EXECUTIVE SUMMARY

1. Irrigated agriculture covers an extensive area in the Usangu wetlands and their catchment (over 43,000 ha). The main irrigated crop is wet season paddy (just under 41,000 ha), while the other 2500 ha is dry season irrigation of maize, beans and vegetables. Both forms of irrigation are fundamentally for commercial purposes; households relying on the rainfed wet season maize crop for domestic use.

2. Paddy irrigation in this area is dynamic and complex. The irrigated area changes between years according to the amount of rainfall. Large areas of paddy cultivation have been abandoned (over 5000 ha) over time, but the area of paddy cultivation is still increasing. The location of intakes along a river often changes, and it is not uncommon for rivers in flood to change course, taking the course of one of the irrigation furrows that abstract from it. Finally, some furrows take water from one sub-catchment to another sub-catchment.

3. Demand for irrigation water for paddy begins in October, and finishes in July. Transplanting takes place from November (top-end) to March (tail-end). Harvesting takes place from April (top-end) to August (tail-end). From the time the paddy fields are ploughed, farmers like to keep 6 – 10 cm depth of water in their fields. The paddy is grown in small basins that help to keep the level of water constant. The basins are drained two weeks before harvesting. Average yields for paddy are around 2.5 t/ha, reaching as high as 3 t/ha at the top-end, and as low as 2 t/ha at the tail-end of an irrigation system.

4. The use of inputs such as fertiliser and improved varieties for paddy is limited. This is because they are expensive and because farmers are unwilling to bare the risk of investing too much in the paddy crop when the failure of the rains can mean the failure of their crop. Farmers usually grow the traditional Kilombero variety of paddy, and irrigation water is the only input. Normal plot size for paddy cultivation is between 0.5 and 2 ha.

5. Dry season crops are grown from April to November or December (depending on when the rains start). The main month for planting dry season maize is July, once the rainy season maize crop has been harvested. Typical dry season crops are maize, beans, tomatoes, potatoes and other vegetables. Plot size for dry season crops is usually smaller than for paddy, normal plot size being between 0.1 and 1 ha. There is greater use of agricultural inputs for dry season cultivation, including manure, fertilisers, and quick growing varieties of maize. Farmers irrigate dry season crops once or twice a week, usually in the early evening.

6. There are six main types of irrigation system in the SMUWC project area – indigenous smallholder irrigation systems, externally modified irrigation systems, large-scale NAFCO irrigation schemes, large-scale smallholder irrigation schemes, Peri-NAFCO indigenous smallholder irrigation systems, and Baluchi irrigation systems.

7. The indigenous irrigation systems and Peri-NAFCO systems usually have traditional intake structures, made of stone, sand, brushwood and mud. The furrows themselves are unlined earth ditches. These systems are labour-intensive and maintained on a regular basis by all of the farmers using the system.

8. In externally modified systems the traditional intake structure has usually been replaced with a concrete intake and weir, and will also have a control gate with which unwanted water can be diverted back to the river. In most cases these control gates have been removed. Large-scale schemes also have concrete intakes. All of these systems are capital intensive to maintain, relying on cash contributions from the user group to pay for the higher of excavation machinery.

9. For paddy, allocation schedules are only introduced at times of great water scarcity, which may occur at the beginning of the season if the rains are late, or at the end of the season if the rains finish early.

Water is usually allocated to each secondary canal for a fixed period of time. At other times, there is a *de facto* staggering of the distribution of water from the top-end to the tail-end. This is inequitable, but works well as it staggers the demand for water and requires minimal organisational effort.

10. For dry season crops, there is usually some system of allocating water to different areas of dry season cultivation on a time basis.

11. If farmers fail to get the amount of water they need for either their paddy or dry season crops, they will go out at night to try to divert water to their plot.

12. Most furrows are managed by a traditional irrigation committee that is responsible for organising the maintenance of the furrow and allocation schedules should water become scarce. In some furrows (notably externally modified systems and large-scale schemes) irrigation is managed by a formally registered organisation – either a co-operative or association. A group of furrow users must form such a legally recognised body if they wish to apply for the water right for the water that they are abstracting from the river. In externally modified systems, a more complex series of committees has usually been established. However, not all of these committees are functioning because farmers do not see the purpose of many of the committees, and they create too much work for the farmers themselves.

13. Membership of a furrow user group usually depends on two things – cultivating land within the command area, and contributing to furrow maintenance (either through labour or cash contributions).

14. For each Ward and/or Village there are a series of by-laws relating to irrigation and use of the furrows. However, these have usually been lost and are not strictly adhered to. The list of by-laws is usually more comprehensive where there has been external intervention, but they are still not enforced, mainly because farmers see little purpose in them and they are too much work for the leaders (who are unremunerated) to enforce.

15. There is usually no upstream-downstream allocation of water between different furrows. However, attempts have been made to form some kind of sub-catchment organisation along three rivers. In two of these cases, the allocation schedule introduced to divide water between the different furrows is working well. In the other case, the Kimani River, the committee is no longer functioning. There is a fourth example, where the Ward Executive Officer himself organises an allocation schedule between the different furrows along the Kyoga River.

16. The biggest conflicts over irrigation water are top-end/tail-end and upstream/downstream problems. When the conflict and arguments are particularly bad the case is normally referred to the Ward Development Committee.

17. The Water Office is introducing a system of statutory water rights with concomitant annual water user fees for the irrigation furrows in the area. At present, very few furrow user groups own the water right to the water they are abstracting (less than 10%). Problems with the introduction of water rights include the fact that very few furrows have any means of controlling or measuring the amount of water that is being abstracted (although it is a legal requirement that every abstraction with a water right should have a functioning control gate). For most of the furrows where a water right is already held, the furrow users do not actually know how much the water right is for.

18. There are several examples of external interventions into indigenous smallholder irrigation systems in the project area. However, these projects have not always achieved their aims of increasing agricultural output or the efficiency of water use. Key problems are as follows:

- Infrastructure: Infrastructure is capital intensive to maintain and there is a lack of ownership of the new infrastructure by the furrow users. As a result, furrow users are unwilling to contribute to furrow maintenance.
- Institutions: The institutions introduced to manage the scheme are often too complex, represent the interests of the influential people within the user group rather than the majority of farmers, and, because they now handle money rather than just organise labour, leaders frequently embezzle funds. Many of the institutions introduced are co-operatives, and there is a historical distrust of these organisations by farmers. Finally, the tasks leaders are required to undertake are often to onerous for an unpaid position, so many tasks are not fulfilled.

- The aims of the projects are often different to the aims of the farmers themselves – farmers aim to minimise risk, while the projects aim to maximise yields.

19. The two NAFCO farms are facing severe financial and managerial difficulties, and only a very small proportion of these farms is now cultivated by NAFCO. Out of 6000 ha, over 1500 ha is now rented out to smallholders. The future of these two state farms is currently in the hands of the Public Sector Reform Commission, and it is likely that the farms will be sold.

20. There has been very extensive development of 'Peri-NAFCO' irrigation based on drainage and spillover water around these two farms. There is over 5000 ha of this Peri-NAFCO irrigation. Therefore a large number of households are dependent on NAFCO drainage and spillover water for their agricultural activities, and often for domestic water supplies as well. Therefore how to secure the water supply to the Peri-NAFCO irrigated areas will need to be considered when deciding the future of the NAFCO farms.

21. Because of the extensive irrigated area in the SMUWC project area, irrigation water management will be an integral part of a natural resource management strategy. The strategy should build on the successful elements of irrigation management that already exist, and learn from the mistakes of past interventions. Two suggestions are made:

    - A proposal for a pilot sub-catchment water management programme that would focus on the upstream-downstream management and allocation of water.

    - Dr. Bruce Lankford, the Water Management Specialist, has made a proposal for management transfer of the NAFCO farms. The Peri-NAFCO users should be an integral part of this process, indeed the Peri-NAFCO irrigated areas could be considered as an extension of the scheme itself. Also, it is important to research and build on the experience of transferring management to smallholders at the Madibira Smallholder Scheme and the renting of land to smallholders at the Mbarali NAFCO farm.

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LIST OF ACRONYMS

CEP	Community Engagement Programme
DIO	District Irrigation Officer
EMSIS	Externally Modified Smallholder Irrigation System
FAO	Food and Agriculture Organisation
ISIS	Indigenous Smallholder Irrigation System
KIP	Kimani Irrigation Project
KRCC	Kimani River Canal Committee
LSSIS	Large-Scale Smallholder Irrigation System
NAFCO	National Agricultural and Farming Corporation
RBMSIIP	River Basin Management and Smallholder Irrigation Improvement Programme
RBWO	Rufiji Basin Water Office
SMUWC	Sustainable Management of Usangu Wetlands and Its Catchment
t/ha	Tonnes per hectare
TSh	Tanzanian Shillings (US$1 = TSh 800; UK£1 = TSh 1300)
UVIP	Usangu Village Irrigation Project
WDC	Ward Development Committee
WIA	Women in Irrigated Agriculture
WUA	Water User Association
WUF	Water User Fee

1. INTRODUCTION

Rapid expansion of irrigated agriculture in the Usangu Sub-Catchment since the 1950's is identified as a potential cause of the drying of the Great Ruaha River. It is estimated that the total irrigated area in the Usangu Catchment is approximately 43,500 ha, of which 37,700 is smallholder irrigation that is both used and managed by local people (based on results of irrigation survey). Large-scale state-owned farms that are managed by the National Agriculture and Food Corporation (NAFCO) ha account for the other 6200. The aim of this work is to provide an understanding of how local people manage their irrigation water supply that can be used to develop a natural resource management strategy that will actually be of benefit to and therefore implemented by local people. This work links to both the Water Management component of the SMUWC project (understanding water use), as well as the Community Engagement Programme (CEP) component (working with local people and other stakeholders to establish directions for a water resource management strategy).

Therefore, this report has five key aims:

1. To provide an understanding of how farmers work together to build, operate and maintain irrigation systems.

2. To provide a comparison between the different types of community irrigation in the project area.

3. To analyse the impact of previous irrigation projects in the area and draw out the lessons that can be learnt from these projects.

4. To provide an understanding of the processes that are occurring on and around the state-owned farms.

5. To identify directions towards the water management component of the Natural Resource Management Strategy.

This report begins with a brief description of the work undertaken and methodologies used to collect the information given (section 2). Section 3 provides an introduction to irrigation in the project area, including a definition of what irrigation is, a brief history of irrigation in the Usangu area, and a summary of the different types of irrigation found in the project area. Section 4 provides an introduction to agricultural activities in the project area, discussing the crop-cycle and on-farm water management practices for both wet season paddy and dry season irrigated crops. The organisation of smallholder irrigation is addressed in section 5, which includes sub-sections on physical infrastructure and maintenance; the allocation of water and conflict management; leadership and membership; and by-laws and rule enforcement. This section includes comparisons between the different types of irrigation found in the Usangu.

Upstream-downstream water management and allocation of water is the focus of section 6, providing a description of some of the upstream-downstream water management initiatives that have been tried to date. Section 7 discusses the role of statutory water rights and annual Water User Fees in the management of smallholder irrigation systems. Section 8 analyses the impact of previous irrigation projects such as the Kimani Irrigation Project (a smallholder 'improvement' scheme) and the Kapunga Smallholder Scheme (which involved the building of a large-scale smallholder irrigation scheme). The current status of the NAFCO farms and the smallholder irrigation that has developed around them is discussed in section 9.

In section 10, the issue of how local-level water management initiatives could feed into a broader natural resource management strategy. The main focus is on a pilot sub-catchment water management programme, but the issue of the future of the large-scale NAFCO farms and the importance of this to water use within the project area is also highlighted.

The data presented in sections 2 – 8 is a summary of the detailed findings given in the different working papers written by the consultant (November 1998, February 1999, March 1999, December 1999). If more detail about a particular irrigation system is required, these papers should be consulted.

2. WORK UNDERTAKEN AND METHODOLOGY

The community irrigation work has been undertaken in four separate inputs, totalling five months. The inputs have been spread over one agricultural year beginning in late November 1998. Further inputs were conducted in January - February 1999, March 1999 and August – November 1999. During this time detailed work was undertaken at a number of case study furrows. Each of the case study furrows were considered to be representative of the different types of irrigation found in the project area (see section 3 and table 1 below). Comparative and fact finding visits were made to other systems as and when necessary.

For each case study irrigation system, group interviews were undertaken with men and women (separately and in mixed groups). These group interviews included participatory mapping. On the maps the respondents were asked to locate the intake, secondary canals, any upgraded structures (e.g. control gates) the cultivated area (distinguishing between wet and dry season), where surplus water drains to, and any other distinguishing features. The map was then used as a basis for discussion about a number of issues. These included the allocation of water, differences in the crop cycle between the top and tail-end, differences in the cultivated area between wet and dry years, allocation of water between neighbouring furrows abstracting water from the same source, how and when the system is maintained, and so on.

To verify the maps, time was spent walking around the furrow identifying the key features illustrated on the maps. At the same time, farmers working in the fields were interviewed to find out about how the allocation, maintenance and leadership arrangements effects individuals within the system. Individuals were asked questions about the timing of their agricultural activities in relation to the water supply, what they do to maximise the amount of water they receive, how they respond to shortage or excess of water supply, conflicts with other farmers and so on. As stated above, the data collected from each case study irrigation system is presented in detail in the different working papers.

Due to lack of data about the extent of the irrigated area, the number of households irrigating, the amount of water being abstracted from rivers and other important data, it was agreed with the Water Management Specialist that a comprehensive questionnaire survey be undertaken of every furrow in the catchment. This was conducted between September and November 1999. Some of the data from this survey is used in this report. A full report of the survey and results are given in a Technical Appendix. Much of this data will be used in the Irrigation Impact Model to be produced by the Water Management Specialist.

Whenever possible, this work was undertaken with the District Irrigation Officer, Mr. Rogers Masha and the relevant Ward Extension Officer. If Mr. Masha was not available, fieldwork was undertaken with just the Ward Extension Officer for that area.

3. INTRODUCTION TO IRRIGATION IN THE USANGU WETLANDS AND THEIR CATCHMENTS

Irrigation is defined as the artificial control of water in order to meet crop water requirements. This definition includes the use of residual moisture from flood recession, drainage systems and the capturing of runoff in rainwater harvesting systems, as well as the canal irrigation systems that most people think of as irrigation. The other forms of irrigation are found in the project area, but this report will focus on canal irrigation. This is because it is very extensive and has significant implications for both rural livelihoods and downstream flows. The areas of flood recession agriculture, drainage and rainwater harvesting are relatively limited.

An irrigation system is defined as 'both the physical infrastructure of works and also the social infrastructure of rules and procedures that ensures the operation of technology and the delivery of water' (Vincent, 1995). An irrigation scheme is defined as a formal, externally sponsored (either by government and/or donor) project to build new irrigation systems or to upgrade existing systems. Throughout East Africa, irrigation canals are generally referred to as 'furrows'.

German missionaries first introduced irrigation to the Usangu Plains in the early 19th century. They built small furrows to provide domestic water to the missions and to irrigate vegetable gardens. In the 1940's, the Baluchi people introduced paddy irrigation, which spread quickly among local farmers. The most rapid expansion of the irrigated area probably occurred in the late 1980s after trade liberalisation in 1986. Prior to this, all agricultural produce was sold to co-operatives. Producer prices were low, and payments were late or non-existent. With liberalisation in 1986, a number of traders began to operate in the area, and producer prices increased rapidly, encouraging farmers to increase production and extend the cultivated area. The availability of land with favourable conditions for profitable paddy cultivation encouraged migration from the surrounding highlands, and up to 21 different ethnic groups can be found cultivating paddy in the project area (Branner Jesperson, 1973). Of the 43,500 ha of irrigation in the project area, approximately 2500 ha is used for dry season irrigation of maize, beans and vegetables, while the other 41,000 ha is supplementary irrigation of rainy season paddy (based on results of irrigation survey).

