Uporoto areas, animals are kept in remote areas away from the normal village grazing areas. In most cases these are their old settlements known as "mahame" where farmers claim that there are better and adequate pastures. One member of the family will visit once or twice per week to check the health of the animals and in case of new borne. In this system animals are not milked.

(iv) Milking and cleaning of shed

In pastoralist areas, adult women and male children milk the animals. In areas where they did not have cattle culture and dairy animals were introduced recently, women are not used to milking. In this case adult men milk the animals. Cleaning of sheds is common in zero grazing systems, and for non-ruminants like pigs and chicken, and is mostly done by women and female children.

(v) Disease control and treatment

There is a wide range of animal diseases in the Usangu wetlands and its catchment. Men spray or dip the animals and they play a major role in disease control for cattle, sheep and goats. Women normally treat small stocks like chicken and ducks using local herbs.

6.4 Labour use and division in livestock management

In livestock management, involvement of household members depends much on the type of animal and production systems used. With ruminants managed under extensive system of keeping animals, mostly men and male children are responsible for grazing, watering, dipping/spraying, care of sick animals, cleaning sheds and stock marketing.

When management is under zero grazing the involvement of women is increased especially in feeding, cleaning of shed, milking and milk marketing. Tables 6.3 a and b show the involvement of members of the household in management of ruminant and non-ruminant animals as reported by respondents.

6.5 Constraints to livestock production

(a) Livestock diseases

There is high prevalence of livestock diseases and respondents ranked this as number one problem causing high mortality rates in livestock (table 6.4). Farmers reported tick borne diseases namely: East Coast Fever and Anaplasmosis as a big problem. In most villages it was reported that dipping facilities are either lacking or not functional. Contagious Bovine Pleuro Pneumonia (CBPP), Black quarter, lumpy skin and calf scours are other diseases claiming cattle deaths. New Castle Disease (NCD), Salmonellosis and Coccidiosis are causing deaths in poultry especially chicken to the extent of almost wiping the flocks in most households.

(b) Inadequate veterinary services

Inadequate and sometimes lack of veterinary services in terms of drugs and advisory services was ranked second by respondents. Extension staff are very few and in most cases live far from the livestock keepers. In Madibira ward, for example, there is only one extension staff for the whole ward and he is staying at Mkunywa village. This Livestock Extension Officer has to serve farmers in Ikoga village that is situated more than 50 km away. Pastoralists therefore have learned to treat their animals. Farmers complained of high cost of drugs required for treating their animals. Livestock keepers also use different indigenous strategies in coping with livestock diseases. Use of herbs is common but not very effective.

With trade liberalisation, there have been a lot of drugs with different trade names. It would be of help for the livestock department to plan for short-term para-professional training to these groups in order to up-date their knowledge on these new medicines in the market.

Table 6.3a Percentage of respondents on division of labour and decision making for the management of non-ruminant animals in the household

Activity	Adult Men	Adult Women	Children Men	Children Female	Both Adults	Both Children
Indoor feeding	4.3	52.2	8.7	0.0	30.4	4.3
Fetching of water	5.2	65.2	3.4	3.4	12.1	10.3
Care of young stock	7.7	74.4	1.3	0.0	14.1	2.6
Dipping/spraying	25.0	50.0	0.0	0.0	25.0	0.0
Cleaning shed	8.2	75.3	1.4	4.1	9.6	1.4
Care of sick animals	21.4	60	1.4	1.4	15.7	0.0
Stock marketing	25.3	45.3	0.0	0.0	29.3	0.0
Decision when to sale	19.5	42.7	0.0	0.0	37.8	0.0

Source: Questionnaire survey, 2000.

Table 6.3b Percentage of respondents on division of labour and decision making for the management of ruminant animals in the household

Activity	Adult Men	Adult Women	Children Men	Children Female	Both Adults	Both Children
Grazing and watering	27.8	7.8	43.3	3.3	8.9	6.7
Care of young stock	47.7	14.0	26.7	2.3	8.1	1.2
Cutting of grasses	46.7	26.7	6.7	0.0	20.0	0.0
Indoor feeding	33.3	33.3	6.7	0.0	26.7	0.0
Fetching water	15.0	29.5	31.8	0.0	18.2	4.5
Dipping	68.4	10.5	15.8	0.0	5.3	0.0
Spraying	88.0	8.0	4.0	0.0	0.0	0.0
Cleaning shed	27.9	42.3	14.8	1.6	13.1	1.4
Milking	31.5	35.2	18.5	0.0	7.4	7.4
Care of sick animals	74.4	8.1	4.7	0.0	12.8	0.0
Milk marketing	38.2	41.2	5.9	2.9	11.8	0.0
Stock marketing	85.4	4.5	2.2	0.0	7.9	0.0
Decision where to graze	91.7	0.0	0.0	0.0	8.3	0.0
Decision when to sale	77.3	4.5	1.1	0.0	17.0	0.0

Source: Questionnaire survey, 2000.

Table 6.4 Livestock production problems in different farming systems (% of respondents)

Problem	FS1	FS2	FS3	FS4	FS5	Total
Inadequate grazing lands	18.2	40.0	45.0	45.3	30.9	37.4
Poor quality forage	9.1	37.1	35.0	43.4	25.0	32.6
Dry season forage	18.2	40.0	45.0	45.3	26.5	35.8

Unreliable rainfall pattern	27.3	42.9	45.0	43.4	26.5	36.4
High incidences of livestock diseases	72.7	77.1	85.0	79.2	69.1	75.4
Lack of veterinary services	72.7	65.7	65.0	73.6	63.2	67.4

Source: Questionnaire survey, 2000.

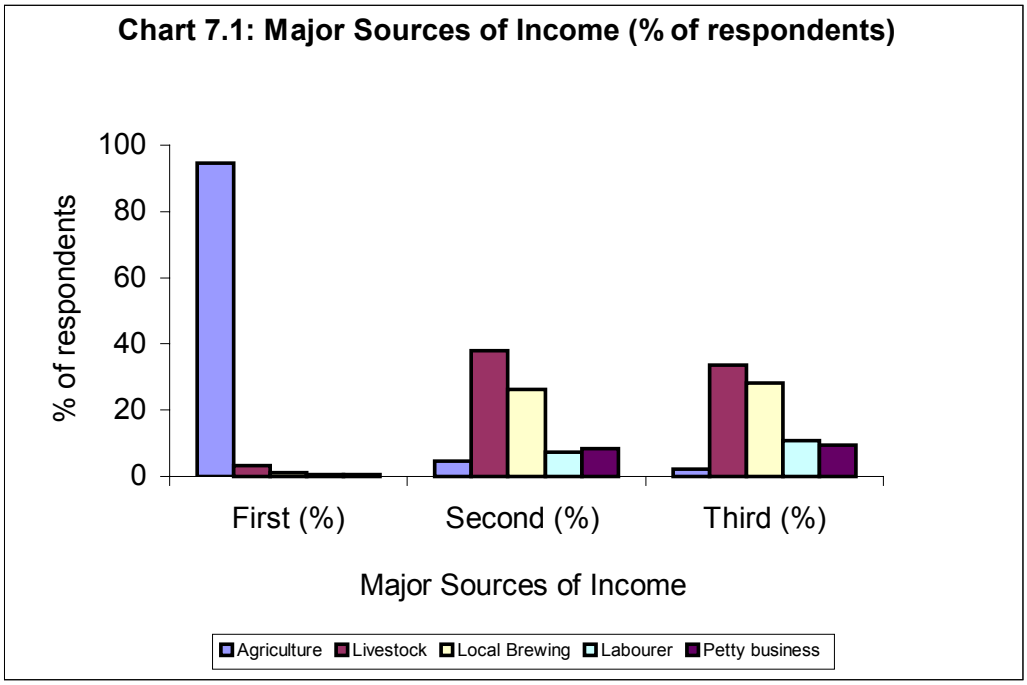
(c) Conflicting interest in the livestock department

During discussions with farmers it was revealed that sometimes campaigns for vaccination are combined with tax collection and therefore farmers tend to hide some of their animals. This was reported almost in all villages and might be a root cause of spreading of diseases that could be controlled by vaccination like CBPP.