There are seven basic different types of irrigation system in the project area, which are described in detail in table 1. This work will focus on types 1 – 6 listed in table 1. Rainwater harvesting systems were investigated, but there are small in area and involves opportunistic cultivation, these plots only being cultivated in years of heavy rainfall. Therefore it is felt that it does not have a significant impact on the overall water balance of the project area. The NAFCO farms are considered in relation to the Peri-NAFCO smallholder systems and the Kapunga Smallholder Scheme, which are dependent on NAFCO water for survival.

Irrigation in the Usangu area is very dynamic and therefore complex. There are five factors that contribute this dynamism and complexity:

1. In the indigenous systems (ISIS and Peri-NAFCO) used for paddy cultivation, there is core area that can be irrigated every year, including years of poor rainfall. There is also a peripheral area that can only be cultivated in years of average or above average rainfall. In this respect, it needs to be emphasised that the irrigation of paddy in Usangu is supplementary irrigation, with irrigation water supplementing rainwater. For those in the peripheral areas, the volume of irrigation water available is not sufficient for paddy cultivation if rainfall is poor.

2. The location of intake structures is often changed as the area around old intakes is eroded and the top-end of the furrow incises too deeply. As the furrow incises, land at the top-end falls out of the command

area. When this happens, farmers may try to overcome the problem by extending the tail-end of a neighbouring furrow in order to get water to their plots. This has happened at Isenyela Furrow.

3. Some of the irrigation furrows transfer water from one river channel to another, and even across sub-catchments. For example, using the Makambalala River, farmers manage to transfer water from the Great Ruaha catchment to the Kimani catchment. This is aided by the fact that slopes in the Usangu basin are very shallow.

4. In some places, notably along the Kyoga River in Nyeregete Village, there are extensive areas of abandoned paddy. This was abandoned for two reasons. Firstly, as upstream irrigation systems were developed and expanded, the amount of water reaching this downstream location declined. Simultaneously, the Mbarali Peri-NAFCO systems were developed and expanded. By the early 1990's all those who had cultivated near the Kyoga had acquired land along one of the Peri-NAFCO furrows in another area of the village, and abandoned their Kyoga plots. Based on the results of the irrigation survey, approximately 5378 ha of irrigated land has been abandoned, the most common reason being lack of water. Out of the 71 furrows where abandoned land was reported, 52 cited lack of water.

5. Finally, the rivers themselves are very dynamic, and will change course when in flood. Often they will take the course of an irrigation furrow, which is reported to have happened along both the Kimani and Mlowo Rivers. All of these factors

These factors, combined that the area of paddy cultivation is still expanding, mean that the pattern of irrigation in the project area is continually changing, both between seasons and over the long-term.

Table 1: Different Types of Irrigation System in the SMUWC Project Area

Type of System	Description
Indigenous Smallholder Irrigation System (ISIS)	A system that has been built and is managed by local people themselves and where there have been no external interventions to modify the system. Usually local locally available materials such as stones, grasses, wooden poles and earth are used to build intake structures and aqueducts. Occasionally these systems have concrete intake structures and other materials that need to be purchased (e.g. pipes and corrugated iron). The building and maintenance of these systems is labour-intensive, with the earth canals dug and cleaned by hand. ISIS are found in both the upper catchment (where they are used for dry season cultivation) and in the lower catchment (where they are used for a mix of rainy season paddy cultivation and dry season cultivation). Usually water is abstracted from a river or spring, but there are also ISIS that are based on NAFCO drainage water (see the detail on Peri-NAFCO furrows below). An example of an ISIS in the upper catchment and used for dry season irrigation is Igomelo Furrow (see Community Irrigation Working Paper, December 1999). An example of a lowland ISIS used for wet season paddy cultivation is Isenyela Furrow, (see the Community Irrigation Progress Report, 5/2/99).
Externally-modified smallholder irrigation scheme (EMSIS)	A system that has had external interventions to modify the system. For example, to build a concrete intake with control gate, to realign the canals, to level the ground. External contractors rather than local people often undertake the work. An example is the Kimani Irrigation Project (see Community Management of Irrigation Progress Report, 5/2/99).
Large-Scale NAFCO Irrigation Scheme (NAFCO)	This is a formal government and/or donor sponsored project to build a large-scale, state owned irrigated rice farm. In the project area there are two such farms that are managed by NAFCO – Mbarali Rice Farm (3200ha) and Kapunga Rice Farm (3000 ha). External contractors built the farms using heavy machinery. They have large concrete intake structures capable of abstracting large amounts of water (6 – 8 m^3/s). The main and secondary canals are deep (1.5 – 2 m) and wide (1.5 – 2 m). Maintaining the system is capital rather than labour intensive. The future of NAFCO (a government parastatal) and the state farms is uncertain. The management of the two farms is poor with only a small proportion actually cultivated by NAFCO and large areas hired out to smallholder farmers. More information about the NAFCO farms is given in the Community Irrigation Working Paper, February 1999, and Working Paper, December 1999.
Peri-NAFCO Irrigation Systems	These are indigenous irrigation systems that have been built and are managed by the water users themselves. However, instead of abstracting water directly from rivers or springs, they abstract water from the NAFCO farm drains. They make use of locally available materials, or collect contributions to pay for concrete structures. As with indigenous systems, the canals are usually dug by hand. More information about the Peri-NAFCO systems found in Mwanavala village is given in the Community Irrigation Working Paper, November 1999.
Large-Scale Smallholder Irrigation Scheme	This is a formal, government or donor sponsored project to build a new, large-scale irrigation scheme specifically for smallholder farmers. They are built using outside contractors and are capital rather than labour intensive. The intake and control structures are concrete and the main and secondary canals built and maintained using excavation machinery. For example the 800 ha Kapunga Smallholder Irrigation Scheme, and the 3000 ha smallholder scheme at Madibira. More detail about these schemes is given in the Community Irrigation Working Paper, November 1999.
Baluchi Irrigation Systems	These are indigenous irrigation systems built, managed and used by Baluchi families in the project area, for example the Permuhammed Furrow in Rujewa (see Community Irrigation Working Paper, December 1999). There are two such furrows in the project area. They make use of locally available materials such as stones an mud for the intake structures, using concrete where necessary. The building and maintenance of these furrows is usually labour intensive, with the Baluchi families concerned contributing money to pay for labourers to do the work.
Rain Water Harvesting Systems	This is where farmers build bunds to trap rainfall run-off in order to get water to a sufficient depth for paddy cultivation. There are scattered patches of rain water harvesting to the north of Madibira Irrigation Scheme, where farmers capture water coming off the northern hills.

4. AGRICULTURAL PRACTICES IN THE USANGU WETLANDS AND THEIR CATCHMENTS

This section will focus on on-farm irrigation water use, and the use of other inputs such as improved varieties, fertilisers, labour and manure. It shows that farmers' cultivation activities in the wet season are very dependent on the timing and amount of rainfall. It also reveals that farmers are very careful in their management of water. With paddy they build small basins that enable them to control the depth of water and keep the depth of water at a constant level. Similarly, with dry season irrigation farmers irrigate slowly using small flows of water in order to maximise infiltration and minimise soil erosion. For paddy, the use of inputs other than water and labour is limited. For dry season crops, there is greater use of both artificial fertilisers and manure.

4.1 The crop cycle

The key crops grown in the project area are rainy season paddy and maize, with some dry season cultivation of maize, beans and vegetables. Paddy is grown on the lower alluvial fans on clay soils, which are ideal for paddy cultivation. Maize and dry season crops are grown on the upper alluvial fans and foothills, where the soils are sandy loams, which have less clay in them and are more suitable for crop such as maize and vegetables. The two main crops we are concerned with here are paddy and dry season crops, since they are the crops that require irrigation. Wet season maize is rainfed and is important to local people as it is their staple food, while paddy is a cash crop. Average plot size for maize is approximately 0.2 ha, and the maize crop is women's responsibility. However, most farmers (both men and women) state that paddy is the most important crop, and if they had to focus on only one crop, it would be paddy. This is because of the cash income that paddy provides, which is sufficient to meet the household maize requirements and other expenses such as school fees. Dry season crops are used for a mix of subsistence and commercial purposes. High value vegetable crops and some maize are sold, while beans and some maize are used domestically.

Table 2 illustrates the typical crop cycle for rainy season paddy, rainy season maize, and dry season crops (distinguishing between maize, which has a longer growing cycle than dry season vegetables). The busiest time of year for farmers is between December and February when they are preparing and transplanting paddy fields as well as planting and weeding maize fields. The next busy time is when they are harvesting both the rainy season maize and paddy crops. The quiet time for many farmers (especially for those who do not grow dry season crops) is the dry season, between August and October.

The preparation and planting of paddy is staggered between the top-end and tail-end of a furrow, according to the availability of irrigation water and the onset of the rains. The farmers at the top-end of an irrigation system are the first to clear their fields and plant nursery plots, doing this work as early as late October. These farmers are then ready to harvest in late April or May. The farmers at the tail-end wait until the rains start before they can do this work, usually in December, but if the rains are late, they have to wait until January. In years of bad rainfall, some tail-end farmers are found transplanting as late as March in the hope of getting at least some harvest. Tail-end farmers usually harvest in July.

The wet season maize crop is planted when the heavy rains begin, usually in December. It is then harvested in June and July.

Farmers begin to plant their dry season crops as soon as the rains lessen in April, but the main planting season (especially for maize) is in July. This is because most of the land used for dry season irrigation is used to grow rainfed maize in the wet season. Farmers continue to plant dry season maize until the end of the dry season in October. Planting maize at this time is hard work in furrows that are also used for paddy irrigation because from November to early January there is a lot of competition for water with the paddy farmers. However, if the crop is successful it is harvested in February or March, which is when maize prices

Table 2: Table to Show Typical Crop Cycle in the Usangu Plains

	September	**October**	**November**	**December**	**January**	**February**
Paddy	Clean fields and furrows	Cleaning and ploughing fields. Cleaning furrows	Ploughing fields Planting nursery fields	Planting nursery fields Preparing basins, puddling and Transplanting	Preparing basins, puddling and transplanting	Preparing basins, puddling and transplanting. Weeding
Rainy season maize	No activities	No activities	No activities	Plough and clear fields Planting	Plough and clear fields Planting	Weeding
Dry Season Crops: Maize	Planting and weeding	Weeding and harvesting	Weeding and Harvesting	Weeding and harvesting	Weeding and harvesting	Harvesting
Dry Season Crops: Vegetables	Planting and harvesting	Planting and harvesting	Harvesting	Harvesting	No activities	No activities

	March	**April**	**May**	**June**	**July**	**August**
Paddy	Weeding	Bird Scaring	Bird scaring Harvesting	Harvesting	Harvesting, threshing, cleaning	No activities
Maize	Weeding	Weeding	No activities	Harvesting	Harvesting	No activities
Dry Season Crops: Maize	Harvesting	Planting	Planting	Planting and weeding	Planting and Weeding	Planting and weeding
Dry Season Crops: Vegetables	No activities	Planting	Planting	Planting and harvesting	Planting and Harvesting	Planting and harvesting

are very high, and a good profit can be made. Maize planted this late only requires irrigation water in the early stages of growth, and is not irrigated once the rains begin. Other typical dry season crops are tomatoes, sweet peppers, onions, Irish potatoes and mchicha (a spinach-like plant). These crops are continuously planted and harvested throughout the dry season.

4.2 Paddy cultivation

Normal plot size for paddy is between 0.5 and 2 ha. Each plot is divided into a series of basins or '*vijaruba*' in Swahili. Basin size varies between 1.5 m^2 and 10 m^2. Basins are constructed in order to control the flow of water through the plot, and to keep water levels at a constant depth. Keeping water level is very important as an uneven field can result in some of the paddy drowning while other paddy suffers from drought. The overall result of uneven fields is a decline in yields. Once constructed, the farmers use the same basins each year. They reinforce the bunds each season when they are puddling the basins. The basins and good control of water levels is an essential part of maximising paddy yields. Therefore these basins are a form of landesque capital, the bunds representing an investment of time and labour that increases the value of the land.

Many farmers own their own plots, but as land suitable for paddy irrigation has been allocated, new arrivals and young people rent land. The cost of hiring a paddy plot varies according to location of the irrigation system and relative location along the furrow (top-end or tail-end). For example, a top-end plot in Mwanavala village, which is close to the urban settlements of Ubaruku and Rujewa can cost TSh 30,000 per acre, while a tail-end plot costs TSh 20,000. A top-end plot in the Kapunga Smallholder Scheme, which is over 20 km from the main settlement of Chimala, can be hired for TSh 20,000 per acre at the top-end , and for TSh 10,000 per acre at the tail-end.

Farmers often live far (up to 30 km) from their paddy plots, preferring to live on the higher, upper alluvial fans. This is because of the humidity, mosquitoes, malaria and other water borne diseases found close to the paddy cultivation areas. During the growing season they build temporary houses close to their paddy plot, and stay overnight at times of peak labour demand (transplanting and harvesting).

Prior to the onset of the rains, farmers clear their paddy fields. This is often done by burning, which is the most effective way of removing the thorns that have grown up during the dry season. Once they receive some irrigation or rainwater, they prepare the nursery fields. This involves first dampening the soil to soften it and make is easier to work. A fine seed bed is prepared by hand, using a *jembe* (an axe-hoe). The seeds are planted (either by broadcasting or by planting individual seeds) and the nursery fields covered with straw in order to maintain soil moisture. The fields are lightly irrigated as and when necessary. The paddy is left in the nursery fields for four weeks before transplanting.

A few days before transplanting, the farmers will irrigate their plots in order to soften the soil. The land is then ploughed, usually using an ox-plough. After ploughing, the farmers will try to get about 6 cm of water onto his land, and then begin to puddle, building up the basin bunds as they do so. From this point until two weeks before harvesting, farmers will try to keep 6 – 10 cm of water in their fields. After puddling and before transplanting, the farmers will go through each basin checking that the water levels are constant within each basin, and make any adjustments necessary. Once the water levels are good, transplanting begins. This can take one to two weeks, depending on the size of the plot and the amount of labour available to the individual farmer. After transplanting, the main tasks are to check on water levels in the fields once or twice a week and weeding. Keeping more than 6 cm depth of water in the basins helps to prevent weed growth, but at the tail-end of irrigation systems water levels tend to drop if there is a lack of rainfall, increasing the weed problem. In the six weeks before harvesting, bird scaring is an important job. Farmers use scarecrows and flags to keep birds away. They may also send their children to the fields to keep the birds away. Two weeks before harvesting the basins are drained. Once harvested, the paddy is threshed and then sold.

The men in a household usually do ploughing and puddling work, while women transplant and weed the paddy. Both sexes help with the harvesting, although it is the male head-of-household who actually sells the crop and decides how the money should be spent.

Very few inputs are used apart from labour and irrigation water. Most farmers prefer the traditional Kilombero variety, which has a good flavour and fetches a good price. A small proportion of each year's harvest is kept can be kept as next years seed, so new seed does not need to be purchased at the beginning of the season. Some farmers use improved varieties such as India Rangi and Subermart, but these are relatively expensive, and new seeds need to be purchased at the beginning of each season, by which time farmers have little capital remaining. The use of fertilisers, pesticides, herbicides or manure is rare. Artificial inputs are not used because they are expensive. Even if a farmer can afford them, the extra financial investment involved exposes him or her to greater economic risk should the rains, and therefore their paddy crop, fail. Manure is not used because it is difficult to carry sufficient quantities to the distant paddy fields. It is interesting to note that the three farmers interviewed who were found to use fertilisers were all at the top-end of the Kapunga Smallholder Irrigation Scheme, where supplies of irrigation water are very reliable, and each farmer has a 1 ha plot, which is slightly larger than average. They therefore felt more confident investing in their rice crop because they were certain of a return. They also used improved varieties (India Rangi), and hired machinery (tractors and combine harvesters) to plough and harvest their 1 ha. All three were using Nitrogen fertilisers, but were using only about 50% of the amount required for paddy.

Farmers who have the capital will hire cattle to undertake ploughing work, and labour to undertake puddling, transplanting and harvesting. Farmers who do not have the money use their own labour and plough their fields by hand. It costs approximately TSh 12,000 per acre (TSh 30,000 per ha) to hire cattle and/or labour for ploughing or transplanting work. Hiring labour for harvesting costs less at around TSh 8,000 per acre (TSh 20,000 per ha).

Average yields for smallholder farmers are between 3 t/ha at the top-end and 2 t/ha at the tail-end. Yields at the very top-end are usually slightly less than 3 t/ha because farmers try to harvest early in order to fetch a good price for their paddy. Tail-end yields are relatively low because of inadequate water supplies and late planting. Because of low use of fertilisers and manure, farmers reported that yields are falling. Despite this, they continue to cultivate their land every year. If they leave their fields fallow at all it is because of lack of water rather than a desire to restore soil fertility. Some farmers reported that they had acquired newly cleared land at the tail-end of a system in the hope of higher yields. However, they had not left their fields further up the system fallow, but were hiring them out to people who do not own a paddy plot.

Once harvested, paddy is sold by the sack-load to independent traders, who usually come to buy the paddy directly from the field. One sack is between 80 – 85 kg. At the beginning of the harvesting season, the producer price for one sack can be as high as TSh 25,000, but by the end of the harvesting season this can fall as low as TSh 6000. Some of the traders are local people while others come from Mbeya and Dar es Salaam. Most own lorries and send the crops to big urban centres such as Dar es Salaam and Mbeya. Very few farmers are able to store their paddy until prices rise again at the end of the dry season.

Once the paddy has been harvested the plot is left until the beginning of the next rainy season. It is not used for any other crops during the dry season. This is partly because of lack of water and the clay soils used for paddy cultivation are very hard to work without a good supply of water to soften them. Also, farmers are concerned that if the basins are ploughed and furrowed for dry season crops it will take a long time to restore the basins at the beginning of the next paddy season.

As reported in section 3, it is not possible to cultivate the whole command area of an individual irrigation system every year. In a year when the rains are late or very poor farmers in the periphery of the command area will either not plant paddy at all, or have to abandon the crop because they fail to get sufficient water once they have transplanted. In this case, tail-end farmers reported that they try to rent land further up the furrow in the core area, where irrigation supplies are more reliable. This is relatively easy because, if the

cause of the problem is late rains, farmers in the middle reaches with large plots (more than 1 ha) will not have time to cultivate and transplant the whole area. They are therefore willing to rent a portion of their plot out to others.

4.3 Dry season cultivation

Dry season crops are grown around perennial rivers that provide a constant supply of irrigation water. Dry season plots are usually very small – about 0.1 – 0.2 ha. Many farmers in the upper alluvial fans rent these plots as they only have paddy plots, and do not own land that is in a suitable location for dry season crops. Dry season plots are rented for between TSh 10,000 – 15,000 per acre (TSh 25,000 – TSh 37,500 per ha). Farmers in the lower foothills and the upper catchment usually only grow dry season crops and wet season maize and beans, and do not grow paddy because they live too far from the paddy growing areas on the lower alluvial fans.

Dry season crops are often grown on ridges of soil. When the crops are irrigated, water is passed down the furrows between the ridges and allowed to infiltrate into the soil. This is done slowly, carefully controlling the amount of water used in order to maximise infiltration and minimise soil erosion. The crops are irrigated until the soil is saturated. This is done once or twice a week, depending on the crop (mature maize requires water once a week, while tomatoes need water twice a week and prevailing weather conditions (the hotter it is, the more frequently irrigation is required). It takes up to 90 minutes to irrigate 0.1 ha. Farmers try to irrigate dry season crops in the late afternoon and evening. This is when evapotranspiration levels are falling, and it minimises stress on the plant. If they are unable to irrigate in the evening, farmers will irrigate in the early morning, when evaporation rates are also low. Only if they are very desperate will they irrigate in the middle of the day.

For dry season crops, there is greater use of inputs such as manure, fertilisers and pesticides. This is because the crops are high value, the inputs are only required over a small area, much of the land is continually cropped in both dry and wet season, and it is easier to get manure to these places. For example, farmers using Igomelo Furrow bring manure from Igawa by the truckload. The crops are sold to independent traders who come to the fields with bicycles to collect large baskets of tomatoes, maize, onions and so on. They then take the produce to the nearest market centre (often Rujewa, Ubaruka, Chimala, Igurusi or Mbeya) for sale. One farmer with 1.8 ha of land along Igomelo Furrow claimed that he makes nearly TSh 3,000,000 (US$ 3750) per year from his dry season crops. Another farmer renting 0.2 ha of land along the Njombe Furrow near Chimala claimed to obtain a net income of TSh 178,000 (US$222) after the cost of inputs from dry season crop sales.

5. ORGANISATION OF SMALLHOLDER IRRIGATION

5.1 Physical infrastructure and maintenance

A range of physical infrastructure is found in the smallholder irrigation systems in the SMUWC project area. In general, indigenous smallholder irrigation systems (ISIS), Peri-NAFCO and Baluchi systems have traditional intake structures made from locally available materials such as stones, brushwood and straw. Plates 1 and 2 illustrate two examples of traditional intakes made from local materials. The intake weirs are either built right across the river forming a dam (e.g. Isenyela intake), or half to three-quarters the way across, depending on how easily water is diverted into the furrow and the risk of flooding (e.g. Igomelo intake and the intakes in Mwanavala village). Water seeps through these traditional intake structures, which means that it is almost impossible for an ISIS to abstract all of the water from a river or spring. In general, most ISIS do not have a control gate at the intake, which makes it difficult to control the amount of water entering the furrow. However, in times of flood traditional intake structures are usually washed away by the strong flow in the river, preventing flooding in the furrow itself. In some indigenous systems water users have collected cash contributions to build concrete intake structures and control gates. For example, because of flooding problems, water users in Mtwegwambogo Furrow in Mwanavala village all contributed TSh 2000 towards the cost of purchasing and installing a control gate.

In externally modified systems (EMSIS) the traditional intake structures have usually been replaced with a concrete structure and control gate. Again, the concrete weir usually extends right across the river. Because there is no seepage of water through the concrete structures, it is possible for these systems to abstract a large proportion of river water at times of low flow.

With nearly all of the irrigation systems in the project area, the furrow itself is an unlined earth canal. The main canal in ISIS's, Baluchi systems and Peri-NAFCO systems are dug by hand and are therefore relatively narrow and shallow. A typical main canal is 0.5 – 1 metre deep, and approximately 0.75 metres wide. Secondary canals are approximately 0.5 metres wide and 0.5 – 0.75 metres deep. Water is diverted from the main canal to secondary canals using temporary mud dams. These systems do not usually have tertiary canals leading to individual farmers' fields, but water passes from one farmer's paddy basins to another farmer's paddy basins. This through flow results in water being recycled between several farmers.

In an EMSIS the main and secondary canals are usually widened and deepened using excavating machinery. Main canals can be up to 2 metres wide and 2 metres deep. Along the main and secondary canals there are a series of concrete diversion structures with control gates. However, it is usually the case that farmers have removed the control gates. Large-scale smallholder irrigation schemes and some externally modified systems (e.g. Majengo scheme) have tertiary canals that divert water to individual farmer's fields, so each farmer can directly control how much water enters his or her fields.

In ISIS's, Peri-NAFCO systems and Baluchi systems the main canal usually drains directly back to the river, or to a gully, which takes surplus water back to the river. Occasionally the main canal will drain into another irrigation furrow. Surplus water in the paddy basins either drains back to the furrow, passes through gullies back to the river, or runs over the ground back to the river. Because throughflow from farmers' fields often drains through to the main canal or other secondary canals, water is continuously being recycled, and helps to ensure that water eventually reaches the tail-end of a system. In externally modified systems, drainage systems are put in place, so that once water has passed through the fields, it drains directly back to the river. Farmers frequently complain that this reduces the opportunities for recycling water, and reduced the amount of water that reaches the tail-end. In LSSIS's and externally modified systems where a tertiary canal serves each plot individually, there is usually a tertiary drain that leads to a

Plate 1: Stone intake at Isenyela Furrow, Kimani River

Plate 2: Traditional Intake, Igomelo Furrow, Mbarali River

secondary drain and hence back to the river. Therefore, only one farmer uses the water before it is diverted back to the river.

The smallholder irrigation furrows are cleaned and maintained one to three times a year. A furrow used for rainy season paddy cultivation is cleaned before the beginning of the growing season between October and December, which is the main cleaning session in the agricultural year. This is when traditional intakes are strengthened and rebuilt, vegetation removed from the banks of the main and secondary canals. It is cleaned again towards the end of the growing season in April or May, when demand for water is still high but the rains diminished. The furrow is cleaned in order to minimise losses of water. If the furrow is then used for dry season irrigation, it is cleaned again during the dry season in either June or July. A furrow used for just dry season cultivation is normally only cleaned once, which is at the beginning of the dry season.

Rebuilding traditional stone and brushwood intakes takes about two days to complete, with a member from every household that uses the intake assisting. The intake needs to be rebuilt before each rainy season in order to minimise seepage losses through the structure and to strengthen it against strong flows in the river. Cleaning the main canal and secondary canals takes an additional two days. Traditional intakes require weekly maintenance throughout the growing season, and may need to be rebuilt following particularly heavy storms. For example, the Mlowo River in Muhwela village is very narrow, straight and deeply incised. During a rainstorm, flow in the river becomes very high and fast, and frequently washes away the mud, straw and brushwood intake structures. Farmers in this area reported that they rebuild the intakes between five and seven times in a rainy season. Farmers who use an ISIS tend to identify the intake as being the biggest difficulty associated with irrigated agriculture. This is because of the labour required to maintain the structure, and because water seeps through the structure back to the river. The solution they identify is to build a concrete intake structure, which from their perspective will reduce labour requirements and increase the flow of water in the furrow.

The labour-intensive nature of traditional intakes is compounded by the fact that on occasion they need to be relocated. It is not possible to control the amount of water being diverted with a traditional intake. This can result in the erosion of the land around in the intake, and incising of the furrow itself, leaving land at the top-end of the furrow high and dry. This happens at Isenyela Furrow, and every ten to fifteen years, they relocate the intake and dig a new channel to serve the top-end of the furrow command area. As stated previously, there are also cases where, when rivers have been in flood, they have changed course to follow the course of an irrigation furrow. Examples include the Kimani River and the Mlowo River. When this happens, new intakes and new irrigation furrows have to be dug, and areas of paddy irrigation shifted according to where the furrows are now located. This adds further to the workload.

Attendance at maintenance work in an ISIS or Peri-NAFCO system is generally good, with only one or two households failing to send a representative. Farmers are informed when cleaning will take place either by someone walking around the village calling out the information (if all of the water users live in the village where the furrow is located). If many of the water users live far from the furrow, as they do at Mtwegwambogo Furrow in Mwanavala Village, a meeting is held at harvest time - when most people are present - to set a date for when cleaning will begin before the start of the next cultivating season. If a user fails to turn up or send a representative, they are fined approximately TSh 500 for every day that they fail to attend. Both men and women can attend furrow work, and therefore female-headed households are expected to send a representative to undertake the work. Similarly, if emergency repairs are required (for example, the intake has been washed away in a heavy rainstorm) all the water users are called to the intake (someone going around the village to inform farmers what has happened) to undertake the necessary repairs. Those who do not receive the information or who fail to turn up are fined TSh 500.

For ISIS's, there is no specific financial cost to maintaining the furrow, and therefore water users are not expected to make any financial contributions beyond turning up with the relevant agricultural tools in order to assist with the maintenance work. However, if there is some specific work or repairs that will incur a financial cost, money is collected from the water users. For example, the TSh 2000 was collected from each

user of Mtwegwambogo Furrow (Mwanavalla Village) in 1997 in order to cover the cost of building a control gate.

The Baluchi Irrigation Systems are also labour-intensive to maintain, and the Baluchi families that use them pay labourers to rebuild the intake structure and to clear vegetation from the furrow. The cost of maintaining the Permuhammed Furrow in Rujewa is approximately TSh 350,000 per year.

An EMSIS is usually less labour intensive than indigenous systems. They have a permanent concrete intake structure which does not require rebuilding each year and nor does it require constant maintenance throughout the cultivation season. However, there may be a need to desilt the structure from time to time. Because the main and secondary canals of these schemes have often been dug using mechanically, machinery is also required to clean and dredge the canals because they are too deep, too wide and would take too long to be cleaned by hand. Therefore machinery as well as manpower is used to maintain the furrow, making the maintenance process capital rather than labour intensive. Furrow users are usually expected to contribute money to meet the cost of hiring machinery and paying labourers, while the users themselves are often expected to clean narrower secondary and tertiary canals themselves. For example, with the Kimani Irrigation Scheme, each household is expected to give one sack of paddy (of approximately TSh 6,000 – 10,000 in value) at harvest time. Some of the money from the sale of the rice is then used to cover the cost of maintenance (the rest should be used to cover the cost of the Water User Fee, as discussed in section 6). Similarly, farmers in the Majengo Irrigation Scheme are expected to pay TSh 1500 to cover the cost of maintenance.

However, users of the Kimani Scheme to date have refused to contribute a sack of paddy each year to meet the costs of maintenance. They feel that maintaining the system is the responsibility of those who undertook the project and the government. There are three key reasons for this:

1. Farmers argue that there was a lack of consultation about the detailed plans for the project.

2. Farmers feel that the infrastructure installed is of poor quality.

3. Where the infrastructure has failed, they have had to make their own improvisations to get water.

In many areas the secondary canals are lower than the fields they are supposed to serve, inlet pipes have broken and so on. Also, water does not reach the tail-ends of the secondary canals. Therefore, one group of farmers reopened the old Ros Campuni Furrow intake in order to get water to the tail-end of the Makonji Secondary Canal. This furrow was originally shut as part of the realignment of the Kimani Furrow under the project. The farmers who rely on water from the reopened Ros Campuni Furrow build and maintain the traditional intake each year, and clean out the main Ros Campuni canal leading to Makonji Secondary Canal. Because of the labour input this requires, they do not feel inclined to give money to the Scheme leaders for the costs of maintenance. In another area, farmers have installed a pipe to take water from the main canal to their paddy fields as the secondary canal that is supposed to serve their land is too deep. Following the heavy rains of 1997/98, the intake of the Kimani Irrigation Scheme was badly silted up. It took the scheme managers a long time to organise for the intake to be cleaned, and although the water users were not receiving water, they were reluctant to assist in the process unless they were paid. It was at this time that the old Ros Campuni intake was rebuilt.

The Large-Scale Smallholder Irrigation Schemes (LSSIS) are also capital intensive to maintain, requiring heavy machinery to dredge and clear the main and secondary canals (see plate 3, illustrating the cleaning of Kapunga Smallholder Scheme Secondary Canal). As with EMSIS's, furrow users themselves meet the cost of maintenance. For example, in Kapunga Smallholder Irrigation Scheme, water users pay TSh 5000 per year to cover the cost of maintaining the system and any other expenses. Unlike the Kimani Scheme, farmers are willing to pay this. Firstly, this is because the scheme was built for the farmers and they obtained land on the scheme free of charge, prior to this most of the farmers who were allocated land on the

Plate 3: Cleaning Kapunga Smallholder Scheme Secondary Canal, September 1999

scheme were landless. Secondly, the water supply and infrastructure is such that all of the scheme users are able to obtain a paddy crop every year, regardless of rainfall, and therefore they know that they will get a good return on their TSh 5000 investment. Thirdly, there is a tough penalty for not paying. If a farmer fails to pay, the Ward Development Committee has the power to confiscate the 1 ha of land that was allocated to him or her when the scheme was built. Because Madibira has only recently been commissioned (December 1998) and operation and maintenance is still organised by the project, it is not possible to say to what extent farmers on this scheme will be willing to contribute to the operation and maintenance of the system. However, at present the co-operative that will eventually manage the scheme has very low capacity in terms of both operational skills and financial resources. So far, farmers have been very reluctant to invest the TSh 100,000 that is required to become a member of the co-operative. Therefore is seems likely that when the scheme is handed over to the co-operative there will be problems in ensuring good operation and adequate levels of maintenance.