7. THE HOUSEHOLD SOCIO-ECONOMY

7.1 Off-farm sources of income

Major sources of income in the study area are from crop and livestock sales. However, many farmers supplement their income through non-farm livelihood activities. These include: local brewing; selling labour to others; art and craft; petty business; brick making; artisanship, charcoal making and lumbering. About 26.3% of the respondents ranked local brewing as the second source of income; and on average 50% of the women are involved in local brewing. The highest numbers were recorded in Iringa (100%) and Mufindi (81%) and it ranked second in order of importance. Chart 7.1 below shows the major sources of income in order of importance as ranked by interviewed farmers in the study area.



Petty business is common amongst the young farmers where they buy produce to sell in nearby towns and open markets. Women are involved in preparing foodstuff like bread and doughnuts for sell in the village open markets. Few farmers were employed in nearby institutions such as TANWAT in Njombe and the tea plantation in Mufindi.

The sale of natural resources was more pronounced in Njombe, Makete and Mbeya, mostly sold as fuel wood from their own wood lots and timber for construction. It was difficult to get data on people involved in the sale of products from natural forests, such as charcoal, due to by-laws imposed as a result of campaigns against deforestation. Some families received remittances from their husbands who work outside the village in places like Tanga, Kilombero and Kilimanjaro where they are employed in sisal, sugar and tea plantations. Fishing was only reported at Ikoga village where farmers are fishing from the swamp. Little fishing was also observed at Idumulavanu along the

rivers. This implies that non-farm activities provide opportunity for diversification and contributes to the household economy. The variation between farming systems is summarised in table 7.1 below.

Table 7.1 Sources of income for rural livelihood by farming system (% of respondents)

Farming system	AG	LIV	LB	NR	AC	ART	PET	TRD	LAB
Potato FS									
First	100								
Second		10	50				20	10	
Third		55.6	22.2				11.1		11.1
Maize-Potatoes FS									
First	100								
Second		33.3	33.3	9.1		55.5	6.1	3.0	
Third		38.5	38.5	3.8	5.3	15.4			
Maize-Beans FS									
First	100								
Second		55	10		5	5	5		20
Third		30.8	38.5				15.4	7.7	7.7
Maize FS									
First	94.3		3.8						1.9
Second	3.8	37.7	26.4		1.9	3.8	9.4	3.8	3.8
Third	4.3	23.9	28.3	2.2	4.3	6.5	8.7	2.2	17.4
Rice-pastoralist FS									
First	89.7	8.8					1.5		
Second	9.5	39.7	23.8		3.2	1.6	7.9	3.2	9.5
Third	2.9	38.2	17.6			11.8	14.7	2.9	11.8

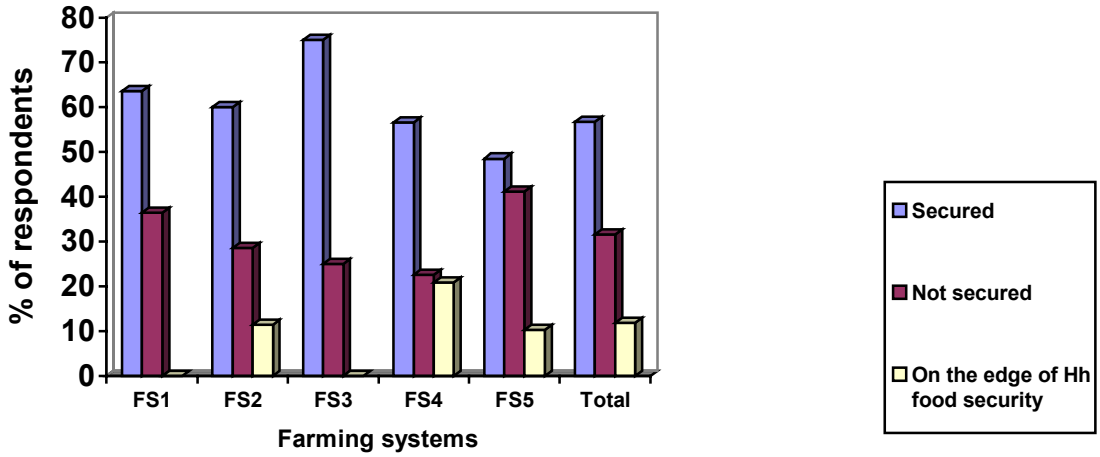
Source: Questionnaire survey, 2000 (AG=Agriculture; LV=Livestock; LB=Local brewing; NR=Natural resources; AC=Arts & Craft; ART=Artisan; PET=petty business; TRD=Trading & Business; EMP=Employment; LAB=Labourer)

7.2 Household food security

Many activities in the rural areas are geared towards securing a household food supply. A variety of food crops are grown in different farming systems for the purposes. Mixing of crops such as maize, beans and vegetable like pumpkins, cowpeas is a way of ensuring that household get enough food to sustain the family for the whole year.

The rating of household food security indicates that 56.7 percent of the respondents are having enough food for the whole year. About 31.6 percent of the respondents are not secured and 11.8 are on the edge of food security. Chart 7.2 shows the extent of household food security in the different farming systems.

Chart 7.2: Rating of Household Food Security in different Farming systems (% of respondents)



7.3 Source of fuel wood

Fuel wood is the main source of energy used in the rural areas in the Usangu wetlands and its catchment. The major source of fuel wood is the natural forest as reported by 69.9 percent of respondents. Only 18.6 percent of respondents indicated that they get fuel wood from own wood lots especially in Njombe, Makete and Mbeya district. Table 7.2 below shows different sources of fuel wood as reported in the study area.

Collection of fuel wood is done by women (85.8%) and sometimes assisted by their female children. Men are involved in cutting trees when the household is using fuel wood from own wood lot or bought from neighbours. Men were also involved in cases of use of oxen for transportation. Time taken to walk to fuel wood collection points is shown in chart 7.3.

Chart 7.3: Time on walking to the fuel wood collecting points

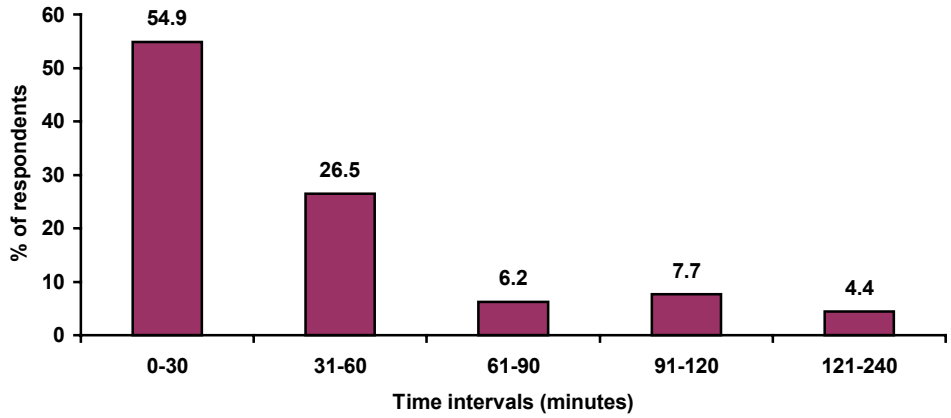


Table 7.2 Sources of fuel wood used by farmers (% of respondents)

Source of fuel wood	Potato FS	Maize-Potato FS	Maize-Beans FS	Maize FS	Rice-Pastoralist FS	**Total**
Own wood lot	10.0	48.6	27.8	17.0	3.0	18.6
Village wood lot	-	-	-	5.7	-	1.6
Neighbouring village	-	2.9	-	1.9	1.5	1.6
Natural forest	90.0	20.0	61.1	69.8	95.5	69.9
Buying trees from neighbour	-	28.6	11.1	1.9	-	7.1
Institutional forest	-	-	-	3.8	-	1.1

Source: Questionnaire survey, 2000.