5.2 Allocation of Water and Conflict Management

At times of peak demand there is not sufficient water in the system to allow all farmers to undertake the farming activities that they would ideally like to be undertaking at that point in time. Usually allocating water between farmers using is a way of ensuring a reliable and timely supply of water to the farmers, allowing as many of them as possible to undertake the relevant farming activities. Competition for water also the biggest cause of conflict between water users, and again allocating water is a way of resolving this. This section will look at how the allocation of water within the smallholder irrigation systems in the project area works. It will focus on the allocation of water for wet season paddy, and the allocation of water for dry season crops.

5.2.1 Allocation of water for wet season paddy irrigation

In general, allocation schedules are only implemented when there is a scarcity of water. At other times farmers are allowed to take water as and when they like. This is important to farmers as they like to see a constant supply of water to their fields, and try to keep the level of water in the basins between 6 and 10 cm. Therefore, top-end farmers will only follow an allocation schedule if they see that there is a real problem in the middle reaches and tail-end of the furrow. There are three key periods in the crop cycle when water scarcity can occur. Firstly, if the rains are late, there can be intense competition for water when farmers are transplanting in December and January. Secondly, there is intense competition if there is a long (two to three week) break in the rains which often occurs in January. The third period is when the rains diminish, and tail-end crops are still at the growing stage. This is a particular problem if the rains finish early. Access to water during these three periods depends on a farmer's relative position along a furrow. Those at the top-end receive water first, and those at the tail-end receive water last. As discussed in section 4, this is reflected in individual crop calendars. Top-end farmers plant their nursery fields in October and can harvest as early as April. Farmers at the tail-end plant nursery fields in December or January, and do not harvest until July.

This top to tail-end distribution of water is also reflected into the different answers to the question 'in which month or months is there the most competition for water?' The answer varied according to where a farmer cultivates along the furrow. Top-end farmers reported that competition for water is most fierce at the beginning of the season, when they are trying to transplant. Tail-end farmers experience the most competition for water at the end of the rainy season in April and May. Their crops are still growing, but rainfall is less, and therefore they are dependent on irrigation water.

In the ISIS and Peri-NAFCO systems his natural top to tail-end distribution of water acts as an informal means of allocating water. If top-end farmers transplant early because they can get sufficient furrow water they then harvest early, meaning that they are not competing with tail-end farmers for water at the end of the wet season. Conversely, if tail-end farmers wait for the rains to begin before transplanting, they are not in competition for water at the beginning of the season. Therefore, as long as the rains are well-timed and sufficient, there is a natural staggering of water use that works well. However, if the rains are late or finish early, a problem arises. When this happens, leaders of indigenous systems tend to formalise the staggering of water. For example, if the rains are late, once the top-end farmers in Isenyela Furrow have finished transplanting their paddy, they are expected to leave water in the furrow so that farmers further down the furrow can transplant. In this case, furrow leaders reprimand and possibly fine top-end farmers who continue to take water without respecting the needs of tail-end farmers.

An allocation system may also be put in place if there is a break in the rains and at the end of the rainy season in order to ensure that farmers whose paddy is still growing receive sufficient water. Water is usually allocated to each secondary canal each day in turn. In general it is not possible to allocate water to individual farmers because they receive water through another farmers field rather than directly through tertiary canals. When an allocation schedule is put in place, it is followed, although farmers reported that by the time than an allocation schedule is put in place it is usually too late and water will not reach the tail-end of the furrow anyway.

In externally modified systems and large-scale smallholder irrigation schemes the introduction of a water allocation system was usually an integral part of the project. Under these schemes farmers are grouped according to which secondary or tertiary canal they are using. Farmers are told which days each secondary or tertiary canal will receive water, and therefore when they should plant their nursery fields and when they should transplant. Under this system of allocation, farmers do not receive a constant supply of water, but the supply of water is rotated between different areas within the irrigation scheme. The idea is that each farmer will receive a sufficient amount of water for his or her paddy, but not any surplus. Because water should be equitably distributed along all parts of the furrow, tail-enders will also receive a sufficient supply of water, increasing their yields and, in a good year, the irrigated area. Top-end farmers will not be able to

transplant particularly early, because the aim of these allocation schedules is to maximise yields and the irrigated area, and not to maximise individual farmers' profits. However, in the irrigation schemes visited, it was found that these proposed allocation schedules are not followed, and water users had removed the control gates from the diversion structures so that it is not possible to divert water from one particular area to another area. As with indigenous systems, allocation schedules are only implemented at times of great water scarcity. Instead they are following the natural staggering system that is found in the indigenous systems, with some formal allocation system if the rains finish early.

Farmers do not follow the allocation schedules recommended under these irrigation schemes for a number of reasons:

1. Farmers like to see a constant flow of water through their fields, which prevents weed growth. They see the allocation of water as water rationing.

2. Farmers like to plant their nursery fields and transplant as soon as the available water supplies allow them since an early harvest means good producer prices. Although yields are lower, a farmer who harvests in late April or early May can obtain up to TSh 25,000 per sack of rice compared with TSh 8 – 10,000 later in the season (July and August).

3. Farmers live usually far from their paddy fields, which makes it difficult police any allocation schedule and ensure that farmers are not taking water out of turn. Policing an allocation sequence would also increase the workload of furrow leaders, who are not remunerated for their work. Therefore, leaders only enforce an allocation schedule when it is really necessary. One of the reasons why an informal top-end to tail-end distribution of water works well is that it requires minimum input to manage and enforce, ultimately making it a more sustainable system if less equitable.

4. The irrigation of paddy is supplementary irrigation, meaning that furrow water is only supposed to supplement rainwater. Without rain, there is only sufficient river water to allow a few top-end farmers to grow paddy, even if a strict allocation schedule is introduced.

In years of low rainfall, this unequal distribution of water can cause conflict between top-end and tail-end farmers, especially in large systems that serve a large area (500 ha or more), a large number of people and more than one village. This is usually the case with some of the externally modified systems such as Kimani, which has a command area of more than 1000 ha in a wet year, and serves two villages. The tail-end village, Mabadaga, is in constant conflict with the top-end village, Mbuyuni, over the allocation of water. People in Mabadaga complain that leaders in Mbuyuni village do nothing to ensure that farmers there follow the allocation sequence (allocating water between the different secondary canals), which would mean that more water would reach Mabadaga on the allotted days. For example, the Kimani Scheme leaders introduced an allocation schedule between the different secondary canals in the very dry 1998/99 season. While this schedule was followed between the users of the secondary canals in Mbuyuni Village, people from Mabadaga complained that water was not allowed to pass down the secondary canal that leads to their village. These conflicts are taken to the Ward Development Committee for resolution, but to date there has been no satisfactory resolution of the conflicts. Clearly such conflicts reach a peak in years when the rains are poor, but diminish in very wet years when the rains are good.

Fewer conflicts were reported on the smaller systems and in indigenous systems. This is because there are fewer people between whom the water needs to be shared, and because water often drains back to the furrow, water can be recycled, reducing water supply problems at the tail-end. Tail-enders in Kimani Furrow reported that their problems had been exacerbated since the Kimani project because drainage structures had been put in, reducing their supply of water.

In order to maximise their access to water, many farmers in the middle of a furrow and at the tail-end go out to irrigate after dark. Even if an allocation schedule has been introduced, water is not formally allocated to any one secondary canal at night. Therefore furrow users are free to take water as they like. Most people

dislike going out at night, so they only do so at times of intense water shortage. Night irrigation is seen as men's work, and unless a female-head of household can afford to pay some men to go out for her, she will find it difficult to get water at night. Richer households pay other people to do this work for them. It was reported that it is at night that the most fights over water occur. The people trying to irrigate walk up the furrow closing off any other secondary or tertiary canals into which water is being diverted. This means that farmers further up the furrow who are trying to take water suddenly find their water supply cut off, and if they catch another farmer closing their intake, this often results in arguing and fighting. Farmers reported that most arguments and fights over water take place at night.

Overall, an allocation schedule will only be used if water is very scarce. At other times water is distributed according to an informal staggering of cultivation along the furrow. A schedule will be introduced if the rains are late and poor (as they were in the 1998/99 growing season), and at the end of the growing season when the rains diminish. Attempts to introduce a more constant system of allocating water, with the idea of increasing yields and the irrigated area, have failed. However, it should be remembered that paddy cultivation in the Usangu is dependent on rainfall, and irrigation is supplementary. Therefore in a dry year, even if an allocation schedule is strictly followed, there will not be sufficient river water for tail-end farmers to cultivate paddy.

5.2.2 Dry season crops

In furrows where there are many farmers growing dry season crops, there was found to be some basic system of allocating water. Again, water is not allocated to individual farmers but allocated by area or secondary canal. For example, in Igomelo furrow, where there are 195 households growing dry season crops on 82 ha, the furrow is divided between the five top-end secondary canals and the four tail-end secondary canals. The top-end farmers can irrigate on Tuesday, Wednesday and Thursday, while the tail-end farmers can irrigate on Friday, Saturday, Sunday and Monday.

Farmers reported that these allocation systems are followed, and very few farmers take water out of turn. Even when water is scarce, people are more likely to go out at night (when water is not formally allocated) to try to obtain the water their crops need rather than break the allocation sequence. Farmers are prepared to follow some type of allocation sequence in the dry season rather than the wet season because unlike paddy, dry season crops do not need a constant supply of water, so do not mind waiting one or two days before irrigating their crops. Also, they do not live far from the areas that they grow dry season crops so it is easy to check on the state of the plants, if they need water, and, if necessary, go out after dark to irrigate.

In general there are few conflicts over access to water for irrigation purposes in the dry season. However, farmers did report that some arguments can break out between farmers if they are trying to irrigate after dark and they find that another person has diverted their water away.

5.3 Leadership and membership of a furrow user group

The ISIS and Peri-NAFCO systems are organised by some form of Irrigation Committee. These committees usually have a Chairman and a number of other ordinary members. The number of ordinary members usually depends on the size of the furrow and number of secondary canals (there is usually at least one representative for each secondary canal), but the number usually varies between 3 and 15. In theory, irrigation committees are part of village government, being a sub-committee of the Village Social and Economic Development Committee. However, although many of the committee members are also part of village government, the irrigation committee for a specific furrow tends to act independently, and rarely needs to refer to village government. The committee elected, with the regularity of these elections varying between places. In some villages seem to take place on a regular basis every five years, while in others it was reported that new elections are held as and when necessary.

The members of a furrow user group are all those farmers who own land in the command area (whether they own it or rent it) and who contribute labour or money towards the maintenance of the system. Those who rent land within the system on a regular basis and who live in a village neighbouring the system are expected to attend maintenance work on all occasions. They can also attend furrow meetings, but may not be allowed to vote when new leaders are being elected. Those who come from several miles away and rent land only occasionally are expected to attend any maintenance work that takes place while they are there, but otherwise the land owner is expected to contribute to furrow maintenance on their behalf. However, they have no rights to attend furrow meetings, and cannot vote in furrow elections. When a new person moves into an area and begins to irrigate, they may also be expected to make a financial contribution as well as attend furrow maintenance work. This is especially the case where sections have been improved using contributions from the farmers. One example is Mashkamili furrow, which abstracts water from the NAFCO Kapunga drainage canal in Ukwaheri Village. This was originally constructed by one man in the mid 1990s. He used his own resources to build a concrete sluice across the drain and to dig the furrow. Therefore, when new people join the furrow, they are expected to contribute money to this person in order cover his costs of building the furrow.

In schemes where there have been external-interventions and in some indigenous systems, water users have been formally registered with the government as either an association or a co-operative. Associations are registered under the Ministry of Home Affairs, while co-operatives are registered under the Ministry of Agriculture and Co-operatives. A condition for being granted a statutory water right is that the holder of the right be a legally registered body. Holding a statutory water right is normally a prerequisite for external aid, which is why EMSIS and smallholder schemes are either registered as a co-operative or an Association. Some indigenous system users have also registered as an Association or co-operative in order to obtain the statutory water right, either to secure their water supplies or with the long-term aim of obtaining external assistance to upgrade the irrigation system. The establishment of an Association is simpler than establishing a Co-operative. An Association is established according to an act passed by the colonial government in 1954, which does not specify a particular structure or constitution. However, the co-operative Act of 1991 is more stringent. In particular, it requires that all members be a shareholder of the co-operative, and is very specific about the structure of a co-operative and how the constitution is formed.

The leadership of these associations or co-operatives is more extensive than with indigenous systems. There is usually a Chairman, a Secretary, and an Accountant, as well as a number of ordinary members. There may be a number of sub-committees, usually with a sub-committee for every secondary canal. There may also be sub-committees that deal specifically with finance and maintenance. As with indigenous systems, leaders are elected.

As with indigenous systems, membership of these co-operatives or associations depends upon owning land within the command area and contributing to furrow maintenance. However, furrow users also have to officially register as a member of the Co-operative or Association, and may have to pay a joining fee.

For both traditional committees and formally registered organisations, there is a similar set of responsibilities that the system leaders undertake. The first and main task is seen to be to organise the cleaning and maintenance of the system. The second task is to ensure the equitable distribution of water, especially in times of water scarcity. In this respect, furrow leaders are responsible for resolving water-related disputes between water users. However, as discussed in section 3.2 above, enforcing any allocation schedule is hard work. Generally furrow leaders are not remunerated for their work, and therefore their tasks need to be kept as short and simple as possible, which is why allocation schedules are only rarely used, people preferring the more informal practice of staggering crop production according to the availability of water. A third set of tasks are to enforce by-laws and rules relating to the use of the furrow, and to punish those who do not follow the by-laws and rules (see section 5.4 below).

5.4 By-laws and rule enforcement

Many villages have by-laws that address the use of irrigation furrows within the village. The village government may have set them, but more often the by-laws have been set at the Ward Level. Typical by-laws relating to the use of irrigation furrows cover the following issues:

1. Maintenance of the system. Maintenance is to be undertaken regularly by all members, and that those who fail to attend maintenance work or contribute the specified amount of money will be find a certain amount for every day they fail to attend (usually TSh 500 per day).

2. Allocation of water. Many EMSIS and LSSIS by-laws give some system for rotating water between secondary canals and that those who fail to follow the allocation sequence will be fined a certain amount.

3. Expansion of the system. Farmers should not cut new secondary or tertiary canals without the prior permission of the leaders. Failure to ask for permission will result in a fine.

4. Use of water. People should not wash their clothes in the furrow or river, or foul the water in any other way.

5. Watering of Livestock. Cattle should not be allowed to trample in the furrow or damage the infrastructure in anyway. Those found watering their cattle in the irrigation furrow will be fined.

The number of by-laws and rules tends to be greater and more complex in systems where there has been external intervention when compared with indigenous systems. The extent that they are actually known and enforced varies between systems, according to the point of time in the agricultural cycle, and the scarcity of water. In many villages it was not possible to get a copy of the by-laws relating to irrigation as they did not actually have a copy. Leaders could summarise what the most important laws are (suggesting that these are the ones that are actually used and enforced) but often stated that there are more complex by-laws that they could not remember off-hand (suggesting that they are rarely used or enforced).

By-laws about maintenance are the most strictly enforced and followed because maintaining the system is crucial to ensuring an adequate water supply and therefore a successful crop. Therefore all water users have an interest in ensuring that the system is well maintained. Because maintaining the system is labour intensive (and where cash contributions are used, relatively expensive), there is a strong dislike of 'free-riders' who use the system without contributing to its maintenance, so fines are also strictly imposed. As discussed previously, by-laws relating to the allocation of water are generally only imposed at times of great water scarcity and conflict.

By-laws relating to the use of furrow water by livestock vary between locations. In villages where there are a large number of agro-pastoralists (notably the Peri-NAFCO systems around Kapunga, and in Mwanavala village North-East of NAFCO Mbarali), these by-laws are not strictly enforced and in the dry-season cattle are free to water from the furrows. Furrow users are stricter in the rainy season in order to prevent crop damage. In areas where agriculturalists are more dominant, the rules about livestock grazing and use of the furrows are strictly enforced. In these cases livestock keepers can be fined up to TSh 100,000 if their cattle cause damage to the furrow.

6. UPSTREAM AND DOWNSTREAM ALLOCATION OF WATER

A major source of conflict over access to water is between furrow user groups that abstract water from the same source, and with other users using the source (e.g. livestock keepers and domestic water supplies). In most sub-catchments there is not system of allocating water between the different furrows. In general, users of each furrow try to abstract as much water as the intake structure and flow in the source will allow, although they will leave some water in the furrow for downstream users. For example, in Mwanavala Village, the Nyamaluluja stream from which the furrows abstract is very small and narrow. This means that it would be relatively easy for water users to build an intake structure capable of abstracting all of the water in the stream. Water users do not actually do this because there are strict village by-laws about not blocking the flow to downstream users. This is particularly important along the Nyamaluluja where there are 23 furrows abstracting from the stream.

However, downstream water users often do not receive adequate water for cultivation until the rains begin, mainly because most of the water has been abstracted upstream. This is a particular problem if the rains are late, if there is a break in the rains, and if the rains finish early. Ultimately, the result is conflict, with downstream water users going to upstream at night to remove stones and logs from other intakes in order to allow more water to pass downstream. This was reported as happening frequently along the Kimani River, where water users from Isenyela Furrow go upstream to intakes for Uturo Village and the Kimani Furrow and attempt to send more water down to their furrow. The Kimani Furrow causes a problem because it is a concrete structure. It allows the water users of the Kimani Furrow to take more water, and makes it more difficult for downstream water users to adjust the amount of water that is being abstracted. In this respect, one advantage of traditional intake structures is that they are not water tight, and water seeps through them. The result is that the furrow cannot abstract all of the water from the river, and water is left in the river for downstream users.

There have been four known attempts to create some form of upstream-downstream management of water resources. These have been along the Mlowo River, the Kimani River, the Mswiswi River and the Kyoga River. The Mlowo and Kimani examples were both facilitated by external agents as part of development projects, while local leaders facilitated the Mswiswi and Kyoga examples themselves.

The sub-catchment management of water found along the Mlowo River was facilitated by the RBWO in 1997/98. The Mlowo River was chosen after participatory research undertaken by UVIP revealed severe water problems suffered by downstream furrow users and, in particular, the NARCO ranch (the very end user along the Mlowo River) during the dry season and at the beginning and end of the paddy season. A River Committee was established. Water is allocated to upstream furrows on Mondays and Tuesdays, and to mid-reach furrows on Wednesdays and Thursdays. On Fridays water is allocated to the furrows at the tail-end of the river, and on Saturday and Sunday water is allocated to NARCO. In total there are 19 furrows abstracting from the Mlowo River. It is relatively easy to organise an upstream-downstream allocation for the Mlowo River, as the majority of the intakes are in Muhwela Village, and are in very close proximity to each other. The allocation scheduling seems to work well within the irrigation furrow systems, but NARCO complains that they still do not receive sufficient water. The only time the allocation schedules are not followed is when there has been heavy rainfall and there is sufficient water for everybody.

The Kimani River Canal Committee (KRCC) was established as part of the Kimani Irrigation Project with the aim of facilitating the distribution of water between the different furrows using the Kimani River at times of scarcity. The KRCC was an important element of KIP because it was originally intended to extend the project to encompass the other furrows on the river. There are three villages (Mbuyuni, Uturo and Mabadaga) that are dependent on water from the Kimani River, and five furrows that abstract water (of which, Kimani Furrow is the upstream furrow). KRCC consists of representatives from each of the five furrows. It is no longer functioning effectively. Water users from the top-end of Kimani Furrow did not mention the committee as one of the institutions responsible for managing water in the area. However, users

of Isenyela Furrow (the end user of Kimani River) did identify the KRCC as one of the institutions responsible for water management, but reported that it was unable to resolve downstream water users problems and no longer functions. Instead, the downstream and tail-end farmers take their complaints and problems to the Ward Development Committee to be resolved.

People from four villages and nine irrigation furrows use the lower reaches of the Mswiswi River in the dry season, which is when a locally established River Committee instigates an allocation schedule. The committee consists of a representative from each village. It was established in 1994 after the Women in Irrigated Agriculture (WIA) built a concrete intake structure on what is referred to as the 'WIA Furrow' on the upstream end of the river. With this intake, water users from the WIA Furrow could abstract nearly all of the dry season flow. This prompted the local leaders to form a River Committee to allocate water equitably between the different furrows. The allocation schedule only includes abstractions in the lower reaches of the Mswiswi, and not the four furrows in the upper catchment. Usually water is allocated to each furrow for one or two days in turn. However, on the date of our visit on 20th October 1999, the allocation schedule had just been altered to 5 days for each village (rather than per furrow, although water users reported that each furrow tends to serve a particular village). This was because the flow in the river was exceptionally low, and this was the number of days required for all water users in each furrow to receive sufficient water. However, this meant that water users would be going without irrigation water for 20 days. As farmers like to irrigate their dry season maize at least once a week, they considered the allocation schedule a problem. However, they would not break the schedule as those caught doing so are not fined, but are taken straight to a local court. To overcome the problem, farmers were planning to use bucket irrigation as necessary, and pray for the rains to start soon.

At times of water scarcity, an allocation schedule is instigated between the furrows abstracting water from the lower reaches of the Kyoga River. The Ward Chairman rather than a Formal River Committee do this. He calls a meeting with all of the different Furrow Chairmen, and they decide between them how to distribute water. The Ward Chairman reported that the water users follow the scheduling, but the issue was not followed up any further with ordinary water users.

In conclusion, some of these upstream-downstream water management initiatives work well and provide a basis for a pilot sub-catchment water management programme (see section 10). However, to date they have only included irrigation users, and not domestic users or livestock keepers. They have tended to focus on issues of allocation schedules based on set-time allocations and not issues of water rights, which would involve measuring and allocating specific volumes of water between different furrows. Finally, the River Committees where they exist do not address problems of pollution. These will be issues to consider in a pilot sub-catchment programme.

7. STATUTORY WATER RIGHTS AND WATER USER FEES

It is a legal requirement for all people who are abstracting water from rivers and springs to hold a statutory water right. Only one water right is granted per abstraction, so the user group of an irrigation system own the water right as a group, rather than as individuals. Water rights and concomitant annual water user fees (WUF) are one of the main instruments used by the Water Office to manage water abstractions. For this reason, it is important to carefully consider the relationship between smallholder irrigators and statutory water rights with water user fees.

Water rights were first introduced in colonial times. Colonial legislation gave all pre-existing, 'native' indigenous furrows a traditional water right, which was held on their behalf by the relevant district authority. All new abstractions were to apply for a water right, including abstractions for indigenous furrows. However, in the post-independence era, enforcement of water right legislation was weak and many new abstractions such as the numerous furrows found in Usangu were built without any application for a water right. Water users believe that their right to abstract water is based on a combination of two things. Firstly, that they have used their own labour to build the intake and furrow. Related to this is that within a furrow system, an individual's right to use furrow is based on him or her contributing labour to maintain the system. Secondly, water is seen as a gift from God, free for all to use so that they can meet their basic needs.

In 1994 a revision was made to the 1974 Water Act, which requires that all abstractions, including indigenous furrows, have a statutory water right. Through the revision of the water law and through the establishment of Water Basin Offices in both the Rufiji Basin (established 1993) and the Pangani Basin (established 1991), the Government of Tanzania is attempting to revitalise the system of water rights. The River Basin Management and Smallholder Irrigation Improvement Programme (RBMSIIP) support this policy.

Under the 1994 legislation the concept of Water User Fees (WUF) were introduced. Once a water right has been granted, the water right holder is charged an annual water fee in addition to the one time payment of the application fee. The application fee for a water right for irrigation is TSh 30,000, while the WUF is TSh 30 for every 1000m^3 of water abstracted. The purpose of the WUF is two-fold:

1. It is to meet the running costs of the River Basin Water Office (in this case the Rufiji Basin Water Office – RBWO), which, through the River Basin Water Board, is responsible for issuing and policing Statutory Water Rights.

2. To introduce the concept of the economic value of water to water users and to encourage them to use water more efficiently.

In terms of the economic value of water, the less water a user abstracts, the less the user has to pay. The idea is that the users will monitor will monitor the amount of water they are abstracting, and reduce the amount that they are taking when they do not need it. If a user can prove that they are abstracting less than the allocated water right, they can obtain a rebate on their WUF.

For a furrow user group to apply for a statutory water right, they first approach the District Irrigation Officer (DIO). The DIO gives them an application form, which he helps them to complete. He calculates the theoretical amount of water they need at different times of year, based on the assumption that paddy requires 2 l/s of water per hectare, while dry season crops require 1.5 l/s per hectare. Therefore, the water right for an irrigation system with 500 ha of paddy and 50 ha of dry season crops would be 1 m^3/s in the wet season (November to May) and 0.075 m^3/s in the dry season (June to October). This would result in an annual WUF of TSh 473,040 for paddy and TSh 35,478 for dry season crops, making a total of TSh 508,518 for the year. Once the application form is complete, the DIO forwards it to the RBWO, who calculate whether the application is feasible based upon known flows in the river and the other water rights already granted for

that source. The RBWO presents the application form and their recommendation to the Rufiji Basin Water Board, who decide whether the water right can be granted or not. If it is granted, the user group then pays the TSh 30,000 application fee.

Only a legally recognised entity can hold a statutory water right. Therefore, in order to hold a water right an irrigation user group needs to form a legally registered Association or Co-operative, it is the job of the DIO to help them with this process. The water right holder is also obliged to build a control gate near to the point of abstraction. This is so they can reduce the amount of water being abstracted when water is not required, and can control the amount of water being abstracted in time of drought in accordance with instructions from the water office.

Once the water right has been granted, the WUF is collected by the RBWO on an annual basis. The RBWO sends officers out to the users to collect the money, which enables them to check the abstraction point and the amount being abstracted.

Most irrigation schemes and externally modified systems have a statutory water right since ownership of the water right is usually a prerequisite for external aid. Several indigenous systems are now applying for a water right, with two main reasons for doing so:

1. To obtain external aid. For example, Igomelo furrow formed a Co-operative and applied for a water right in 1997 when it was selected as an RBMSIIP pilot scheme.

2. To have the legal right to the water that is being used, and to prevent others who might build an abstraction upstream from taking their water supply. However, although the water right has given those furrows that have one the legal entitlement to the water that they use, without policing of water rights and control of the amount of water abstracted, it does not guarantee supply.

There are three key points that need to be made about the relationship between smallholder irrigation systems and statutory water rights with a concomitant WUF – those of control gates, measuring the volume of water abstracted and actually paying the WUF. Firstly, of those indigenous and externally modified schemes that have a SWR, only a few have a working control gate. For example, the Kimani Scheme had a control gate when the concrete intake structure was first built, but the farmers have removed the gate, so the water users are taking as much water as the design of the weir and the amount of water in the river allows them to. Similarly, unless there is a particular problem of flooding, building a control gate is low on the order of water user's priorities. In general, they would rather spend the time and money building a concrete intake than a control gate. The RBWO has now worked with two furrows in the Usangu area (Mandeleo and Njalalila Furrows on the Luna River) to build a control gates. Farmers were expected to contribute money and labour in order to construct the gate, but the RBWO gave technical assistance and provided the materials. In the case of control gates, it is important to learn from the experience in the Pangani basin, where there was a mass programme of building control gates on all of the indigenous furrows in the Kilimanjaro area, where there are over 500 indigenous irrigation schemes. These gates were paid for by the donor and built by external contractors, with no prior consultation of the water users. Unsurprisingly this programme created suspicion about the Water Office's intentions, created a negative attitude towards the introduction of statutory water rights and WUFs, and several gates were destroyed. Therefore, there needs to be some assistance to help water users to build control gates. However, if these control gates are to be used and not destroyed, farmers have to attach some importance to having a functional control gate, and feel a degree of ownership over the gate. Care needs to be taken to learn from the Pangani experience.

The second issue is that of actually measuring the volume of water abstracted. Almost none of the furrows in the Usangu area have any type of gauge to measure the amount of water being abstracted. Those that do are the large-scale irrigation schemes – NAFCO Mbarali, NAFCO Kapunga and the Madibira Scheme. Having no form of gauge makes it very difficult for water users to actually follow any water right that they are granted. Similarly, once a water right has been granted, the water users are expected to keep a record of how much water is abstracted. Any rebate on the WUF is based upon these records. It is not possible to

keep these records if there is no system of gauging abstractions. Even if there was a gauge, keeping records requires some kind of organisation, and remuneration of the person responsible for keeping the records (assuming records should be kept on a daily basis). As with control gates, water users will need assistance in installing gauges (which would probably be an integral part of the control gate) and setting up a system of recording water levels. Also, water users will only spend time undertaking these activities if they see some advantage in doing so.

The third issue is that of paying the WUF. Most water users are willing to pay a few thousand shillings to cover the cost of the water they use if they can see some value in doing so. As with most fees, they expect to receive a service in return. In this case, they expect the RBWO to ensure the regular and timely supply of water in accordance with the granted statutory water right. At present this is not being achieved. This is because to date only a relatively small proportion of water user groups have applied for, and been granted, a water right, and even then the majority of those that have a water right have no way of controlling or measuring the amount of water they actually abstract. Therefore the RBWO will have to make sure that the water users receive value for money. If farmers do not think they are getting value for money, they will not pay. This is the case in the Kimani Scheme, although the reasons for not paying financial contributions does not relate to the RBWO but is a legacy of the project itself. Because farmers do not think that the Kimani project has improved the situation within the irrigation system, they are unwilling to pay their cash contributions, which means scheme leaders are unable to pay the WUF (the outstanding bill is currently TSh 7,000,000).

In the long term, the introduction of statutory water rights and WUFs will be an important element in managing the water resources of the Usangu catchment. They can be used to divide water equitably between upstream and downstream users, and to decrease the volumes of water abstracted at individual abstraction points. Establishing and monitoring water rights would be an important part of a pilot sub-catchment water management programme. However, if statutory water rights and WUFs are to be sustainable and work to the advantage of water users themselves as well as to water management in the Usangu Catchment as a whole, the process of introducing them will take a long time. The approach will need to be participatory and flexible in order to address the needs of the water users (for example, risk minimisation, a reliable supply of water and conflict resolution) as well as the needs of the water managers (increased flows downstream and cost recovery). This issue is discussed further in relation to sub-catchment water management in section 10 below.

8. ANALYSIS OF EXTERNAL INTERVENTIONS AND SMALLHOLDER IRRIGATION SCHEMES

A number of donor-funded smallholder irrigation improvement schemes have been undertaken in the project area. The smallholder improvement schemes have involved upgrading pre-existing indigenous systems, and are referred to here as externally modified smallholder irrigation systems (EMSIS). This is because the term 'improvement' implies that the schemes are better after the interventions have taken place, which is not always the case. There have been five key EMSIS schemes:

1. The Usangu Village Irrigation Project (UVIP), 1985 – 1996. This was funded by the FAO and aimed to upgrade six indigenous furrows. Work was completed in three of these systems.

2. Women in Irrigated Agriculture (WIA). This was also implemented by the FAO (funded by the Netherlands Government), and was undertaken in close co-operation with UVIP.

3. The Kapunga Rice Project, 1988 – 1992. This project had three components – the building of the NAFCO farm, the building of a smallholder irrigation scheme, and improving the existing smallholder irrigation systems abstracting from the Chimala river.

4. The Kimani Irrigation Project (KIP), 1991 – 1994. This project planned to upgrade 4300 ha of irrigated agriculture in the Kimani Sub-Catchment, of which only 500 ha was completed.

5. Smallholder Irrigation Improvement Programme, 1997 onwards. This programme is part of the World Bank funded River Basin Management and Smallholder Irrigation Improvement Programme. Under this programme up to six indigenous furrows will be upgraded.