7.4 Perception of farmers on villages level institutions

The village-level institutions present in the study area include village government, representatives of government extension services, religious institutions and non-governmental organisations. All the villages visited have a village government, sub-village leaders, and a number of committees to oversee the implementation of development goals. The Village Executive Officers are Local Government employees who assist the Village Chairmen in implementing local government activities at village level, like tax collection and maintaining order in the villages.

The presence of village level institutions and rating of perception of farmers on the performance of the institutions present in the villages is summarised on tables 7.3 a and b. The role of Community Development Officers was perceived more of a mobilisation rather than developmental. Forestry Extension Officers are regarded more on policing of forestry reserves rather than extension services. Although farmers reported the presence of Agricultural Extension Officers in some of the villages, there was no regular contact and their visiting schedules were not known to farmers. In some cases farmers perceive farming is 'business as usual' and an extension officer is needed when there are problems. As discussed earlier, extension staff are few and those present did not have facilities such as transport to enable them move in the villages allocated to them. Some Village Extension Officers save more than three villages.

Table 7.3a Presence of services of village level institutions by farming system (% of respondents)

Institution	Potato FS	Maize-Potato FS	Maize-Beans FS	Maize FS	Rice-Pastoralist FS	**Total**
Village Government	100	100	100	100	100	100
Religious institutions	45.5	88.6	90.0	96.2	82.4	86.1
Informal Groups	36.4	65.7	65.0	30.3	17.6	36.6
Agricultural Extension	0	94.3	85.0	64.2	52.9	59.1
Community Dev. Officers	0	28.6	40.0	11.5	13.2	17.7
Forest Extension	0	42.9	60.0	15.1	8.8	22.0
NGOs	0	40.0	42.1	7.5	4.4	15.7

Source: Questionnaire survey, 2000

Table 7.3b Rating of services of village level institutions (% of respondents)

Institution	Excellent	Good	Average	Bad
Village Government	19.0	42.4	31.0	7.6
Religious institutions	7.5	40.3	45.9	6.3
Informal Groups	11.9	41.8	32.8	13.4
Agricultural Extension	10.1	39.4	40.4	10.1
Community Dev. Officers	6.3	28.1	59.4	6.3
Forest Extension	2.5	55.0	3.0	12.5
NGOs	25.0	64.3	10.7	-

Source: Questionnaire survey, 2000

8. SUMMARY OF MAIN FINDINGS AND RECOMMENDATIONS

8.1 Summary of main findings

Rainfed agriculture is mainly subsistence and is practiced by all rural households in the study area. There is a great variation in the study areas within and between the highlands and the lowlands. The study identified the eight farming systems existing in the Usangu wetlands and its catchment based on the agro-ecological and geo-morphological characteristics, economic and social realities. Five of these were studied and described in detail.

The current farming systems are a result of interactions and interdependencies between natural, economic and socio-cultural of farmers' own priorities, resource availability and capabilities. Natural circumstances such as altitude, rainfall, soils, and topography influence farmer's decision on the type of crops to be grown. External socio-economic circumstances including farmer's access to inputs, produce markets, prices, availability of consumer goods and extension services also influence their decisions. Resource constraints in terms of land, water, labour, cash and capital limit farmers capacity to make substantial changes in their farming systems.

The rural livelihoods of people in the Usangu wetlands and its catchment depend on agriculture and livestock keeping as major sources of income. Men and women were found to participate equally in agricultural activities. In many cases men were more involved in land preparation, while women played a big role in planting and weeding. Many farmers supplement their income through non-farm livelihood activities that include: local brewing, selling labour to others, art and craft, petty business, brick making, artisanship, charcoal making and lumbering.

The crop production systems in the rainfed agriculture are very dynamic and in most cases crop and crop mixtures grown reflect the dietary preferences and the market opportunities of the farmers and risk avoiding strategies. In the highlands and medium plateau, crops grown include maize, beans, round potatoes, green peas, sweet potatoes, wheat, pyrethrum, coffee, sunflower, finger millet, vegetables and fruits. In the lowlands, the main crops produced are maize, cowpeas, pigeon peas, groundnuts, millets, sorghum, sweet potatoes, cassava and sugarcane. Paddy is mostly grown under irrigation either in traditional or improved schemes.

Livestock is practised both in the highlands and lowlands, where cattle, goats, sheep, donkeys, chicken, rabbits, ducks, pigs and guinea pigs are kept. There is high population of local zebu cattle and small ruminants in the lowlands, and in the highlands, dairying and pig production is common. Chickens are kept by almost all rural households.

Farmers, especially young farmers, are engaged in production of high value crops such as horticultural crops, but lack of processing industries and handling facilities for the produce leads to high post harvest losses and low farm gate prices.

Most of the farmers in rural areas lack working capital due to an absence of rural financial services to promote savings and credit. Financial capital limits farmers' capacity to make substantial changes in their farming systems and livelihood diversification.

There is great potential in all farming systems for crop production, but currently productivity is very low. Increase in production is a result of increase in acreage as opposed to intensification. Production of rainfed crops is suffering from conflicts in terms of resource allocation such as labour because all

crops are grown at the same time and there is always competition. Other important production constraints mentioned include low soil fertility, unreliable rainfall, diseases and pests. In addition lack of markets for their produce, low farm gate prices, high costs of inputs such as fertilisers and pesticides, low levels of mechanisation of farm operations and inadequate extension services limit the utilisation of the potential available in the study area.

Most of the potential farmland is under continuous cultivation. In areas where there is land pressure cultivation is now spreading to steeper slopes with serious erosion susceptibility, as observed in Ulenje, Galijembe, Imalilo and Malangali villages and Matamba area. In the lowlands, more clearing of land is experienced. Most of the villages lack clear land use plans for the natural resources management. Farmers are aware of the global concern on environmental degradation, as by laws for deforestation control exist and in some villages there are environmental committees. There is, however, lack of knowledge on appropriate land husbandry for the sustainable utilisation of the natural resources, maintenance and improvement of rural livelihoods.

Livestock keeping is an important enterprise for the majority of farmers in rural households. Livestock was ranked as a second income source in order of importance of household income generating activities. However, there is very low off-take of animals, the output levels are low and there is limited commercialisation. Dairying though promising in integration of crops and livestock production, is facing the problems of marketing of products such as milk and low productivity of animals due to low capital investment. High incidences of diseases coupled with inadequate veterinary services are the major limiting factors.

Recommendations are made towards the development of a strategy for the sustainable utilisation of the natural resources, maintenance and improvement of rural livelihoods in the study area.