In addition to these five programmes, there have also been two projects to build new large-scale smallholder irrigation schemes (LSSIS) – the Kapunga Smallholder Scheme and the recently commissioned (1998) Madibira Smallholder Scheme.

All of these programmes have two fundamental aims - to improve agricultural productivity (by increasing yields and expanding the irrigated area), and, within the indigenous smallholder systems, to increase the efficiency of water use. The project documents imply that indigenous systems are unproductive (with average yields of 2.5 t/ha of paddy) and inefficient users of water (figures of 15 – 20% are quoted[1]). Typical project activities are both physical and institutional. Physical activities include building concrete intakes, realigning the main and secondary canals, installing concrete diversion boxes with control gates and digging drainage channels. Some schemes (e.g. the UVIP work at Majengo Furrow) have also involved land-levelling and redistribution of land. Institutional activities have included establishing a legally registered co-operative or association to manage the system, establishing a number of sub-committees such as finance, operation and maintenance and secondary canal committees (see section 5.3). KIP also involved establishing a River Committee to help resolve upstream-downstream conflicts.

However, these schemes have not always been successful in meeting their aims, as the examples from the Kimani Scheme referred to throughout this paper illustrate. Three key problems with physical infrastructure can be identified:

1. Infrastructure is capital intensive. Instead of using their own labour to build and maintain the system, water users are dependent on having the capital to hire the necessary machinery to maintain the furrow.

[1] The idea of water use efficiency is not well defined in the different project documents, but work undertaken by the SMUWC Water Management Specialist has shown that the term must be used critically. The issue of water use efficiency is discussed in detail in his working papers.

2. Lack of ownership of the new infrastructure. This is because it has been built and paid for by someone else, and therefore water users see it as someone else's responsibility to maintain the new infrastructure (usually the government's responsibility). This is compounded by the fact that the water users are often not consulted about the detailed infrastructure plans (a common complaint at the Kimani Scheme) and that they are not longer able to physically maintain the infrastructure themselves.

3. Poor quality of infrastructure. This is a particular problem at the Kimani Scheme, where water users have had to adjust the infrastructure themselves in order to get water to their fields. Also, all infrastructure deteriorates over time. Because of the capital intensive nature of the infrastructure in these schemes, it is difficult for the water users to raise the capital to pay for materials, machinery and technicians needed to carry out the necessary repairs.

There are also four key problems associated with the institutions that are established under these schemes. These are problems of leadership, a distrust of co-operatives, a failure for all the different sub-committees to actually function, and a failure to implement all of the by-laws and management strategies established under the project.

Firstly, although the leaders of these organisations are elected, the leaders are often those who are already influential and wealthy within the furrow user group. As a result, the interests of poorer water users may not be their priority. Their interest in being a leader of the irrigation organisation often lies in the further power it gives them, as well as money earning opportunities. Unlike most of the traditional committees used to manage indigenous furrows, being a leader of one of these schemes involves collecting money from the furrow users and managing the scheme bank account. This creates opportunities for embezzlement, which seems to be a frequent problem within these schemes. For example, Chimala Ward Development Council recently disbanded the leadership of Kapunga Smallholder Irrigation Scheme because the system had not been cleaned in the 1998/99 season, and it was not clear what had happened to the money that had been collected to undertake the cleaning work. Therefore, in many of these schemes, there is a general feeling of mistrust of leadership among the furrow users.

The second problem is that of a general distrust of co-operative Societies. During ujamaa, farmers were required to sell all of their produce to co-operatives. Towards the end of the ujamaa, co-operatives were collapsing. They either failed to pay farmers for their produce, or payments were late and very low. Often funds were simply embezzled, or the co-operative failed to receive payments from central government because of corruption at higher levels. In other cases, the co-operative simply failed to get the produce to market. The result is that there is a general feeling of distrust about co-operative societies, and people are unwilling to invest in becoming a member. This is a particular problem in the new Madibira Smallholder Scheme, where water users are required to invest TSh 100,000 to become a member of the co-operative.

Thirdly, many of the sub-committees established under the improvement projects fail to operate beyond the life of the project. This is because the users do not see any practical purpose or advantage in the work the committee is supposed to undertake. For example, in the Kimani Scheme, the secondary canal sub-committees continue to function because water users see the importance of the committees' work in organising maintenance. However, a number of other sub-committees do not function, such as the Kimani River Canal Committee, the Planning and Finance Committee, the Operation and Maintenance Committee, and the Procurement Committee. Instead, the Main Canal Committee undertakes the functions of these committees as and when necessary.

Fourthly, committee members do not undertake many of the tasks assigned to them under the constitution of the Co-operative of Association. For example, they do not meet on a regular basis, they do not implement or enforce any recommended allocation sequences or by-laws. Members of the committees that manage indigenous furrows usually have two very basic tasks. First and most important is to organise the maintenance of the furrow. Secondly, when water is scarce they should implement some sort of scheduling of water. This minimises the demands on committee members' time, which is important given that they are also farmers themselves and have their own cultivation activities to undertake. The tasks given to leaders

under irrigation improvement schemes and large-scale schemes are more onerous than this, and in general involve greater responsibilities, such as collecting cash contributions from water users. However, they are not remunerated for their work, which reduces the incentive to actually to do more than the necessary minimum, and increases the incentive to embezzle funds.

Issues three and four should not necessarily be considered as problems. This is because the tasks assigned to the various sub-committees and to furrow leaders are not always relevant to the day-to-day needs of the farmers and the sustainable operation of the furrow. Also, farmers were not consulted and therefore do not actually agree with many of the recommended practices and by-laws. For example, most farmers, especially at the top-end, like to see a constant flow of water through their fields especially at the beginning of the season when tail-end water users can still wait for the rains. Therefore they do not follow allocation schedules recommended. The result is the staggering of planting times down the furrow, and therefore staggering of demand for irrigation water, as discussed in section 5.2.

A final problem with these schemes lies in the aim to increase yields (usually from 2.5 t/ha to 4 t/ha) through 'better farming practices'. This usually means increased use of inputs such as artificial fertilisers and high yielding varieties. As discussed previously, few farmers can afford these inputs and are not willing to bare the extra financial risk such an investment would expose them to. As such, farmers are more concerned with minimising risk than maximising yields. Therefore, these schemes have failed to increase yields.

Of all the smallholder irrigation schemes, the Kimani project has suffered the most problems, and this is reflected in the fact that the project was not extended beyond the first phase. However, all of the other schemes have suffered from some if not all of these problems. For example, in the Madibira project there is a reluctance among smallholder farmers to invest in the newly established co-operative, and doubts over the technical ability of the co-operative to operate and maintain the scheme if there is not a extra funding for a prolonged hand over period. There are also questions over the financial capacity of the co-operative to maintain and operate the scheme. In the Majengo scheme, water users are concerned that the concrete infrastructure is beginning to deteriorate, and that they do not have the resources to repair the furrow. There are also areas where the furrow was misaligned and the land badly levelled so that it is no longer within the furrow command area.

There are a number of lessons that can be drawn from the examples of smallholder irrigation schemes in the SMUWC project area:

1. The objectives of the project need to be the objectives of the furrow users themselves. If the project fails to meet the water users needs then they have little incentive to co-operate or sustain project activities once the project itself is finished.

2. Furrow users need to have the capacity to actually meet and sustain the objectives of the project. For example, as discussed above, the objective of increasing yields through the increased use of agricultural inputs is useless if farmers cannot afford them.

3. Any physical interventions need to be carefully planned with the water users, ensuring that the alterations are not beyond the water users' technical, financial and labour capacity.

4. Capacity building and institutional development needs to be based, if possible, upon existing institutions and the tasks they undertake. New institutions and new tasks should not be created if the water users do not see any value in them and cannot support them once the project is finished. If the water users identify a need for new institutions and new tasks (such as the allocation of water) are to be introduced, they need to be developed by the water users themselves with checks to make sure that they are sustainable in the long-term. There then needs to be long-term follow-up of these institutions to assist with any difficulties that might occur.

The overall implication of these four lessons is that the water users need to be full, active participants in project from the conception stage onwards. This includes all groups of water users – men and women, top-end and tail-end farmers, young and old, agro-pastoralist as well as agriculturist – and not just local leaders.

9. STATUS OF NAFCO FARMS AND PERI-NAFCO WATER USE

The two NAFCO farms – Mbarali and Kapunga – cover a total area of 3200 ha. Mbarali Farm was completed in the mid 1970's, and Kapunga in 1992. Both farms are facing severe managerial and financial problems. The list of problems include:

- Lack of working capital to purchase inputs and to pay wages.
- Broken and worn out machinery.
- Poorly levelled fields that result in poor control of water at the field level and low yields (see working papers by the Water Management Specialist, Dr. B. Lankford for more detail on this).
- An invasion of wild rice.

As a result of these problems, NAFCO Mbarali managed to cultivate only 500 ha in the 1998/99 season, while NAFCO Kapunga claimed to have cultivated 592 ha (although aerial photography shows the area to have been much less than this). Average yields on the NAFCO cultivated area are very low, achieving approximately 1.5 t/ha.

To overcome some of the problems, both farms hire out land to smallholder farmers. The people that hire the land are often relatively wealthy businessmen, and local government officials. Approximately 1000 ha and 500 ha were hired out at Mbarali and Kapunga farms respectively. Smallholders build bunds and small basins within the area that they hire, improving their control over the level of water in the field[2]. Also, because they transplant rather than broadcast, they prevent the growth of weeds such as wild rice. They achieve average yields of 2.5 t/ha. However, these large farms were designed to be irrigated in blocks, with one block irrigated and planted one week, and another block the next week and so on until the whole farm is planted. When smallholders hire a plot from NAFCO, they are given instructions about when they will receive water and when they should be ready to transplant. The smallholders rarely follow these instructions, preferring to transplant when they are ready to transplant. As with smallholders throughout the project area, they also like to see a constant supply of water to their fields. As a result, the smallholders are constantly opening and closing the control gates out of sequence. They usually do this at night, often flooding parts of the farm and causing damage to canal infrastructure. The overall result is that many of the tail-end smallholder farmers do not receive sufficient water, especially if the rains are poor.

Despite the relatively small area actually cultivated and irrigated, the two farms have continued to abstract large quantities of water throughout both the dry and wet season. The Mbarali Farm does have a small area of dry season cultivation and some fish ponds, but the Kapunga Farm has no legitimate use for the water it is abstracting in the dry season. Neither of the farms have paid their Water User Fee bill since the fees were first introduced and both farms owe over TSh 6,000,000 each. The RBWO have threatened to cut the water supply to the two farms, but there seem to be political problems with doing this, particularly at Mbarali. The Mbarali scheme has a small HEP station that supplies power to Rujewa town, which gives it political leverage with local politicians and officials.

Since the schemes have been completed, large areas of Peri-NAFCO irrigation have been developed, which are dependent on drainage water from the farms. This has been possible, in part, because of the large amounts of water the farms abstract from the river and the small area actually cultivated on the main NAFCO farms. These two factors combined mean that there has been plenty of water in the drainage

[2] These basins are not as carefully built as the basins found in the smallholder systems. Farmers are less willing to invest time and effort into accurately levelling the land through bunding because there is no guarantee that they will be able to rent the same plot in the next season.

ditches for the past few years. There are 48 furrows that use NAFCO Mbarali drainage water, totalling approximately 4000 ha of paddy cultivation. Figure 1 illustrates the network of furrows around Mbarali NAFCO farm. There are two furrows that use NAFCO Kapunga drainage water, totalling 900 ha of irrigated land, which serves over 400 households. In many of these areas, water users are also dependent on the furrows for domestic water supplies and to water livestock, and settlements have developed around the irrigation systems (e.g. Mwanavala Village and Inyala Kitongoji in Ukwaheri Village). These farmers produce average yields of 2.5 t/ha. Therefore, a large number of households are dependent on NAFCO drainage water for their livelihoods, and these people will need to be carefully considered in any future management strategy for the NAFCO farms.

In some cases, the leaders of Peri-NAFCO systems have tried to apply for the Statutory Water Right to the water that they are using. However, because only one water right is granted per direct abstraction from a source (river or stream), it is not possible to grant Peri-NAFCO users their own water right. Both the RBWO and NAFCO have suggested to Peri-NAFCO water users that they should contribute to the cost of the NAFCO water user fees. In the case of Mbarali, each village where NAFCO drainage water is used for irrigation, a contribution of TSh 378,400 was requested. This has not been paid because smallholders do not trust NAFCO management to pass the money on to the Water Office, and they are already providing unpaid labour when NAFCO is cleaning and repairing their canals. In Kapunga, no such request has been made. Relations between NAFCO and the smallholder Peri-NAFCO farmers at Kapunga are limited, although it has been suggested that the smallholder pay the gatekeeper to keep the intake gates open in the dry season in order to provide sufficient water for the livestock keepers at the tail-end (in Ukwaheri Village).

Peri-NAFCO smallholders at Mbarali reported that they have been affected negatively by the trend to hire out land on the NAFCO farm to smallholders. It was argued that they now receive less drainage water because the smallholders on the farm are not following allocation schedules and are trying to take irrigation water all the time.

The future of the NAFCO farms is uncertain and in the hands of the Public Sector Reform Commission (PSRC), which is responsible for the privatisation of state-owned assets. The Kapunga farm has recently been advertised for sale in the national newspapers. Given the large amounts of water that these two farms abstract the future of these farms needs to be an integral part of the SMUWC Natural Resource Management Strategy. This needs to include careful consideration of how to mitigate any negative impacts a change of management of these farms would bring to the Peri-NAFCO water users. With respect to the Peri-NAFCO users, there are three important scenarios to consider:

1. If the farms were to be bought by a private company, who bought the whole area back under cultivation there would be less drainage water for the Peri-NAFCO farmers. In this case it might be necessary to negotiate with the company to allow a certain amount of water through the farm for the smallholders in return for a contribution towards the cost of the WUF.

2. A change in ownership might result in the re-negotiation of the SWR. The aim of the new owners would be to minimise abstractions and to reduce the annual WUF, and the RBWO might want to stop dry season abstractions. This would require mitigating measures in the Peri-NAFCO areas with no alternative supplies of water, such as providing domestic water supplies and livestock watering points.

3. The smallholder farmers themselves believe that the NAFCO farms should be converted into smallholder schemes, and land distributed to local people. This would involve a process called ‘Irrigation Management Transfer’ (see paper by Dr. B. Lankford). There would need to be careful consideration of the position of the Peri-NAFCO farmers within the process of management transfer, and whether the Peri-NAFCO systems should be considered an integral part of the NAFCO farm.

In a recent conversation with the SMUWC Team Leader, the Rufiji Basin Water Officer stated that the RBWO recognised the extent of this Peri-NAFCO irrigation around Mbarali. As such, they are considering

the feasibility of building a separate offtake at the Mbarali NAFCO intake, which would take water directly to the main smallholder Peri-NAFCO areas. The smallholders would then apply for their own SWR, and pay their own WUF. SMUWC should also consider this option as part of the broader Natural Resource Management Strategy.