8.2 Recommendations

Based on the findings of the study a number of intervention measures with regard to sustainable utilisation of the natural resources, maintenance and improvement of rural livelihoods in the catchment are needed. Possible areas of intervention are as follows:

i. Rainfed agriculture will remain the major source of income for the rural people, and land resources are important factors in achieving increased productivity. There is a need to identify, develop and implement sustainable land husbandry practices for both the highlands and lowlands. In the highlands, practices such as crop rotation and fallowing should be encouraged. In the lowlands soil and water management practices such as use of water bunds in rice cultivation and ridging in rainfed crops should be encouraged.

ii. The introduction of high value crops should accompany land conservation practices to optimise benefits or return to land and labour.

iii. Diversification of crop enterprises into non-traditional crops like pepper production under irrigation in the off-season production should be encouraged.

iv. Establish and understanding of indigenous technologies existing in different farming systems and knowledge of uptake pathways in land husbandry. The role of community leaders in land husbandry should be well established and integrated in the village development teams (TMV) that are currently promoted by SMUWC.

v. Promotion of uses of organic fertilisers that is currently done by extension departments and research should continue as a strategy for organic matter amendment in the farming systems. Studies to determine optimal level of organic fertilisers and combinations of organic and inorganic fertilisers required under different farming systems. The problem of transportation should be addressed by introducing simple carts.

vi. Food security strategy should focus on development of early maturing and drought resistant varieties of maize, sorghum and pulses in order to address the problems of unreliable rainfall especially in the medium and low altitudes.

vii. Promotion of value adding technologies like oil extraction in sunflower and processing of horticultural crops would increase farmers' income, and hence rural livelihood.

viii. The extension departments of the district councils, in collaboration with research institutions, should develop and demonstrate labour saving technologies in paddy and other rainfed crops to reduce the competition in labour allocation.

ix. Integration of crop-livestock production systems, particularly in the high and medium altitudes, should consider introduction of high yielding livestock and zero grazing.

xi. Valley bottom cultivation ('vinyungu') is important for food security, but in some areas farmers are cultivating in areas too close to river banks, which may create problems of sedimentation. Proper cultivation practices should be looked at to ensure better utilisation of 'vinyungu'.

x. Empowering farmers through promotion of farmers' organisation in order to address problems of accessibility of extension services and marketing of crop and livestock produce is recommended.

xii. Empowering farmers by promoting rural financial services such as savings and credit associations will enable farmers have more opportunities and capacity to make changes in their farming systems through livelihood diversification.

REFERENCES

Agricultural Research Institute Uyole, Progress Reports, 2000

Dumea, H.A. Watershed Management Relevance, Strategies and Approaches to Farmers. In Power, S., Makungu, P. and Quaraeen, A. (eds) 1997. Watershed Management, Participatory and Sustainable Development. Proceedings of DANIDA's 2nd International workshop on Watershed Management held in Iringa region Tanzania, from 26 May to 5 June 1997.

HIMA 1994. The Livestock/Farming System Study of Matamba Division.

King, A and Ole-Lengisugi. 2000. Livestock on the Usangu Plains. Report submitted to SMUWC Project.

Msolla, M., J. Hansen and A. Bjoernshave-Hansen, 1977. Sustainable Management as a Component of Watershed Management. Power, S., Makungu, P. and Quaraeen, A. (eds) 1997. Watershed Management, Participatory and Sustainable Development. Proceedings of DANIDA's 2nd International workshop on Watershed Management held in Iringa region Tanzania, from 26May to 5 June, 1997.

Mussei, A.N., R.P. Mbwile, J.K. Kamasho, C.M. Mayona, G.J. Ley and R.M. Mghogho. 1999. Agro-ecological zones and farming systems of the Southern Highlands of Tanzania. ARI Uyole, Mbeya, Tanzania.

Qaraeen, A. 1997. HIMA's Conformity with Tanzania's National Policies and Strategies for Sustainable Development. In Power, S., Makungu, P. and Quaraeen, A. (eds) 1997. Watershed Management, Participatory and Sustainable Development. Proceedings of DANIDA's 2nd International workshop on Watershed Management held in Iringa region Tanzania, from 26May to 5 June,1997.

Samki, J.K. and Harrop, J.F. 1982. Fertiliser Recommendations Related to Ecological Zones in Tanzania. Mlingano.

Shanner, W.W., Phillip, P.F. and Schmehl, W.R. 1992. Farming Systems Research in Development: Guidelines for Developing Countries. Boulder: West View Press.

Sustainable Management of Usangu Wetlands and its Catchment, Interim Report, 2000.

URT/EEC. 1987. United Republic of Tanzania/European Development Fund. Regional Agricultural Development Plan, Iringa Region Final Report Annex 1, Agrar-Und Hydrotechnik GMBH. Germany.

APPENDIX I

Terms of Reference for the Farming Systems (rainfed) Study

The Consultant will undertake an extended rainfed farming systems survey within the Usangu catchment. This includes both highland and lowland farming systems, but excludes the pastoral systems of the Usangu plain. Likewise, while the integration of irrigation needs to be assessed, detailed information on irrigation practices has already been collected and does not form part of the present assignment.

The major rainfed cultivated areas to be assessed are thought to be the area south and south-east of Mbeya; along the southern watershed between Mbeya and Matamba; Matamba area, Njombe south to the Usangu plain; the north-eastern highlands (Makambako to Iringa); and the southern Usangu plain from the Chunya escarpment to Madibira. The area falls within two regions (Iringa and Mbeya) and six districts – Mbarali, Mbeya rural, Makete, Njombe, Mufindi, and Iringa rural.

The objective is to prepare an overview of the rainfed farming systems of the catchments. Expected outputs include a map showing location and area of different farming systems, and a report describing each farming system. It is expected that most of the information will be obtained from secondary sources (National agricultural statistics, Regional, district and ward data, documented sources; other projects e.g. HIMA; etc.), with verification and elaboration through primary data collection at village and farmer levels. An extensive farmer/participatory process is not envisaged.

Specific topics to be covered by the survey include:

Cultivation - area
- crops –annual cropped area; crops grown (perennial, annual)
- fallow – area; rotation
- seeds – traditional/improved, sources,
- fertiliser – type, amount, sources, etc.
- yields
- use/division of family labour (gender, adult/child)
- other inputs – labour sources, mechanisation, etc.
- cultivation practices (hoe, animal traction, tractor, etc.)
- input costs (seeds, fertilisers, labour, etc.)
- constraints – access to inputs, credit, labour, etc.
- seasonal calendar
- marketing (amounts, location, prices)
- perceived problems – fertility, erosion, rainfall, etc.

Integration of livestock - types of livestock
- numbers
- uses (traction, milk, meat, fertilisation, etc.
- amount and sources of pasture
- labour (for herding)

Other income – forest products, bees, handcrafts, etc.

Relative importance of different activities re. Household survival/income.

Changes over time (20 years ago, 40 year ago) – crop area, crop type, yields, etc.

APPENDIX II:

Itinerary for the formal survey

Date	Activity
21/8/2000, Monday	Travel to Mbarali. Make logistic arrangement at SMUWC office and travel to Iringa
22/8/2000, Tuesday	Selection of farmers for interviews at Lumuli village
23/8/2000, Wednesday	Interviewed farmers at Lumuli village and travel to Mafinga
24/8/2000, Thursday	Selection of farmers for interviews at Maduma and Idumulavanu villages
25/8/2000, Friday	Interviewed farmers at Maduma village
26/8/2000, Saturday	Interviewed farmers at Idumulavanu village and travel to Njombe
27/8/2000, Sunday	Break
28/8/2000, Monday	Selected and Interviewed farmers at Imalilo village
29/8/2000, Tuesday	Selection of farmers at Itunduma village
30/8/2000, Wednesday	Interviewed farmers at Itunduma village
31/8/2000, Thursday	Selection of farmers at Malangali village
1/9/2000, Friday	Interviewed farmers at Malangali villages
2/9/2000, Saturday	Travelled to Mbeya, weekend break
3/9/2000, Sunday	Break
4/9/2000, Monday	Selection of farmers at Ikoga and Nyamakuyu villages
5/9/2000, Tuesday	Interviewed farmers at Nyamakuyu and Ikoga villages, travel to Rujewa
6/9/2000, Wednesday	Selection of farmers at Nyeregete and Itamba villages
7/9/2000, Thursday	Interviewed farmers at Nyeregete village
8/9/2000, Friday	Cancelled interviews at Itamba village (car breakdown)
9-10/9/2000, Sat & Sun	Break
11/9/2000, Monday	Interviewed farmers at Itamba village and selected farmers for interviews at Kimani village
12/9/2000, Tuesday	Interviewed farmers at Kimani villages, omitted Usalimwani village due to problem of cattle theft and funeral
13/9/2000, Wednesday	Travel to Matamba, selected farmers at Ng'onde and Igenge villages
14/9/2000, Thursday	Interviewed farmers at Ng'onde and Igenge villages, travelled to Igurusi
15/9/2000, Friday	Farmers selection at Iyawaya village
16/9/2000, Saturday	Farmers interviews at Iyawaya village, travelled to Mbeya
17/9/2000, Sunday	Break
18/9/2000, Monday	Data entry at Uyole
19/9/2000, Tuesday	Farmers selection at Mhwela village
20/9/2000, Wednesday	Farmers interviews at Mhwela village, farmers selection at Simike village
21/9/2000, Thursday	Farmers interviews at Simike village
22/9/2000, Friday	Farmers selection at Kikondo village
23/9/2000, Saturday	Farmers interviews at Kikondo village, selection of farmers at Ulenje village
23/9/2000, Saturday	Farmers interviews at Kikondo village, selection of farmers at Ulenje village
24/9/2000, Sunday	Break
25/9/2000, Monday	Farmers interviews at Ulenje village and farmers selection at Galijembe village
26/9/2000, Tuesday	Farmers' interviews at Galijembe village.
27-29/9/2000, Wednesday to Friday	Data entry and cleaning
30/9/2000 to 14/10/2000	Data analysis and Report writing at Uyole

APPENDIX III

A checklist for semi-structured interviews of key informants during formal survey.

A. Background Information

1. The history of the village and a chronological account of major events e.g. occurrence of drought, famine and family coping strategies, migration, epidemics, collectivisation and its effects, introduction of new crops and technologies and their impact to people and management of natural resources.
2. Identify types/categories of agriculturalists and their relevant attributes (examples of categories: semi-permanent, permanent, temporary, absentees, labourers, etc) and relationship that are developed as a result of their existence. In what way categories are linked with resource use, change in distribution, conservation, conflicts, etc.
3. Understand the history of different ethnic groups that have lived in the village.
Which areas do they occupy, which activities do they undertake, on what scale and under which management leadership?
4. Ethnic inter-relations following the series of major events in the village (e.g. during traditional society, villagisation, and present, since liberalization of the economy).
How is resource use regulated to ensure sustainable management of natural resources?

B. Land, its use and managemnent

1. Land tenure, land availability, allocation or distribution, land transfer and inheritance in the past and present.
2. Types of farming systems/practices, their history, requirements, advantages and problems, institutional organisations and management aspects in the farming system.
3. What farming system practices are considered good and needs to be maintained/promoted? Why and how?
4. How was resources distributed within the family, lineages, community, etc.
5. How are resources owned, managed e.g. land, water, trees of special values, rivers, valleys, springs, wild animals, etc. Are there any changes in the present situation, what are they and why did they occur? Who uses what and the level of dependency?
6. Information regarding major traditional institutions that existed, still existing, their role in management of resources, organizations, strength and weaknesses.
7. Characteristics of families/individuals who use or control certain important resources (e.g. large pieces of land, small forests, wild resources such as foraging areas, malungulu area).
8. How do people perceive ecological changes? How are the changes linked to agriculture and resource utilisation processes?
9. Socio-economic categories of families in the village? Wealth ranking? What are the development needs of the different socio-economic categories?

C. Cultivation of crops

1. Area under cultivation (by village, district, by crops);
2. Crops grown (annual cropped area – perennial, annual; cash and food crops);
3. Productivity (yield) levels of various crops grown, general production trends, causes for undesired situation in the production of crops;
4. Fallow practices – area, lengths, rotation practices;
5. Seeds used – traditional/improved, sources, costs, etc.

6. Fertilisers – types, amounts, sources, costs, etc.
7. Use/division of labour – gender/adult/child, strategies for coping with peak period labour requirement; hired labour (types, sources, costs, etc.);
8. Cultivation practices (hoe, animal traction, tractors – indicating operations done under each and costs, etc.);
9. Conservation practices (if any) – types, impact, etc.
10. Seasonal calendars
11. Storage of crops – structures, post harvest processing, farm transportation, etc.
12. Marketing – amounts, location, prices
13. Constraints – access to inputs, credit, labour, etc.
14. Problems of production – fertility, rainfall

D. Integration of livestock

1. Types of livestock kept
2. Numbers
3. Uses (traction, milk, meat, FYM, dowry, etc)
4. Amount and sources of pastures
5. Division of labour (in herding and other husbandry practices).

E. Household food security

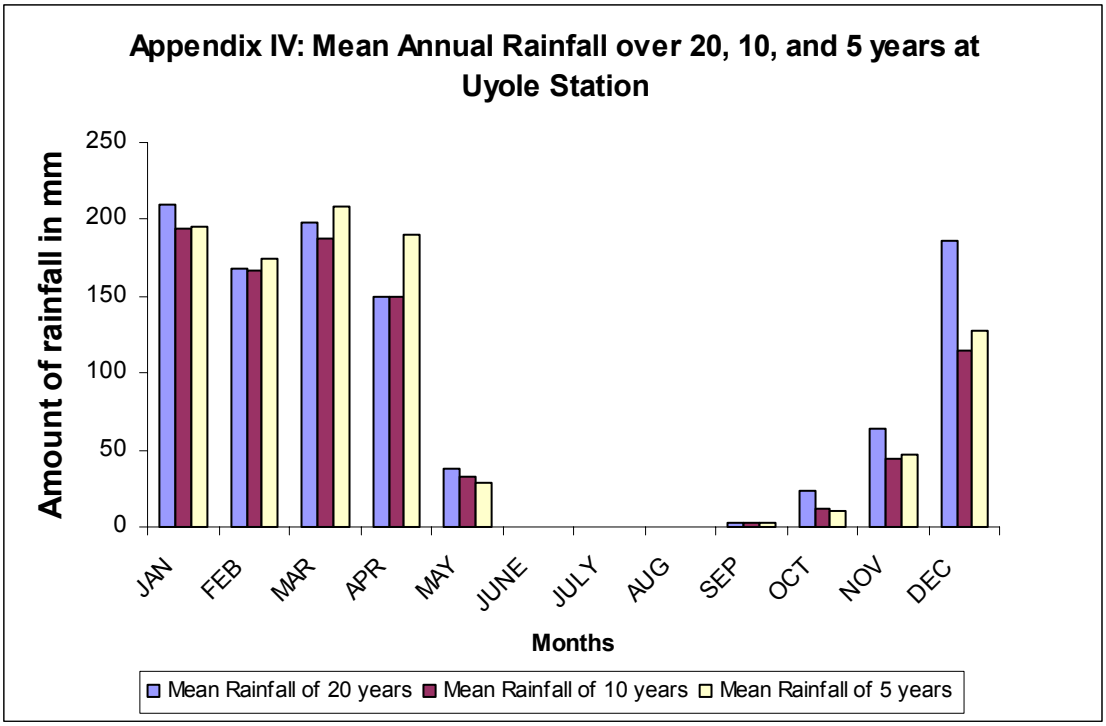
1. What were the traditional staple food crops in the past?
2. What traditional crops are no longer produced or eaten, and reasons.
3. Investigate on famine occurrence in the past, reasons, what coping strategies used, how successful.

F. Other sources of income

1. Opportunity for farmers to be engaged in off-farm activities as a source of income
2. What are the other sources of income (e.g. from forest products, bees, handicrafts, social welfare, etc.)

G. Community and general trends in natural resource utilisation

1. What was the forest like when the village was formed, in relation to how it is now? What major changes and how have they come about? What do they foresee as a future trend?
2. How do people perceive changes in availability of resources such as land, firewood, wild fruits and vegetables, decrease in fallow land, protected forests and increase in cultivated land area?
3. What major changes (rainfall, occurrence of certain diseases, pests, etc) and how do they perceive it?
4. What impact do people think their activities have on the environment? What desires are there for change of negative effects? What types of changes do they intend to make?
5. Strategies for cope with changing environmental situation: Are people planting or conserving trees in their farming systems, what species of trees and why? What are the characteristics of people planting trees, how are they planted, approximate hectares with planted trees, source of seedlings, usage of trees. What other conservation practices in use?


Appendix IV: Mean Annual Rainfall over 20, 10, and 5 years at Uyole Station
Amount of rainfall in mm
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC
Months
Mean Rainfall of 20 years
Mean Rainfall of 10 years
Mean Rainfall of 5 years

APPENDIX V

Villages visited during the formal survey

Village	District	Farming System
1. Lumuli	Iringa	4
2. Maduma	Mufindi	4
3. Idumulavanu	Mufindi	4
4. Imalilo	Njombe	2
5. Itunduma	Njombe	4
6. Malangali	Njombe	4
7. Nyamakuyu	Mbarali	5
8. Ikoga	Mbarali	5
9. Nyeregete	Mbarali	5
10. Itamba	Mbarali	5
11. Mhwela	Mbarali	5
12. Simike	Mbarali	5
13. Kimani	Makete	5
14. Ng'onde	Makete	3
15. Igenge	Makete	2
16. Kikondo	Mbeya	1
17. Galijembe	Mbeya	2
18. Ulenje	Mbeya	2
19. Iyawaya	Mbeya	3

APPENDIX VI

List of Key Informants Contacted During the Farming Systems Survey

District/Place	Village/Town	Name of Contact person	Title
SMUWC Office	Mr. Tom Franks Mr. Geoff King Mr. Mnzava Mr. Mlinga Ms. Vivian Mr. Mtaroni Mr. Mbuya		
Iringa	DALDO's office	Mr. Mwakyembe Mrs. Natai	DALDO DEO
Iringa	Lumuli	Zawadi muyinga	VEO
		Camillius Simba	Village Executive Officer
		Hamida Mukasa	DIVEO
		Raphael Kimbunga	Committee member of the Primary cooperatives
		Daudi Ngesi	Village Chairman
		Nyakunga	Farmer
		Samwel Nywage	Farmer
Mufindi	Mafinga	Nnko	Ag. DALDO Mufindi
		N.B. Mbaga	DSMS
	Maduma	B.K. Kimaryo	DIVEO
		Yotam Kihwela	Farmer
		Raphael Chafumbwe	Farmer
		Salesi Msumule	Farmer
		Jeremia Silimo	Farmer
		Dominicus Mkisi	Farmer
		Chelson Mbakiko	Farmer
		Atanus Chasumbwe	Farmer
		Samwel Mwanga	Farmer
		Raphael Msumule	Farmer
		Isdori Chipangule	Farmer
		Raphael Mkisi	Farmer
		Enok Ngoli	Farmer
		Obadia Emmanuel	Farmer
		Atilio Silino	Farmer
		Joseph Msumule	Farmer
		Jamanus Lalika	Farmer
		Obedi Kiswaga	Farmer
		Janet Chawala	Farmer
		Christina Mkisi	Farmer

	Idumulavanu	Dodi H.H	VEO
		Martin Kihanga	Farmer
		Vetus Pogo	Farmer
		Emilio Mvevere	Farmer
		Bosco Mganda	Farmer
		Titus Msule	Farmer
		E. Mgaya	Farmer
		B. Nzwalila	Farmer
		Ella Kiloko	Farmer
		Mlehwa Kilohoko	Farmer
		Anita Myale	Farmer
		Christina Msungu	Farmer
		Rukia Kihoza	Farmer
		Cristina Msovela	Farmer
		Patricia Mwigani	Farmer
		Maria Msovella	Farmer
		Agnes Msovella	Farmer
		Anamaria Myinga	Farmer
		Sikujua Kalamba	Farmer
		Joseph Msamagilo	Farmer
Njombe	Njombe	Mtama L.Y.	Project Manager HIMA Njombe
	DALDO Office	Dr. Mwakitosi	Ag. DALDO Njombe
		M.Kombe	DSMS small stock
		C.M. Ngoda	DSMS Pyrethrum
		Mtelewe D.	District Information Officer
	Imalilo	H.Mahava	VEO
		Fausta Mbilinyi	Farmer
		Sabela Chaula	Farmer
		Emi Mbwilo	Farmer
		Anet Mbilinyi	Farmer
		Veronika Chengula	Farmer
		Alifa Sanga	Farmer
		Upendo Mbilinyi	Farmer
		Sadru Sanga	Farmer
		Bertha Mdete	Farmer
	Itunduma	Mollel G.	VEO
		Yohana Mgindo	Village chairman
		Juma Athmani	Farmer
		Elina Kinyunyu	Farmer
		Kiwanga Luter	Farmer
		Durxon S. Nywage	Village Executive Officer
		Muhema M. Sihoman	Farmer
	Malangali	R.Makafu	DIVEO
		K.Mawona	VEO

		B. Ngogomi	Village Chairman
		B. Mbewa	Village Executive officer
		Jacktan Luponemo	Farmer
		Furaha Mbangule	Farmer
		Lazaro Kinywafu	Farmer
Mbarali	Rujewa	Dr. Mapunda	DALDO Mbarali
		Mr. Mlinga	District Extension officer
		Mr. Salu	Range Management Officer
	Nyeregete	Kasim Sawani	VEO
		H. Ngande	Farmer
		M. Msagila	Farmer
		A. Mjengwa	Farmer
		J. Kilala	Farmer
		B. Badanga	Farmer
	Ikoga	Mvamba Henry	Village Chairman
		Isdori Mhumba	Village Executive officer
		Fidelis Lusuva	Farmer
		Benitho Kasila	Farmer
		Sikitu Mhomole	Farmer
		Siprian Lyawa	Farmer
		Bundala Gung'u	Farmer
		Thobias Lalika	Farmer
		Martin Kkigwamupi	Farmer
		Joseph Kawuya	Farmer
	Nyamakuyu	Hamisi Ginga	Farmer
		Julius Uhagile	Farmer
		Florance Chalamila	Farmer
		Ramadhani Ginga	Farmer
	Itamba	Guni S.	VEO
		Anyesi Mbenelo	Farmer
		Charles singu	Farmer
		Julius wambali	Farmer
		Rogathia Goliama	Farmer
		Akile Shomari	Farmer
		Sauda Shilunda	Farmer
Makete	Matamba	Kessy D.	Team Leader HIMA Matamba
		Mbogela F.	HIMA officer
		Lupembe	VEO
	Kimani	Josia Kiumbe	Village Chairman
		Nuhu Makwesa	Village Executive officer
		Elifrida Pilla	Farmer
		Godfrey Mbwilo	Farmer
	Igenge	Ibrahim Mbwilo	Village Chairman
		Ernest sanga	Village Executive officer