Figure 1: Sketch Map to show Location of Peri-NAFCO Furrows around Mbarali Farm

Index of Mbarali Peri-NAFCO Furrows

No.	Source	Name of Furrow	GPS at intake	Village
1	Mbarali	Mbarali Rice Farm	0651120/9034439	
2	NAFCO furrow	Mabanda	0649572/9039128	Mabanda
3	NAFCO furrow	Mlango ya kwanza	0646396/9044533	Urunda
4	NAFCO furrow	Mlango ya tano	0643672/9047032	Urunda
5	Mkambe Drain	Jackson Sinapalule	0641935/9047006	Imalilo Songwe
6	Mkambe Drain	Mwangande	0641756/9047220	Imalilo Songwe
7	Mkambe Drain	Kanyamala	0640990/9047461	Imalilo Songwe
8	Mkambe Drain	Abed Fute	0640827/9047616	Imalilo Songwe
9	Mkambe Drain	Andrews Mkweji	0640715/9047676	Imalilo Songwe
10	Mkambe Drain	George Kihombo	0639256/9049736	Imalilo Songwe
11	Mkambe Drain	Japhet Kimwaga	0639247/9049743	Imalilo Songwe
12	Mkambe Drain	Richard Sangalali	0639034/9050016	Imalilo Songwe
13	Mkambe Drain	Wilson Mwamuli	0638922/9050085	Imalilo Songwe
14	Mkambe Drain	Pius Mlawa	0638858/9050155	Imalilo Songwe
15	Nyamaluluja Drain	Majejele	0641531/9052148	Mwanavala
16	Nyamaluluja Drain	Nyagawa	0641480/9052210	Mwanavala
17	Nyamaluluja Drain	Mtwegwambogo	0641317/9052330	Mwanavala
18	Nyamaluluja Drain	Sepelo	0641111/9052399	Mwanavala
19	Nyamaluluja Drain	Chesco Kapunga	0641106/9052380	Mwanavala
20	Nyamaluluja Drain	Raphael Muhanji	0640666/9052340	Mwanavala
21	Nyamaluluja Drain	Ignas Ndilava	0640192/9052118	Imalilo Songwe
22	Nyamaluluja Drain	Annael Chaula	0640283/9052211	Imalilo Songwe
23	Nyamaluluja Drain	Laison Mpale	0640298/9052201	Imalilo Songwe
24	Nyamaluluja Drain	Pilos Nyakunga	0639001/9053444	Mwanavala
25	Nyamaluluja Drain	Mashalubu	0638892/9053348	Imalilo Songwe
26	Nyamaluluja Drain	Richard Ngela	0638234/904160	Imalilo Songwe
27	Nyamaluluja Drain	Mathias Lwanjombe	0638730/9053605	Imalilo Songwe
28	Nyamaluluja Drain	Maseko	0637542/9054889	Imalilo Songwe
29	Nyamaluluja Drain	Mwaniungu	0637062/9055523	Mwanavala
30	Nyamaluluja Drain	H. Nyagawa	0636567/9556205	Mwanavala
31	Nyamaluluja Drain	John Charles	0636021/9055812	Mwanavala
32	Nyamaluluja Drain	Mwachembe	0636014/9055918	Mwanavala
33	Nyamaluluja Drain	Mbombumbombu	0635811/9056251	Mwanavala
34	Nyamaluluja Drain	Maleo Lufunga	0633742/9059082	Mwanavala
35	Nyamaluluja Drain	Funiki	0633453/9059622	Mwanavala
36	Nyamaluluja Drain	Kungila	0633373/9059802	Mwanavala
37	Nyamaluluja Drain	Tedi	0633677/9060640	Mwanavala
38	NAFCO furrow	Montfort	0647674/9039993	Mwakaganga
39	NAFCO drain	Rujewa Mission	0646232/9039189	Mwakaganga
40	NAFCO drain	Mayota	0646229/9039185	Mayota
41	NAFCO furrow	Ibohora	0643084/9040291	Ibohora
42	NAFCO drain	Kilimatinde	0638796/9041984	Warumba
43	NAFCO Furrow	Mapogoro	0636478/9042893	Warumba
44	Lyahamile Drain	Njoo Mlole	0638247/9046560	Imalilo Songwe
45	Lyahamile Drain	Meck Mnyanjala	0638216/9046561	Imalilo Songwe
46	Lyahamile Drain	Lyambeyali	0636902/9044831	Warumba
47	Lyambeyale Drain	Suphian Mwansuli	0636845/9044833	Imalilo Songwe
48	Lyambeyale Drain	Said Alphan	0636835/904483	Imalilo Songwe
49	Lyambeyale Drain	Mboga Salongwele	0635507/9045324	Imalilo Songwe

10. DIRECTIONS TOWARDS A NATURAL RESOURCE STRATEGY

The management of irrigation water resources by smallholder farmers has a significant role to play in an overall natural resource management strategy for the Usangu Wetlands and its catchment. This is especially so given that the aim of the strategy is to improve rural livelihoods and to increase downstream flows. Within individual indigenous irrigation systems, farmers are already managing irrigation water sustainably. They work together to maintain the system on a regular basis. They also have a *de facto* way of staggering the distribution of water that requires minimal organisational input. Any natural resource management strategy should build on these strengths, as well as learn from the lessons of previous interventions.

There are two key areas where this work can contribute to establishing a natural resource management strategy. Firstly, in developing a pilot sub-catchment management programme. Secondly, in developing some alternative management options for the two NAFCO Farms.

Pilot Sub-Catchment Management Programme

As discussed above, access to irrigation water is largely a free for all, both within and between irrigation systems. Furrow leaders only instigate allocation schedules for water at times of great scarcity, by which time it is often too late for the tail-enders whose crops have already failed. There is very little upstream-downstream co-operation over access to water between irrigation furrows, which leads to conflict in times of peak demand. Very few furrows have a statutory water right for the water that is being abstracted. This is compounded by the fact that farmers using traditional intakes have no way of controlling or measuring the amount of water they are abstracting. Even with concrete intakes where there is a statutory water right, the control structures have often been removed and there is no way of gauging how much water is being abstracted. The overall result is that very little water reaches downstream users, be they irrigators, pastoralists or fishermen.

One way of addressing these problems would be to establish a sub-catchment water management pilot programme. A proposal for this has been written by the Community Engagement Specialist (Paul Devitt) and the Community Irrigation Specialist and is reproduced in full in Annex 1. The two aims would be to ensure equitable access to river water among all of those who have a legitimate claim to it, and to ensure an adequate flow into the Great Ruaha River to satisfy downstream requirements. To do this, the programme will facilitate the development of some sort of a forum for sharing water supplies in a single river and its catchment. The process of establishing this forum will be undertaken with great care to ensure that all stakeholders are represented (men, women, upstream, downstream, agriculturalist and pastoralist, and so on). It would have some means of enforcing decisions, and it will be necessary to have an official water bailiff authorised to enforce the agreed system for sharing water. The RBWO (and later the RBWO Rujewa sub-office) will be an integral part of this initiative, helping the water users to establish their water budget, an agreed system of water rights, and policing of the water rights.

Learning from the lessons of previous interventions, care will have to be taken that the tasks given to the management forum are achievable, not onerous and meet with the aims of the water users themselves. Otherwise, as with many of the committees established under the Kimani Project, they will not be sustainable. Similarly, it is essential that the priorities of the water users themselves are put above the priorities of outside institutions such as the water office or central government. Around the world, many previous attempts at establishing catchment level water user groups have failed because they have been dominated by the interests of outside organisations rather than the interests of the water users themselves. In this respect, water management initiatives have tended to impose additional responsibilities on the water users in terms of policing water rights, paying water user fees to central government and building control structures, while there has been no visible benefit in all of this for the water users themselves. Therefore, there has been very little reason for them to co-operate. Any system of water rights introduced as part of the

pilot sub-catchment water management programme would have to be well thought through and negotiated between all of the different water users. The issue of how to measure and control abstractions will need to be addressed, as will the policing of the agreed system of water rights. The system of water rights will need to be of benefit to the water users themselves, and the system of controlling and policing the water rights as simple as possible.

It is proposed that this sub-catchment water management pilot programme be undertaken initially in one selected sub-catchment. One potential pilot sub-catchment is the Kimani River. Within this subcatchment is Mabadaga village, which is a CEP pilot village, and it is where two of the case study furrows are located (Isenyela and Kimani Furrows). Through the CEP, some of the irrigation water access problems are beginning to be addressed, and it would be good to build on this work. The process of establishing the composition and tasks of the body responsible for water management in the selected sub-catchment will be a slow and uneven process of negotiation between the different stakeholders. This work will be an integral part of other proposed programmes to strengthen village and district level institutions. In this respect, district as well as water office staff will be closely involved in the facilitation process. To this extent, SMUWC has already part-funded some training in 'social assessment for water resource management', and it is hoped that the seven local people trained (who were a mix of local officials) will be closely involved in the programme.

Management transfer of peri-NAFCO systems

The second area where the findings from the community management of irrigation work can contribute to a natural resource management strategy is with respect to the two NAFCO farms. As discussed previously, these farms abstract large quantities of water while cultivating relatively small areas and achieving very low yields. Given the impact of these large farms on the hydrology of the Usangu plains, it is important that the natural resource management strategy consider ways of improving the water use efficiency on these farms. The Water Management Consultant (Dr. Bruce Lankford) has produced a working paper on irrigation management transfer as a way of improving water use efficiency. The future of these NAFCO farms is currently being decided, and the Kapunga Farm has already been advertised for sale. It is therefore essential that any initiatives from SMUWC relating to the farms are pushed forward as soon as possible.

The working paper on irrigation management transfer by Dr. Lankford is reproduced in Annex 2. The paper suggests that one option for the two farms is to convert the farms to some form of smallholder system. If this idea were to be accepted, there are three issues that require careful consideration:

1. The role of the Peri-NAFCO systems. If a transfer to a smallholder system were to take place, it is important that these Peri-NAFCO furrows are considered as an integral part of the overall irrigation system. As such, the farmers currently using Peri-NAFCO would involved in the management transfer and integrated into the management structures with the aim of securing their access to water.

2. The Madibira project was originally conceived as another large-scale NAFCO farm, but in the design stages was converted to a smallholder scheme. The success of any management transfer at Kapunga and Mbarali farms would be enhanced by a good understanding of what had and still is happening at the Madibira project, building on what has worked well, and learning from any mistakes that were made. Key questions would include how much are farmers prepared to invest in becoming a member of the scheme, how confidence in the co-operative can be improved, who are the people able to make the most advantage from the scheme, and who are the people who are gaining no benefit from the scheme?

3. There has been a *de facto* conversion of land to smallholder irrigation at the Mbarali land, where nearly half of the land is hired out to smallholders each year. As with the Madibira project, it will be important to look carefully at what is happening at the Mbarali farm in terms of renting land to smallholders, especially what is working and what is not working. Key questions would include who is actually

renting the land at the moment, how much are they prepared to pay for the land, and what the key water and land management problems are that they face on the farm at the moment

Detailed studies of the Madibira and Mbarali smallholder cultivation should give us a picture of who is most likely to take advantage of a conversion to smallholder cultivation and why, and those who are unlikely to take advantage of the scheme and why not. From this it should be possible to develop strategies to enable disadvantaged sections of the population to take advantage of the scheme, who would otherwise not be in a position to take advantage of the scheme. The studies would also help in the process of facilitating sustainable institutions to manage the schemes. This would need to include a consideration of the likely financial resources scheme management would be able to call upon to operate and maintain the irrigation system.

In conclusion, from the detailed studies that have been undertaken, strategies for irrigation water management are becoming apparent. These strategies will help to improve rural livelihoods by improving security of water supplies to all water users, increase flows of water downstream (especially if successful in improving the efficiency of water use on the NAFCO farms). However, it is essential that these strategies be sustainable. For both a pilot sub-catchment water management programme and transfer of NAFCO farms to smallholder schemes this means a long process (of several years) of negotiation and extensive follow-up and support as the water users meet new problems and new challenges.

APPENDIX 1: PROPOSAL FOR A PILOT SUB-CATCHMENT WATER MANAGEMENT PROGRAMME

The sub-catchment as a unit of water management

During the dry season the Great Ruaha River and the Ihefu receive most of their water from several perennial rivers. Apart from the Kimbe (which is hardly perennial) these all flow from the southern escarpment northwards across the plains. All of these rivers are heavily utilised for irrigation, domestic and livestock water. Dry season abstractions along these rivers greatly reduce the flow into the Great Ruaha River.

Although water rights have been issued to some of the water users along these rivers, many abstractions are made without water rights, and there is no means of ensuring that where there are water rights they coincide with the volumes of water actually abstracted. As with access to water within individual irrigation systems, access to the water in these rivers is largely a free-for-all, with the top-enders taking what they want regardless of the needs of the middle- and tail-enders. This situation suits the top-enders, who seldom go short of water, and their interests are not served by restraining their water use for the benefit of those lower down. It also happens that the top-enders are generally more politically influential than those lower down the system, and this makes negotiated settlements over water abstractions difficult. The pastoralists on the central plain, who used to water their cattle and draw domestic water from the lower reaches of the perennial rivers are now obliged to look elsewhere for dry-season water. The Ihefu is an obvious destination.

The pastoralists, especially the Sukuma, are politically marginal. Although they are nominally represented on village governments their participation in public affairs is weak. Consequently their influence on water users upstream is small. In their quest for water they take their stock upstream to the places where water can be found, in the irrigated areas, and this brings them into conflict with the farmers there. Efforts to keep the Ihefu free of livestock, if successful, are likely to exacerbate this conflict greatly.

Irrigation, the major water user by far, has been expanding rapidly in recent years. Some of the expansion is due to small holders opening new furrows and fields on their own initiative. The pattern of expansion is complicated by the practice of ‘shifting irrigation’, whereby some areas are abandoned while others are opened. Despite these contrary tendencies the overall area under smallholder irrigation is increasing. Another factor supporting this trend is the establishment of the Madibira smallholder scheme, which now has over 1000 smallholders and can accommodate another 2000.

The changing practices of paddy cultivation are also increasing dry season water demand. The NAFCO farms used to dry-seed and would start irrigation with the onset of the rains, in about November. There was thus little demand for water during the dry months May to October. Now the big farms are moving over to transplanting. Nurseries are planted out in September. Although the water requirements of nurseries are small the main canals tend to operated at full capacity, with surplus water being led into dry fields, to prepare them for ploughing or into the small holder areas adjacent to the commercial farming blocks. In October 1999 excess water from Kapunga was being lead out into the bush, simply to dispose of it because the main canal was full. Farmers also try to plant as early as possible in the season to get a good price for their paddy. How early they start in the dry season is influenced largely by the availability of water. The combination of these factors - the change from dry seeding to transplanting, the price advantages of early planting, and the waste of excess water - ensures that very little water reaches the drains and the Great Ruaha River.

In most of the small holder irrigation areas some people raise dry season crops - maize, beans, tomatoes, onions, etc. Some have tree crops like bananas, which need water year-round. The intakes are kept open to serve these requirements, but little or no attempt is made to limit the volume of water abstracted to that which is actually needed.

One of the difficulties in the way of negotiating agreements among the water users along a single river course is that rivers cut across administrative boundaries, making it awkward for the existing system of local government to provide a forum for the settlement of water disputes.

Another difficulty is that there is currently no system of ensuring that the intakes along a river course place actual limits on the volume of water abstracted. As a result users become accustomed to taking whatever they want or can get, and resist attempts to restrict their abstractions. The volumes of water users are able to take out of the rivers soon become established as de facto 'rights' and efforts to restrict them become political issues.

Some of the tributary rivers have concrete control structures installed by various projects over the years. Most of them are in the upper reaches of the rivers concerned. If operated correctly they could regulate the volumes of water abstracted in accordance with the water rights. In practice many of these structures have been widened or modified in ways that admit more water than they were designed for. If control structures are to be used correctly they need to have been requested by the water users themselves, with a contribution in terms of labour, cash and materials from the water users towards the building of the structure. To date, the RBWO has installed two control gates on this basis on irrigation furrows in the Usangu Catchment, and there may be potential for more.

As long as the present water use practices along the tributaries to the Great Ruaha River continue there will be no possibility of altering the dry season flows in the Great Ruaha River itself. To regulate the abstractions on the tributaries, even on a single tributary, will be a major task requiring collaboration among communities and institutions at all levels from the local groups of water users (including domestic, irrigation and livestock users) through village governments, wards, districts, and the water board.

Proposal for a SMUWC sub-catchment water management pilot programme

The diversity of interests in water from a single tributary river and the current absence of any unifying social, administrative or regulating bodies within these local catchments points to the need for an innovative approach to the central issues - how to ensure equitable access to tributary river water among those with a legitimate claim to it, and how to ensure an adequate flow into the Great Ruaha River to satisfy downstream requirements.