		Lupembe D.	VEO
		Josephat Nkwama	Farmer
		Robert B. Chawe	Farmer
		Lekinald B. Chawe	Farmer
		Agnes L. Mahenge	Farmer
		Eustina O. Sanga	Farmer
		Nicolas O. sanga	Farmer
		Afloni Chawe	Farmer
		Tubuni Mgaya	Farmer
		Atusungukile Ngogo	Farmer
		Atuvonokisye Mbwilo	Farmer
Mbarali	Simike	Kassim Malise	VEO
		E. Monga	Farmer
		A. Mwaikambo	Farmer
		D. Gambi	Farmer
		M. Kisyombe	Farmer
		S. Luhela	Farmer
		Juma Mwampike	Farmer
	Mhwela	Issa Samson	Farmer
		Gileki Mbilamu	Farmer
		Newton Mwakalobo	Farmer
		Jane Sheyo	Farmer
		Betelina Mwangosi	Farmer
		Joseph Mwashitete	Farmer
		John Mwakosi	Farmer
Mbeya	Mbeya	Muliahela.L	DALDO Mbeya
		Matovu C.	DIVEO Tembela Division
	Galijembe	Nsiya Mwanyonga	Farmer
		Joesph Sakupina	Farmer
		Mbwiga Gristauni	Farmer
		Yasini sayota	Farmer
		Nsallu Ngalle	Farmer
		Elina Mwalyego	Farmer
		Jamhuri John	Farmer
	Ulenje	Anjelina Shonga	Farmer
		Flora Mwamboneke	Farmer
		Atilio Mwajojo	Farmer
		Shimba Mathew	Farmer
		Dionisia Mahinya	Farmer
		Yilongo Winga	Farmer
		Aron Mwandimbo	Farmer
	Iyawaya	Oscar Nassor	Farmer
		Salum Nsagaje	Farmer
		Majaliwa Mwakama	Farmer
		Zadok Mbuja	Farmer

		Juma Simwahenda	Farmer
		Jackson Mwampalanya	Farmer
		Omari Mbwiga	Farmer
		Aron Mwaibole	Farmer
		Saja Mwakanyamale	Farmer
		Shida Samwel	Farmer
	Kikondo	Atanas Mbanga	Farmer
		Emmanuel Feni	Farmer
		Michael Mashaka	Farmer
		Gandesi Nelson	Farmer
		Sadaka Bida	Farmer
		Jeni Binamu	Farmer
		Erasto Njelwa	Farmer
		Julius Swallo	Farmer

APPENDIX VII

Summary of Farming Systems Zonation in Usangu Wetlands and Its Catchment

(a) Farming System 1

Name of the Farming System: Potato Zone

Legend abbreviation:	Pot
Location:	High area of Kikondo in the Kitulo plateau
Towns and Wards:	Kikondo
Estimated area:	
Altitude:	2000-2900 masl
Mean annual rainfall:	1600 mm
Rainfall pattern:	Mono modal
Landscape:	Undulated and some dissected landscape
Parent material:	
Soil:	Humic Andosols
Natural vegetation:	Dominantly short grassland (mostly kikuyu) and remnants of natural forests consisting of *Hagenia sterculea*, bamboo and scattered *Ficus* species.
Estimated population:	
Population density:	
Ethnic groups:	Wasafwa, Wawanji and wanyakyusa
Average household size:	3.73
Average farm size:	6.1 acres
Households with Livestock:	72.7%
Major types of livestock kept:	cattle and pigs
Average cattle herd size:	9 (7-10) herds/household
Type of livestock keeping:	Extensive
Type of cultivation:	Flat cultivation
Major food crops:	Wheat, beans, green peas, round potatoes.
Major cash crops:	Round potatoes
Common cropping patterns:	Mono cropping
Important off-farm activities:	Local brewing
Constraints:	Decline soil fertility, frost damage, High fertiliser prices and inavailability.
Opportunities:	Increased production with improved communications and market opportunities.

(b) Farming system 2

Name of the Farming System: Maize-Potato Farming System

Legend abbreviation:	MaPot
Location:	Njombe Plateau and Uporoto highlands
Towns and Wards:	Igenge, Galijembe, Imalilo, Ulenje.
Estimated area:	
Altitude:	1500-2500 masl
Mean annual rainfall:	1000-2000 mm
Rainfall pattern:	mono modal
Landscape:	Undulating, steeply dissected mountains
Parent material:	
Soil:	Humic Ferralsol, Mollic Andosol, Vitric and Haplic Andosols.
Natural vegetation:	Remnants of natural forest consisting of *Hagenia sterculea* and bamboo. Also Kikuyu grass and *Hyparrhenia* grass dominate higher and lower elevations, respectively.
Estimated population:	
Population density:	
Ethnic groups:	Wasafwa, Wawanji, Wakinga
Average household size:	4.91
Average farm size:	7.9 acres
Households with Livestock:	88.6%
Major types of livestock kept:	cattle, goats, pigs,
Average cattle herd size:	4 (1-12)
Type of livestock keeping:	Cattle, goats, sheep, chicken and pigs
Type of cultivation:	Flat and ridges
Major food crops:	Maize, Beans, Wheat, Round potatoes and G/peas.
Major cash crops:	Pyrethrum, R/potatoes, Wheat, maize and coffee.
Common cropping patterns:	Mixed
Important off-farm activities:	Local brewing and lumbering
Constraints:	Decline soil fertility, crop pest infestation, marketing of produce and fertiliser prices.
Opportunities:	Increased production with improved access to technologies and market opportunities.

(c) Farming system 3

Name of the Farming System: Maize-Beans Farming System

Legend abbreviation:	MaBe
Location:	Mbeya stepped plains and North Ubena plateau
Towns and Wards:	Iyawaya, Inyala, Ng`onde
Estimated area:	
Altitude:	1600-1800 masl
Mean annual rainfall:	900mm
Rainfall pattern:	Mono modal
Landscape:	Undulating
Parent material:	Alluvial and debril fans
Soil:	Xanthic ferralsol, Ferralic cambisol
Natural vegetation:	Miyombo woodland and wooded grassland
Estimated population:	
Population density:	
Ethnic groups:	Wabena and Wasafwa
Average household size:	4.95
Average farm size:	5 acres
Households with Livestock:	95%
Major types of livestock kept:	Cattle, goats, chicken, pigs, guinea pigs, rabbits
Average cattle herd size:	5 (1-15) herds/household
Type of livestock keeping:	Extensive (93.3%), zero grazing (6.7%)
Type of cultivation:	Flat and ridge cultivation
Major food crops:	Maize, beans, r/potatoes, s/potatoes and wheat.
Major cash crops:	Maize, beans, tomatoes and onions
Common cropping patterns:	Mixed.
Important off-farm activities:	Lumbering and local brewing, bamboo wine harvesting.
Constraints:	Decline soil fertility, high fertiliser prices, frost and unreliable rainfall.
Opportunities:	Increased production with improved access to technologies and market opportunities.

(d) Farming system 4

Name of the Farming System: Maize-based Farming System

Legend abbreviation:	Ma
Location:	Mufindi and Kidugala plateau, lower Mufindi, Usangu flats border.
Towns and Wards:	Makambako, Malangali, Wanging`ombe, Chimala and Igawa
Estimated area:	
Altitude:	1000-2000 masl
Mean annual rainfall:	900-1200 mm
Rainfall pattern:	mono-modal
Landscape:	Undulating
Soil:	Humic Andosols, chromic cambisol, xanthic ferralsol,ferralic cambisol and cambic arenosol
Natural vegetation:	wooded grassland, Miyombo woodland and extensive undulating grassland
Estimated population:	
Population density:	
Ethnic groups:	Wabena, Wahehe, Wasangu
Average household size:	6.19
Average farm size:	5 acres/household
Households with Livestock:	94.3%
Major types of livestock kept:	cattle, goats, chicken and pigs
Average cattle herd size:	7(1-20) heads/household
Type of livestock keeping:	Extensive
Type of cultivation:	Flat seedbed and some ridging.
Major food crops:	Maize, beans, r/potatoes, s/potatoes, s/flower and cowpeas
Major cash crops:	Maize, Beans, s/flower, tomatoes, cabbages
Common cropping patterns:	Mixed.
Important off-farm activities:	Local brewing
Constraints:	Decline in soil fertility, unreliable rainfall, and fertiliser prices
Opportunities:	Land conservation would improve soil properties hence, increased production and income to farmers. Promotion of processing industry would improve farm gate prices of produce such as oil seeds.