To address these issues it is proposed that SMUWC initiate a pilot programme in one of the sub-catchments of the Great Ruaha River. These include the Ndembera, Mbarali, Kimani, the upper reaches of the Great Ruaha, Chimala, Lunwa and others. The catchment of each of these rivers is a basic unit of surface water use, and its users are bound together, whether they acknowledge it or not, into a community of common interest.

The RBWO has also requested that SMUWC look into the issue of assisting water user groups to form WUA in the catchments in the project area. The following areas are recommended:

a. The Chimala River catchment water users
b. The reformation of Kimani River WUA (some villages are in Makete District)
c. The Halali (Kyoga) River Association

What the community shares is the interest of the various users in the water of a single river. What is taken upstream is not available for use downstream. Therefore there is built into this community a potential for competition and conflict, especially in the dry season when the river flow is low. The basic objective of the proposed programme is to facilitate the development of a forum for sharing the water supplies in a single river and its catchment among the legitimate users along its length. Due to the inherent competition among the users, especially the familiar antagonism between top-enders and tail-enders, a forum where users meet to negotiate with one another is a necessary but far from sufficient condition for the equitable sharing of the

available water. An authority, operating with legal backing and powers of enforcement, is a necessary adjunct to the forum.

It is necessary to choose one of the tributary river catchments as the pilot area. How is the choice to be made? SMUWC should assemble the available information on each sub-catchment. The information should include:

- land use maps where available (see Polly's and Ronnie's work)
- maps or diagrams and lists showing water rights issued and actual water users
- hydrological data
- a brief account of projects past and present which are related to land and water use
- sub-catchments where the RBWO has requested assistance in establishing or strengthening sub-catchment water management.

A panel would be convened to consider this information and to decide which sub-catchment would be best suited to the pilot programme for water management. The panel would have representation from SMUWC, Water Office, RBMSIIP, Mbarali District and others. The Project Steering Committee might serve as a panel.

Factors to consider when deciding on a pilot catchment might include:

- sub-catchments where SMUWC has already been active (e.g. Kimani sub-catchment – Mabadaga village, studies of Isenyela Furrow and Kimani Irrigation Scheme; Mlowo sub-catchment – Mahongole Village)
- evidence of water users attempting to initiate sub-catchment level water management initiatives (e.g. Mswiswi river) and general desire by water users for such an initiative.
- Sub-catchments where there are particular challenges – e.g. where a river runs across district boundaries (e.g. Ikoga river).

The panel would agree on a team to implement the pilot programme. SMUWC would provide a substantial technical and logistical input to the team. The District would provide an irrigation officer and the support of the (proposed) District Land and Natural Resource Management Team. The Water Office would provide a technician to serve as water bailiff, whose main job would be to ensure that abstractions were made only according to registered water rights, and that infractions were promptly and strictly dealt with. SMUWC would provide the water bailiff with a motorcycle.

An early task of the team would be to assess the data on the selected sub-catchment and to decide what additional information is needed. Reliable information would be needed on base flows in the river, the volumes of water required by all registered and unregistered but legitimate users along the length of the river, and the volume that should be allowed to reach the Great Ruaha River. In apportioning the available base flow (dry season flow) account would be taken of all users, including those needing water for domestic uses, for irrigation and for livestock and the down stream requirements, including the Ihefu, the Ruaha N.P. and Tanesco. Since irrigation is by far the largest user of river water it would be necessary to assemble information on the land use practices and shifts or trends in irrigated areas. Existing water rights would be reviewed in the light of this information.

The process of establishing the composition and tasks of the body responsible for managing the water management initiative (usually referred to as the 'Water User Association' or WUA) will be a slow process of negotiation between the different stakeholders. Around the world, sub-catchment WUA's have often failed to meet their objectives. This is because the aims of outside interests such as Water Offices and Central Government have tended to dominate over the needs and aims of the water users themselves, particularly over issues such as statutory water rights and water user fees. Frequently WUA's have meant additional responsibilities in terms of policing water rights, paying water user fee and building control structures with no additional benefits from the water users' perspective (and particularly the top-end users' perspective). Additional benefits might include rebates or reductions in the water user fee if more water

reaches the downstream end of the system, or provision of irrigation extension services. Therefore, there needs to be careful negotiation between the water users and the external supporting bodies such as the RBWO.

New water rights would be issued in accordance with the water budget, and at the same time an agreed system installed for the regulation of water abstractions as allowed by the rights. This could be either by means of fixed metering devices or by a 'warabandi' (time share) system. To agree on the new water rights, to establish the new system for regulating water abstractions, and to achieve general agreement and active co-operation along the length of the river, will be a major task and will probably take a long time.

Every effort should be made to incorporate or learn from existing methods and arrangements for regulating abstractions. There are examples at Igurusi, Mahongole, Kimani and elsewhere. RBMSIIP has experience of WUAs and methods of water sharing, and should as far as possible be a partner in the pilot programme.

The forum for water users in the pilot sub-catchment should comprise representatives of all the legitimate water users along the length of the river, and would include large and small scale irrigators, domestic water offtakes and livestock owners. It is not clear yet what form the forum should take, but it will be a large and heterogeneous body, which will need strong guidance and chairmanship if it is to be effective in reaching agreement among the members with competing interests.

It will be necessary to give the decisions of the panel some means of enforcement. There may already be adequate legal provisions and if so the forum should be made aware of these. Once established, policing abstractions and the allocation of water is likely to be an onerous task. It will certainly be necessary to have an official - the water bailiff- specifically assigned to the sub-catchment and authorised to enforce the agreed system for regulating abstractions. In this respect, the long-term sustainability of the sub-catchment WUA will depend on external support from the proposed RBWO sub-office to be based in Rujewa.

The most likely cause for these arrangements not working is the operation of local political-cum-economic interests. For the programme to succeed in its aims it may therefore be necessary to have the overt support and the occasional presence of one or more higher political authorities, such as the DC, or the RC or both. The support and presence of senior officials of the Water Office, the Water Board or the Ministry of Water would also contribute to an environment in which the greater good prevails over local and personal interests.

Next steps

The first step will be to identify potential pilot sub-catchments, collate the available information about these catchments and prioritise them. Prioritisation and selection of the actual sub-catchment will be done in collaboration with District and Water Office Officials. Potential selection criteria include:

- Sub-catchments where SMUWC already has already been working (e.g. sub-catchments that include the Community Engagement Programme pilot villages). The advantage being that the project is already familiar with key social and political issues in the area, has already undertaken some data collection, and local actors are familiar with the aims of the project.
- Sub-catchments where there are severe conflicts and/or problems and local people are requesting external assistance to solve these problems (e.g. the Kyoga/Halali sub-catchment).
- A sub-catchment that crosses Ward and District Boundaries would provide useful experience in establishing inter-Ward and inter-District co-operation.
- A sub-catchment where the local people and local leaders are interested in being part of a pilot sub-catchment water management programme.

Once the pilot sub-catchment has been selected the second step will involve basic data collection on land and water use, identifying areas of conflict as well as areas of co-operation.

Step three will involve establish a co-ordinating organisation or forum and the responsibilities it is to undertake. The composition of the forum (men, women, top-end and tail-enders, agriculturalists and pastoralists) and roles of individuals will evolve over time. Careful consideration will need to be given to the more onerous tasks, such as those of a water baliff who will police abstractions, or collecting fees (if applicable). Such jobs are time consuming and stressful. In order to maximise the chances of success and minimise corruption, a system of formal remuneration will be needed. How this can be financed in a sustainable way will be a critical question. Establishing such a forum will be time consuming and there is no blue print. It will need to incorporate officials from the District and/or Water Office, local officials (from the Ward level and councillors), as well as local people.

Step four is participatory planning and negotiation for the management of sub-catchment resources. This will probably overlap with step three, especially in terms of identifying the responsibilities and tasks of the water users' forum. Step five will be implementation.

Step six will be participatory monitoring and evaluation. This will involve asking different water users, members of the managing forum and other key stakeholders about progress and impact of the sub-catchment programme at regular (possibly six monthly) intervals, and adjusting the programme according to the results. This is an important element of ensuring the pilot programme responds to changing circumstances and gives a chance for all stakeholders (including minority groups such as pastoralists) to contribute ideas on how the programme is progressing, what is good, what is problematic, and how the process could be improved.

Resources

Human resources:

Project Staff: Although all project staff will be involved in the programme through their specialist areas (e.g. land use planning, GIS, hydrology) ideally, there will be one senior member of staff to advise and co-ordinate the programme. This person will have one or two assistants (local) to undertake data collection and facilitation work. A question is whether this work can be:

- undertaken on a part-time basis by the Community Engagement Team,
- undertaken by District and Ward Staff who would be trained to undertake the work,
- or requires one or two new members of staff to be employed on this pilot programme full-time

Water Office Staff: It is hoped that the RBWO would provide a counter-part to the SMUWC programme co-ordinator and who would be responsible for continuing the process once the SMUWC project comes to an end. This person would be based at the proposed RBWO sub-office in Rujewa. Eventually, the RBWO sub-office may also be responsible for training and/or providing other staff, such as water bailiffs.

District and Ward Level Staff: As with the Community Engagement Programme, it is hoped that Local Government can provide expert assistance with the facilitation and planning process, and in co-operation with the RBWO take-over the sub-catchment management programme at the end of the SMUWC project.

Local People: The aim of the programme will be to include all local level water users in the planning and implementation process – upstream people, downstream people, men, women, domestic water users, irrigation water users and cattle keepers (both pastoralists and sedentary cattle keepers). Some of these groups are politically and socially marginal – notably pastoralist groups who are usually also the downstream users. For those local people directly involved in the data collection and planning process, the programme will be time consuming. It is important to respect

the fact that they have other activities to undertake (especially women) and to plan programme activities accordingly.

Physical and financial:

Clearly there will be a financial cost in terms of the human resources required. Local Government and Water Office officials involved in the programme will require allowances. If new local assistants are to be employed by the project to work on the programme, there will be extra wage costs.

Physical resources will include transport. Once the sub-catchment forum is in place, transport will be required to police abstractions along the river and to facilitate communications between upstream and downstream water users. Four-wheel buggies or motor-bikes could be used for this purpose.

Timescale

Steps 1 and 2 will be relatively simple and can be achieved within a fixed time-scale:

- Identification of priority catchments and collation of available data about catchments – 4 weeks
- Selection of pilot catchment and data collection – 6 weeks

Steps 3 onwards are less easy to quantify as they are iterative processes and will require a lot of negotiation over both wide ranging issues and spatially extensive areas. However, if the pilot programme is able to begin in or before January 2000, the sub-catchment management forum and management plan should be well established by the end of 2000, with initial activities such as identifying water rights and an allocation system underway.

It will take at least three years of external support for the sub-catchment management forum to become a fully functional and sustainable body. This is because each year produces different problems in terms of amount and timing of rainfall, and each problem will require individual solutions. Until the forum has sufficient experience of solving and adapting to new problems and issues, external assistance (mainly in the form of facilitation) will be required. In this respect, given that the SMUWC project currently ends in March 2001, the establishment and resourcing of the RBWO sub-office in Rujewa will be critical to the sustainability of the pilot sub-catchment water management programme.

APPENDIX 2: WORKING PAPER ON IRRIGATION MANAGEMENT TRANSFER, BY BRUCE LANKFORD

Irrigation management transfer (IMT)

Summary

This is a proposal that SMUWC considers irrigation management transfer as a means to improve water management on NAFCO State Farm irrigation schemes.

Introduction

The two Government-owned NAFCO systems in the Usangu plains are Mbarali and Kapunga. These systems are hydrologically important in the Usangu Plains due to their location on perennial rivers and ability to abstract large amounts of water throughout the year. Observations of the NAFCO farms by members of the SMUWC team indicate that water management is weak, and that as a consequence water abstraction is greater than necessary, particularly during the dry season and at the beginning of the cropping season. A desirable goal of SMUWC capacity-building and improved natural resources management would be to raise irrigation efficiency on these NAFCO systems. It is recognised that the means to achieve this has political implications, however, if not tackled, the effects on Usangu hydrology would continue. A number of options are forwarded for discussion under the banner Irrigation Management Transfer (IMT).

IMT – background

IMT is a global and popular development process on medium to large-scale systems to achieve principally two aims; a) reduced expenditure for government-owned systems; and b) improved water management as a result of greater involvement of farmers in system management. A number of different models exist ranging from participatory management with existing system engineers to total ownership transfer to farmers. The evidence to date is that management transfer does not necessarily result in increased irrigation efficiency. This risk needs to be explicitly recognised by SMUWC.

Rationale for IMT – current NAFCO management

A number of signals found on NAFCO schemes provide some rationale to consider IMT. The key observation is that in close proximity, farming and irrigation are different on the smallholder Peri-NAFCO areas than on the NAFCO fields. Factors such as climate, soil, water supply and crop varieties remain the same, but the Peri-NAFCO smallholder systems are owner-operated while the NAFCO farms are state owned and managed. Some outcomes of this management difference are described below.

a) Average yields on the NAFCO systems are between 1 to 3 tonnes/ha, whereas with the same varieties, traditional smallholders are achieving between 2 to 5 tonnes/ha. There are multiple causes of low yields, such as low use of fertiliser, poor water level control and weed infestation. Although its not easy to say which is the main cause, the consequence for the production-based measures of efficiency is negative, resulting in a low return for water used on the NAFCO farms.

b) Water level control on the NAFCO systems is variable because fields are large, the soil surface is uneven and farmers do not use smaller plots (vijaruba) to control water level and movement. On the Peri-NAFCO systems, plots are smaller enabling greater care over water levels.

c) A high non-crop use of water on the NAFCO systems has been observed. From August through to November, NAFCO managers abstract water and appear to dissipate it on fallow fields and into drains. Dry season irrigation for smallholders is restricted to smaller areas of maize and vegetables.

d) At the beginning of the rice cropping season, it is likely that the amount of water to prepare fields is different; smallholders will irrigate, hold water within the plots and transplant within about 7 days. The NAFCO farms dry plough, irrigate heavily ploughed fields, rotavate, drain water, broadcast or transplant, and then irrigate again. This process takes longer, between 7 to 14 days.

Rationale for IMT – future water management

Benefits of greater production of rice and savings of water for downstream users plus evidence of current smallholder practices provide strong arguments for considering IMT. Again, the evidence is: greater yields on smallholder fields; greater care for water levels within fields; higher density of smaller plots (vijaruba); greater use of labour in preparing fields and ensuring higher planting densities; and possible greater attention to capturing rainwater within fields. In addition a transition stage to new management may present an opportunity to reform the existing water rights, in particular the dry season water right of the NAFCO farms.

Options for IMT

Three broad options are proposed. All of them aim to increase the number of smallholders on the state farms in order to bring about a more intensive management of water and rice cultivation. It is suggested that the target density is similar to other smallholder systems; about one to two farmers per hectare. It is also suggested that in each IMT scenario, water is continuously distributed to each field, and not rotated between fields. Instead the farmers distribute the field supply between plots within their field. In this way, each field is partially irrigated; transplanting begins at the top end and slowly moves down as water is freed up or until the rains arrive when the lower-end portion is then planted up. This is similar to the situation on the smallholder systems. Furthermore, in all three options, a sense of longer-term land tenure could be encouraged. The three options are:

'*Improved status-quo*'. Current managers remain on the farms with SMUWC and District advisers working closely with them to bring about new ways of renting out of land to smallholders. Distribution of water remains largely with NAFCO. Farmers pay a land rent as they do at present.

'*Smallholder system*'. Here the end result mirrors the existing large-scale formal smallholder schemes, e.g. Madibira. Land user rights are given to farmers and water distribution is given over to farmers up to the secondary canal level. Their organisation is managed at the Ward level. Farmers pay a water fee and other communal fees as necessary.

'*Total ownership transference*'. Smallholders are encouraged to own and operate the whole system, either through a private company, co-operative or via an NGO. The organisation pays the water user fee and maintains infrastructure from its income. In the case of full commercialisation, smallholders could even be shareholders of the company.

Implementing these last two options might involve the SMUWC team, local stakeholders and assistance from external management consultants.