(e) Farming System 5

Name of the Farming System: Rice-Pastoral Farming System

Legend abbreviation:	Rc-Pal
Location:	Usangu plains
Towns and Wards:	Nyamakuyu, Ikoga, Mhwela, Simike, Kimani, Itamba
Estimated area:	
Altitude:	750-1000 masl
Mean annual rainfall:	400-600mm
Rainfall pattern:	mono-modal
Landscape:	Lacustrine plain, bajada and piedmonts
Parent material:	Alluvial fans
Soil:	Chromic vertisol and Eutric fluvusol
Natural vegetation:	wooded grassland consisting of *A. kirkii* and *A. stuhlmanii*
Estimated population:	
Population density:	
Ethnic groups:	Wasangu, Wasukuma, Wahehe, Wabena, Wanyakyusa
Population mobility:	
Average household size:	6.81
Average farm size:	13.2 acres
Households with Livestock:	77.6%
Major types of livestock kept:	cattle, goats, sheep, chicken, ducks, donkeys
Average cattle herd size:	54 (1-406) heads/household
Type of livestock keeping:	Agro-pastoralism
Type of cultivation:	Flat and ridging
Major food crops:	Maize, paddy, beans, s/potatoes, g/nuts, cowpeas
Major cash crops:	Maize, paddy, beans, g/nuts
Common cropping patterns:	Mixed, monocropping in paddy
Important off-farm activities:	Local brewing and petty business

Constraints: Unreliable rainfall, marketing of produce, low prices of livestock products, marketing of milk.

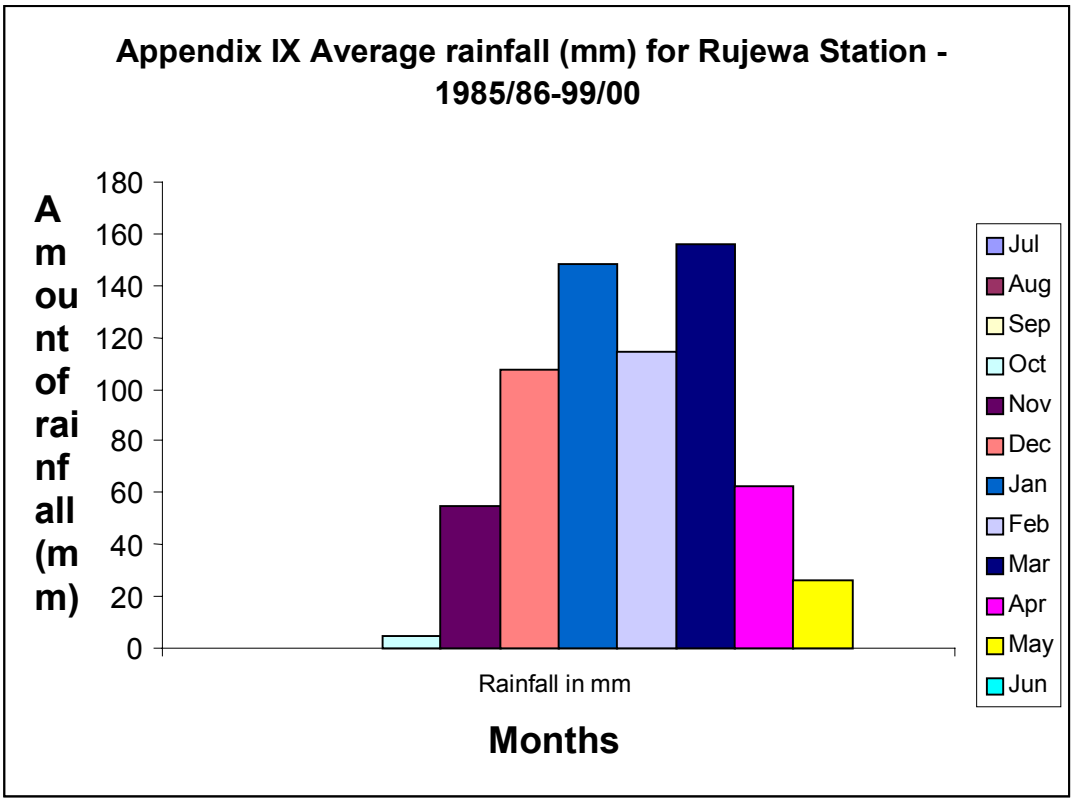
Opportunities: Expanded paddy production with efficient use of irrigation water, leather and other livestock products, ethno-botanicals for livestock diseases and tick control, improving livestock management and develop into local ranching enterprises.

APPENDIX VIII

Surveyed Village Profile in the Usangu Wetlands and its Catchment

Socio Economic Profile	Potato-Pyrethrum	Maize-Potato				Maize-Beans		Maize-based Farming system				
	Kikondo	Galijembe	Imalilo	Ulenje	Igenge	Iyawaya	Ng'onde	Malangali	Itunduma	Lumuli	Maduma	Idumulavanu
No. of sub-villages	6	5	6	10	3	5	3	3	5	7	10	6
No. of Households	306	418	308	389	209	174	390	499	580	502	850	352
Primary School	v	v	v	v	v	V	v	v	V	v	v	V
Dispensary	v								V	v		V
Extension Officer		VEO		VEO		VEO		VEO	VEO	VEO		VEO
Water Supply Tape(T), Wells (W), Natural springs (N)	N			T				W	T		T	W
Road condition Good (G), Bad (B), Average (A)	G	G	A	A	G	G	G	A	G	A	A	A
Transport Condition Good (G), Bad (B), Average (A)	G	G	B	B	A	G	A	B	G	A	A	A
Shops/kiosk service Good (G), Bad (B), Some (S)	G	G	G	G	S	S	S	S	G	S	S	G
Storage Facilities Present (P), None (N)	N	P	P	P	P	P	P	P	P	P	P	P
Milling Machine Present (P), None (N)	P	P	P	P	P	P	P	P	P	P	P	P

Socio Economic Profile	Rice-Pastoralist Farming System						
	Nyamakuyu	**Ikoga**	**Nyeregete**	**Itamba**	**Kimani**	**Simike**	**Mhwela**
No. of sub-villages	5	6	9	6	3	8	9
No. of Households	614	354		354	266	264	646
Primary School	v	v	v	v	V	v	v
Dispensary	v						
Extension Officer	VEO		VEO	VEO	VEO	VEO	VEO
Water Supply Tape(T), Wells (W), Natural springs (N)	N	N	N	N	N	N	N
Road condition Good (G), Bad (B), Average (A)	A	B	A	A	G	A	G
Transport Condition Good (G), Bad (B), Average (A)	A	B	A	G	G	B	A
Shops/kiosk service Good (G), Bad (B), Some (S)	G	S	G	G	S	B	S
Storage Facilities Present (P), None (N)	P	P	P	P	P	P	P
Milling Machine Present (P), None (N)	P	P	P	P	P	P	P


Appendix IX Average rainfall (mm) for Rujewa Station - 1985/86-99/00
Amount of rainfall (mm)
180
160
140
120
100
80
60
40
20
0
Rainfall in mm
Months
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun