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Research on Poverty Alleviation (REPOA)
P.O. Box 33223, Dar es Salaam, Tanzania
157 Mgombani Street, Regent Estate
Tel: +255(0)(22) 270 00 83 / 277 2556
Fax: +255(0)(22) 277 57 38
Email: repoa@repoa.or.tz
Website: www.repoa.or.tz

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The Use of Sustainable Irrigation for Poverty Alleviation in Tanzania:

The Case of Smallholder Irrigation Schemes in Igurusi, Mbarali District

Shadrack Mwakalila
& Christine Noe

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Table of Contents

List of **Tables**

List of Figures

List of Photos

List of Abbreviations

GDP	Gross Domestic Product
GNP	Gross National Product
JICA	Japan International Cooperation Agency
MAFS	Ministry of Agriculture and Food Security
NEP	National Environmental Policy
PRA	Participatory Rural Appraisal
PRSP	Poverty Reduction Strategy Paper
RBMSIIP	River Basin Management and Smallholder Irrigation Improvement Programme
SMUWC	Sustainable Management of the Usangu Wetlands and its Catchment
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Programme
URT	United Republic of Tanzania
VEO	Village Executive Officer
VG	Village Government
WDC	Ward Development Committee
WEO	Ward Executive Officer
WUF	Water User Fees

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ABSTRACT

Irrigation has been found to be a central key part in curbing food scarcity not only in Tanzania but also in many other developing countries. The continued dependence on rainfall in agriculture has proved incapable of sustaining the population increase. This study examines the sustainability of smallholder irrigated agriculture as a means of improving social and economic benefits in the Mbarali district, located in Usangu plains of South-West Tanzania.

Specifically the study focuses on:

- The existing national policies and their roles in irrigation development;
- Characteristics of the existing irrigation systems and their roles towards poverty alleviation;
- Productivity of irrigation schemes and profit margins for poverty alleviation;
- Rural livelihoods strategies towards poverty alleviation; and
- Arrangements of local institutions towards sustainable irrigation.

The study is confined to smallholder irrigation schemes in the Igurusi ward. The selected villages for the in-depth study were Majenje, Igurusi, Chamoto, Uhambule and Mahango.

The methodology employed in collecting data is based on the Participatory Rural Appraisal framework. This study has established that household incomes depend on crop production from irrigated fields and that production per unit area depends on how irrigation is managed. The level of poverty is, therefore, likely to be reduced if irrigation water is available and well managed.

Irrigated agriculture is, therefore, a poverty reducing intervention in the irrigation schemes of Igurusi. Though rice paddy production in the area is asserted as utilising too much of the available water resources, the same is also playing an important role in enhancing food security, income and livelihoods of the local people in the area. Therefore, based on the key research findings, this study provides recommendations on policy, interventions and institutional arrangements for making irrigated agriculture effective in improving economic benefits.

1. INTRODUCTION

Irrigated agriculture provides about 40 per cent of the world's food production from 18 per cent of the world's cultivated land (World Bank, 2003). About 70 per cent of worldwide water diverted from rivers or pumped from underground is used for irrigation (Bower et al., 1999). Irrigated land is far more productive than rain fed land, and the expansion of irrigation acreage over the past 30 years has contributed to gains in food production (World Resources, 1995). Agricultural experts expect continuous expansion of irrigation agriculture in order to meet future food requirements in developing countries. The Word Bank (1991) has pointed out that irrigation has fundamentally influenced not only agricultural productivity but also incomes, employment and subsequently development.

The primary reason for irrigation is to improve agricultural productivity in areas where surface soils are naturally drier. Semi-arid regions often have higher agricultural productivity if irrigated. However, given the large demands placed on water resources by irrigation, the extent of irrigation development has major implications for other water uses, including water needs for domestic, industries, and hydropower, as well as for national parks, wetlands and estuaries. Sustainable irrigation, therefore, refers to sound operation and maintenance of irrigation system that does not degrade entire ecosystems or create conflicts with downstream uses while improving social and economic benefits.

The Tanzanian economy still depends on agriculture as its mainstay. During the period between 1995 and 2000, the contribution of agriculture to the total GDP has been around 50 per cent. The ratio of non-monetary agriculture has been relatively high (44 per cent on average), underscoring the importance of production for own consumption. This non-monetary contribution is large because most farmers operate small-scale farms that contribute 70-80 per cent to total employment and 55% of the country's foreign exchange in 1998 (ESRF, 2000).

However, one of the major constraints to growth in agriculture is the continued reliance by small-scale farmers on hand-hoe cultivation in rain-fed agricultural systems. Irrigated agriculture, therefore, is important for improvement in farm incomes for the majority of the rural population in Tanzania.

1.1 Statement of the Problem

In the Usangu plains there has been concern over rising conflicts over water for irrigation among farmers and access to other water demands such as environmental and tourist demands in the Ruaha National Park, and demand for hydropower generation at Mtera Dam. One of the reasons identified (Kikula *et al* 1996; Mwakalila, 1997 & 2000; Lankford, 2000; SMUWC, 2001, Sokile *et al*, 2002) is poor irrigation management in the Usangu plains, upstream of the Great Ruaha Basin. During the dry season most rivers dry up downstream, leaving only few big rivers to maintain the flow throughout the year. This has brought a lot of environmental, political and economic concerns.

1.2 Study Objectives

The main objective of this research is to recommend policy, interventions, and institutional arrangements for making irrigated agriculture effective in improving social and economic benefits. The specific objectives are as follows:

(a) To examine the organisation of existing irrigation systems and their role towards poverty alleviation;
(b) To assess the productivity of irrigation and profit margins for poverty alleviation;
(c) To identify rural livelihood strategies for poverty alleviation;
(d) To assess the arrangement of local institutions and their roles towards sustainable irrigation.

1.3 Significance of the Study

Much has been reported and documented about the so-called "Mtera Crisis" - the significant draw down of the Mtera reservoir during the dry seasons resulting in a shortage of electricity supply in the country, which in turn leads into a considerable decrease in the GNP pushing the country into further poverty. The study by SMUWC (2001) shows that drawing high volumes of water upstream the Mtera reservoir, in particular for irrigation activities on the Usangu Plains, is the root cause of low inflow to the reservoir. The majority of irrigators on the other hand, and this is particularly applicable to smallholder farmers, argue that they either do not get their share of water or they get very little and too late to be of any significant use. The tendency of some people who have acquired water rights has been to deny the rest of the smallholder farmers the right to use the water, arguing that those with the water rights are the only ones authorised to use all the water. It is expected that the results from this study will provide some insights which will contribute towards making irrigation sustainable as well as improving the social and economic benefits for farmers.

1.4 Study Hypothesis

Three main hypotheses guided the study in data collection and analysis:

(a) There is no significant relationship between irrigation mismanagement and poverty;
(b) Irrigation mismanagement is not the root cause of water use conflicts, low crop production and low household income and hence poverty;
(c) Sustainable irrigation management for poverty alleviation does not require good policies and appropriate institutional set-ups.

1.5 Study Area

This study examines the sustainability of irrigation practices ion the Usangu plains and their roles in poverty alleviation in Tanzania. The study villages selected to represent different irrigation systems found in the study area were: Majenje, Igurusi, Chamoto,

Uhambule and Mahango. These villages were selected to study the three basic irrigation management systems: traditional, improved and modern ways of water management. The systems are represented by the following smallholder irrigation schemes: Kalanzi Irrigation Scheme, Lunwa (Luanda Majenje) Irrigation Scheme and Majengo Irrigation Scheme. The area, therefore, has a good representation of irrigation systems practiced on the Usangu plains.

1.5.1 The Physical Setting

The study area is located in Mbarali district, about 55 km from Mbeya municipality (see Figure 1.1). The altitude ranges from 1,000 metres to 1,100 metres above sea level, with temperatures ranging from 10 to 33^0Celcius. The mean annual rainfall is 600mm decreasing north eastwards. The growing season is of four months duration, from December to March. The soils are mainly dark grey and prismatic cracking clays; and are generally slightly sodic. Farmers in this area have good access to water from local rivers including the Lunwa (Liosi), Mswiswi, Mambi and Meta. These rivers originate from the Uporoto highlands of the southern highlands of Tanzania, forming the main catchment area of the Usangu plains.

1.5.2 The Population and Land Use Change

The changing patterns of land use in Usangu Plains are driven to a large extent by two forces: population increase and the exploitation of economic opportunities. The human population has grown as a result of natural increase and has been augmented by immigration. The immigration has been stimulated by the perception of economic opportunities that the Usangu Plains offer, mainly from irrigation and keeping livestock. These two forces together have accelerated the pace at which land and water resources are used to the point where competition and conflict over them have become a serious problem. The institutions which regulate the use of resources and thereby reduce the scale and severity of these conflicts have not, unfortunately, developed at the same pace.

1.6 Limitations of the Study

Irrigation in the study area is dynamic and complex. It is therefore not possible for a study such as this to deal with all the linking aspects between irrigation and poverty. There are also the limitations imposed by time and financial resources. Therefore, a few focused issues were selected for this study.

1.7 Organisation of the Study

Chapter One covers the introduction, highlighting the problem, study objectives and a brief description of the study area. Chapter Two provides a survey of literature. Chapter Three deals with methodology issues while Chapter Four reports the results of the key research findings. The last section is devoted to conclusion and recommendations.

Figure 1.1. The Location of the Study Villages and Irrigation Schemes

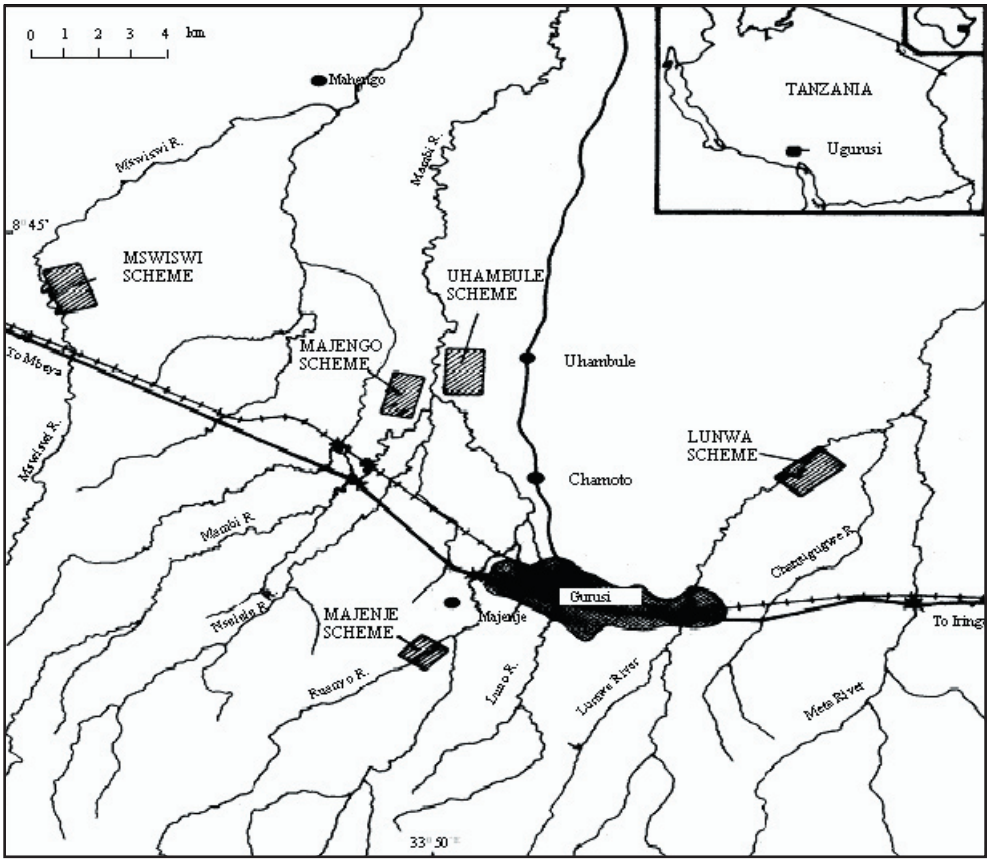


Table 1.1: The Major Characteristics of the Study Villages, Igurusi Ward

Village	Access to Roads and Services	Clinics and Schools	Agricultural Systems and Livelihood	Resource Problems
Majenje	√	√	Rain fed, Irrigated and Business	Irrigation water
Igurusi	√	√	Rain fed, Irrigated and Business	Irrigation water
Chamoto	√	√	Rain fed and Irrigated	Irrigation water
Uhambule	√	√	Rain fed and Irrigated	Irrigated water
Mahango	√	√	Rain fed and Irrigated	Irrigation water

Source: Field data

2. LITERATURE REVIEW

2.0 Preamble

This chapter gives a brief review on the achievement of improved irrigation schemes towards poverty alleviation in Tanzania. Some specific studies on irrigation schemes in Tanzania are reported as well. Also it reviews the policies which either directly or indirectly impinge on irrigation development and management.

2.1 Smallholder Irrigation Schemes for Poverty Alleviation in Tanzania

Traditional small-scale irrigation is the dominant contributor to the total irrigated area in many African countries (Gowing and Tarimo, 1994). In recent times, there has been a resurgence of interest in irrigation in Sub-Saharan countries as an engine for natural development and food security, as evidenced by increased activity of regional institutions working in these fields. The approach taken in supporting irrigation improvement in Tanzania (JICA, 2001; MAFS, 1999) mirrors approaches found elsewhere in the Sub-Saharan region, and, on occasion, elsewhere in the continent. The usual outcomes of such support is an increase in the water for the system being upgraded, especially if located upstream, accompanied by a reduced ability to share water at the river basin scale. According to Lankford (2003) these projects do not commonly conform, match and respond to the complexities of well-developed and evolving smallholder irrigation found in multi-user river basins. Without re-appraisal, the risk is that donors will be unsuccessful with smallholder irrigation schemes and turn away from this sector as they did with large-scale irrigation schemes.

2.2 The Role of National Policies on Irrigation Development and Poverty Alleviation

The policy environment is critical to irrigation development and management, as it provides the framework of national goals and requirements within which regional and local aspirations are to be met. Policies most directly or indirectly impinging on irrigation development/management are such as: The National Land Policy; National Agricultural Policy; National Water Policy; National Environmental Policy and Social policies.

Tanzania's Poverty Reduction Strategy Paper (PRSP) sets out the medium term strategy for poverty reduction and indicators for measuring progress. It defines the objectives for poverty eradication by 2010, with the following key priority areas for achieving its goal:

(a) reducing poverty through equitable economic growth;
(b) improving human capabilities, survival and social well-being; and
(c) containing extreme vulnerability among the poor.

The PRSP recognises the heavy dependence of the poor on the general environment (soil, water and forests), in particular the reliance of households on environmental resources for

income generation. Water is considered a key factor for the socio-economic development and the fight against poverty. Deliberate efforts are, therefore, needed in the management of the resources in order to sustain the desired pattern of growth and consumption, and to ensure that all the socio-economic activities maximize their capacities, as articulated in the Vision 2025. This entails integrated planning, development and river basin management in support of food security and poverty reduction as well as environmental safeguards.

Sustainable irrigation management, therefore, is one of the most important agents to enable Tanzania to achieve its development vision objectives (both social and economic), such as eradicating poverty, attaining water and food security, sustaining biodiversity and sensitive ecosystems. Though irrigation has not been dealt with explicitly, the vision represents a new turning point in the development of Tanzania.

The main objective of the National Agricultural Policy of 1997 is to ensure food security at national and household levels. However, this objective can be achieved through high crop production which can only be achieved if the application of water (irrigation) is done well and the fields are well prepared. The favourable results of improving crop yield and the subsequent benefit of raising incomes might end in vain if agricultural lands are not well prepared and irrigation is carried out haphazardly. Irrigated agriculture protects against drought and ensures food security. It is a means for poverty alleviation as more and more people undertake cultivation of irrigated high value crops. The policy, therefore, calls for proper irrigation management for sustainable development. In a broader context, it aims at attaining national food security through increased production, increased industrial crop production for export, and integrated and sustainable use and management of natural resources.

The objective of the National Water Policy (URT, 2002) for Water Resources Management is to develop a comprehensive framework for promoting the optimal, sustainable and equitable development and use of water resources for the benefit of all Tanzanians, based on a clear set of guiding principles. Therefore, good irrigation management is needed such that each water user gets the amounts of water desired at the right time and ensures that water is available throughout the year, or at least when needed. Through this kind of management, irrigated agriculture can improve household income and hence poverty alleviation.

The National Environmental Policy (NEP) encourages good irrigation management to reduce undesirable environmental impacts such as soil salinity, water pollution and the spread of waterborne diseases. This kind of management could lead to sustainable irrigation for poverty alleviation.

Social and development policies have important indirect effects on water use and management. Water use conflicts in the community could be avoided if proper irrigation management was put in place (i.e. good water allocation and distribution).

From the policy context, it can be concluded that, a common theme in the current policy environment is an overall thrust towards democratization and decentralisation. This trend should, in general, have a positive influence on natural resource management as it

re-establishes the link between real authority and responsibility, and between cause and effect. Currently, decision-makers may be remote from the impacts of their decisions. However, two considerations affect this trend. Firstly, the transfer of authority needs to be matched with a transfer of means. This is not just physical means, but also access to information and the ability to use such information to make rational decisions. As a starting point, people at district and village levels need to be properly informed as to the changes that have been mandated and, in consequence, of their new roles and responsibilities. Secondly, and as a corollary of the first, local communities are unlikely to take broader national or regional objectives fully into account when making their decisions. There remains, therefore, a critical role for central and regional government in ensuring that such objectives are reflected in local decisions – that is, in creating the framework for local action.

3. RESEARCH METHODOLOGY

3.0 Overview

In view of the amount and details of information required in a limited period of time, the methodology was based on the Participatory Rural Appraisal (PRA) approach which is a multi-disciplinary, cross-sectoral approach to engaging researchers and community members in development through an interactive and democratic participatory process. This method is based on interactive learning, the sharing of knowledge and it ensures a high-level participation of local people in the research, hence enriches the findings. The PRA method was applied to quickly generate new information. This involved relaxed rapport, open dialogue, brainstorming and mutual sharing of knowledge, skills and experiences, among others.

The tools employed in field data and information gathering included a focus group discussion, participatory observation and questionnaire monitoring. Essentially, this is a data triangulation technique, an essential means for improving the reliability of data and information.

3.1 Types and Sources of Data

This study used both primary and secondary data. The primary data was obtained from interviews and participatory observations. The major information sought was:

(a) The major characteristics of the existing traditional and improved irrigation systems;
(b) The economic benefits of rain-fed and irrigated agriculture;
(c) The livelihood strategies other than irrigation that are aimed to alleviate poverty;
(d) The existing forms of institutions that are more accessible and beneficial to poor people;
(e) The interventions for irrigation management that are most likely to be effective in poverty alleviation.

3.2 Data Collection Methods

A combination of data collection methods was used in this study. A review of secondary information and data from different project documents and other existing literature from previous studies was carried out. A reconnaissance survey was conducted in the study area to become acquainted, in particular, with the irrigation systems, agricultural practices, farming systems, geographical characteristics and the size (magnitude) of the study area. During the reconnaissance survey, information from the district, division, ward and village levels was collected to give an insight on the current status on the irrigation systems, current agricultural practices, constraints and opportunities of each farming community in the different study villages. Participants' observations, consultation with key informants and group discussions were used as tools for information gathering.

3.3 Sampling Procedure

During the formal survey, a procedure for random sampling of respondents was employed using existing village household lists from the Ward Executive Office. In villages where a household list was not available a taxpayer list was used. In areas where women were exempted from paying tax, efforts were made to get a household list and to make sure that women-headed households were represented. On average, 10 farmers were selected from each village for the interviews.

The formal questionnaire survey was carried out in all the selected villages. The formal survey enabled quantification of some important information gathered during the informal survey. The questionnaire was administered on an individual household basis. Farmer interviews took place at their homesteads to facilitate observation by researchers and to build rapport with the farmers. Wherever possible, husband and wife participated in responding to questions asked.

3.4 Method of Data Analysis and Presentation

Both qualitative and quantitative techniques were used to analyse the data through statistical tabulation including cross tabulation and frequency tables using the SPSS programme. Tables, charts and figures have been used in this report to present the key findings of the study.

4. RESEARCH FINDINGS

4.0 Overview

This part of the report presents the measurements and analysis of sustainable irrigation for poverty alleviation in five villages from the Igurusi Ward of Mbarali District part of the Usangu Plain. The first part of this section presents major characteristics of irrigated agriculture and their role towards poverty alleviation. Essentially it examines the organisation of existing irrigation systems; the role of agricultural practices on poverty alleviation; water use conflicts and resolution in irrigated agriculture system.

The second sub-section provides a comparative analysis of profit margins and returns to labour for rain-fed and irrigated paddy cultivation. It will be appreciated that both profit margin and return to labour are relatively high for irrigated agriculture as compared to rain-fed cultivation, implying that irrigation may lead to poverty alleviation if it is well managed and sustainable.

The third sub-section looks at rural livelihood strategies towards poverty alleviation. It focuses on the combinations of irrigated agriculture and other activities as dominant livelihood strategies. It is particularly concerned with rural livelihood diversification, risk management and policy implications.

The fourth sub-section examines the existing local institutions and arrangement in relation to poverty alleviation.

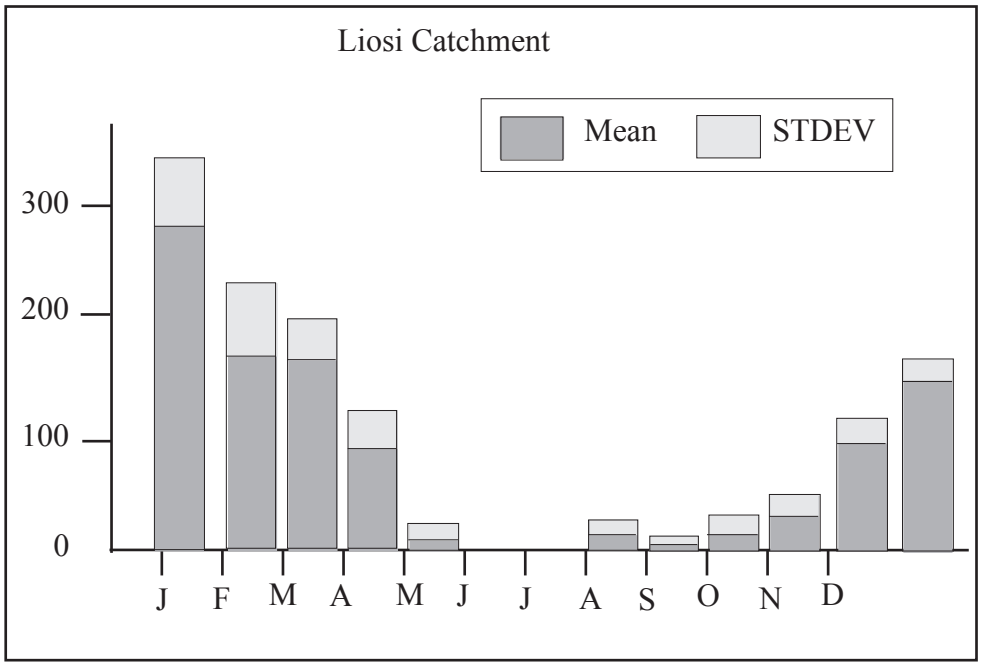
It should be noted that in the context of the irrigation water distribution system of the study area, this report uses the word 'canal'. This refers to the main ditch which is used to convey water from the main intake built from the river. From the canal, the water is led to the fields through 'field channel(s)' or 'furrows(s)'.

4.1 Organisation of the Irrigation Systems and Poverty Alleviation

4.1.1 Why Irrigate?

The primary reason for irrigating land is to improve agricultural productivity in areas where surface soils are dry. Rainfall in the study area is low and typically unreliable. This state of climate limits the growth of agricultural crops, as well as other human activities relying on water for their growth. The rainfall regime in the study area is predominantly from a single rainy season, of November to May, there is no rainfall during the rest of the year. The heaviest rainfall generally occurs in December-January or March-April (Figure 4.1). The relatively high standard deviation in the transitional months is due to variations from year to year of the onset and termination of the rainy season. In addition, the rainfall amount, as well as the onset of the rainy season do vary considerably from year to year, which often has a detrimental effect on crop production, leading to low agricultural production and hence further channels for falling into poverty. Irrigation is, therefore, required to improve crop production and household income to reduce poverty traps among farmers.

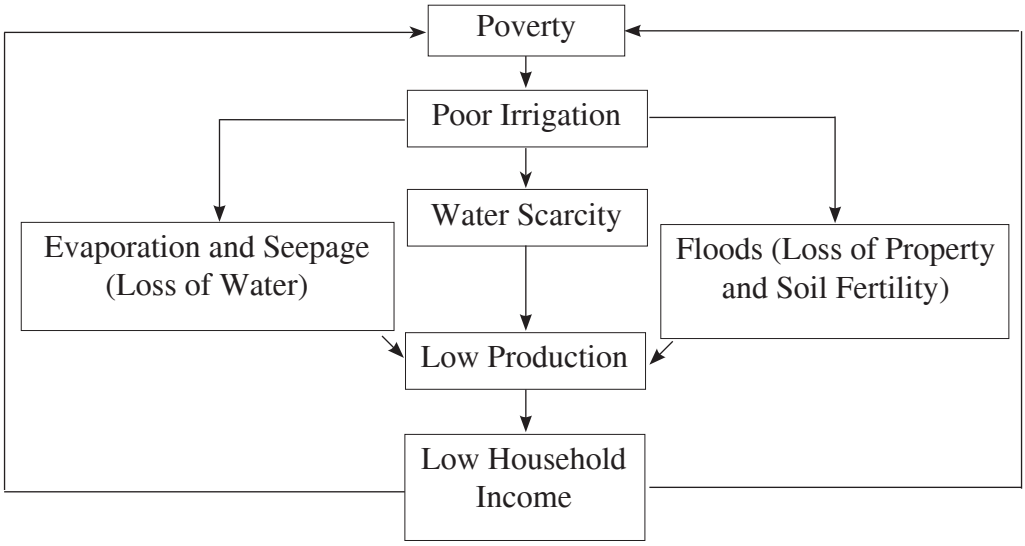
Figure 4.1: Monthly Rainfall Variability from the Igurusi Gauging Station



As depicted in Figure 4.2 below, poverty among households may result from water scarcity and poor irrigation methods that lead to floods and loss of soil fertility, hence poor crop production. Household incomes depend on crop production from irrigated fields and also production per unit area depends on how irrigation is managed. Irrigation mismanagement leads to loss of water and soil fertility leading to low agricultural production, low household income generation and therefore, increased poverty levels.

The level of poverty is likely to be reduced if irrigation water is available at the right times and amounts and well managed, as such conditions provide opportunities to produce more. This might increase food and cash crops and therefore, increase food security and cash among farmers which will consequently reduce or even alleviate poverty. Irrigated agriculture in this area is, therefore, a poverty reducing intervention.

Figure 4.2: Linkages between Irrigation and Poverty



4.1.2 Physical Infrastructure and Maintenance of Irrigation Systems

4.1.2.1 Traditional Smallholder Irrigation Systems

Kalanzi Smallholder Irrigation scheme is a good example of a traditional irrigation system. The system has been built and is managed by the local people and there have been no external interventions to modify the system. Usually, locally available materials such as stones, grass, wooden poles and earth are used to build intake structures and aqueducts. The building and maintenance of these systems is labour-intensive, with the earth canals dug and cleaned by hand. The systems 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). Water for irrigation is drawn from the Mambi river, as depicted in Photo 4.1 below.

Photo 4.1 Intake of Kalanzi Traditional Irrigation Scheme

The amount of water diverted is not controlled because of the absence of the gates. It was noted that the intake is subject to frequent damage. Floods often wash it away during the rainy periods leading to uncontrolled water supplies and reconstruction of the intake every year. Also it was learnt that, there was the possibility that the diversion of excessive water might result in floods big enough to cause damage to properties, crops and life. There was also the possibility that the river might change its course and follow the dug canal.

It was observed that water was conveyed into the fields through traditionally hand dug canals/channels which were not properly designed and had no definite shape for efficient conveyance. The channels lacked control devices for effective conveyance and distribution. These were unlined channels with high conveyance losses through seepage, evaporation, etc. This might result in water scarcity and lead to low crop production as well as household income. It was also learnt that the main canal was dug by hand and was therefore relatively narrow and shallow with a low water carrying capacity. A typical main canal was 0.5 – 1 metre deep, and approximately 0.75 metres wide. Secondary canals were approximately 0.5 metres wide and 0.5 – 0.75 metres deep. Water was diverted from the main canal to secondary canals using temporary mud dams. These systems did not usually have tertiary canals leading to individual farmers' fields, instead the water passed from one farmer's rice paddy basins to another farmer's paddy basins. This through flow results in water being recycled between several farmers. This kind of arrangement was reported to create conflicts between upstream and downstream farmers.

Once the water reached the field it was diverted from the main channel by blocking the canal by using logs, stones etc. It was noted that this system was inefficient, as excess water was wasted in the fields due to the poor land leveling, rather than being channeled back to the main streams. As a result, water users downstream experienced water scarcity and, therefore, low crop production and low household income, which led to further poverty.

Most irrigated fields had no drainage systems, hence a lot of water was being wasted as excess water. This resulted in the formation of swamps downstream and the raising of the water table and ensuing increase of salinity levels. This process lowered soil fertility leading to poor crop production and low household income, hence increasing poverty. Irrigation mismanagement, therefore, could be said to deter alleviation of poverty in the study area.

From interviews and discussions it was observed that, for maintenance of the traditional irrigation systems, farmers were informed as to when cleaning would take place, usually by someone walking around the village making the announcement. For farmers living far from the furrow, a meeting was held at harvest time - when most people were present - to set a clean-up date before the start of the following cultivating season. If a user fails to turn up for the exercise or send a representative, he/she gets fined. Both men and women could undertake the furrow work, and therefore, female-headed households were expected to send representatives to undertake the work. Similarly, if emergency repairs were required (for example, the intake has been washed away during a heavy rainstorm) all the water users were called to the intake, (this involved someone going around the village to inform farmers about what had happened), to undertake the necessary repairs.

With the traditional system, there is no specific financial cost to maintaining the furrow, and therefore water users are not expected to make any financial contributions beyond assisting 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.

The traditional irrigation practices have effects on the production per unit area and household income as far as irrigation management is concerned. Under these systems farmers divert water, a process that sometimes results in floods large enough to cause damage to properties, crops, people, livestock lives and soil erosion through a river changing its course and following the hand-dug canal. Traditional canals are shallow and narrow so they flood easily. They can also cause loss of water through seepage and evaporation leading to water scarcity for crop production thus resulting in low household income and hence poverty. The flood damage causes households to repair or rehabilitate whatever family property that gets damaged. This subsequently involves selling of some of the remaining family property including stored food and livestock in order to obtain money. Eroded soils remain poor for the coming season, implying that, without application of inorganic fertilizers to recover the lost soil fertility, the crop production per unit area becomes poor, leading to low household income and hence setting households into poverty traps.

4.1.2.2 Improved Smallholder Irrigation Systems

Luanda Majenje is an example of the improved smallholder irrigation scheme. This is a system that has had external interventions, for example, the building of concrete intakes with control gates, realigning the canals and levelling the ground. In this study it was observed that water for irrigation is obtained from the source through the intake, built by the government of Tanzania and UNDP funds, from the Lunwa river. From this intake there is a main canal which conveys the water by the force of gravity downwards to a secondary canal, which conveys the water to the fields. From the secondary canal a farmer can draw water using small trenches. The improved intake from Lunwa river is depicted in Photo 4.2 below.

Photo 4.2: Intake of Luanda-Majenje Improved Irrigation Scheme

The improved main canal of the Luanda Majenje smallholders' irrigation scheme is widened and deepened using excavating machinery. The main canal is up to 2 metres wide and 2 metres deep. Along the main canal there is a series of concrete diversion structures with control gates, as depicted in Photo 4.3. The drainage systems were built so that once water has passed through the fields it drains directly back to the river.

The system has a permanent concrete intake structure which does not require rebuilding each year, nor does it require constant maintenance throughout the cultivation season. However, there may be a need to remove the accumulated silt from the structure from time

to time. Because the main and secondary canals of these schemes have often been dug using machines, machinery is also required to clean and dredge the canals because they are deep and 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 the machinery and paying labourers, while the users themselves are often expected to clean the narrower secondary and tertiary canals.

Photo 4.3 Improved Main Canal of the Luanda Majenje Irrigation Scheme

However, it was noted that the improved irrigation scheme has not achieved the aims of increasing the agricultural output or the efficiency of water use, due to the following key problems:

- The infrastructure is capital intensive to maintain and there is a lack of ownership of the new infrastructure by the furrow users. This leads to the users becoming unwilling to contribute to the maintenance of the furrow;
- The institutions introduced to manage the scheme are often too complex, representing 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 may embezzle funds. Many of the institutions established are co-operatives, and there is a historical distrust of these organisations by farmers. Finally, the tasks leaders are required to undertake are often too onerous for an unpaid position, so many tasks are not properly 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.

4.1.3 Allocation of Water and Conflict Management

At times of peak demand there is insufficient water in the system to allow all the farmers to undertake their desired farming activities at particular points in time. Allocating water for farmers is a way of ensuring a reliable and timely supply of water, allowing as many of them as possible to undertake the appropriate farming activities. Competition for water is also the biggest cause of conflicts among water users, and again, allocating water is a way of resolving this. This part examines how the allocation of water works within the smallholder irrigation systems in the study area. It focuses on the allocation of water for a wet season rice paddy, and the allocation of water for dry season crops. Further, it examines the causes of water use conflict and how they are resolved.

4.1.3.1 Allocation of Water for Wet Season Paddy Rice Irrigation

In general, allocation schedules are only implemented when there is 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 required level of water in the basins. 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 during the rainy season, 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. Top-end farmers plant their nursery fields in October and can harvest as early as April. While farmers at the tail-end plant their 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 was most fierce at the beginning of the season, when they were 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 provided water.

In the traditional irrigation system this 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 obtain sufficient water from their furrow then they may 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 the traditional irrigation system tend to formalise the staggering of water. For example, if the rains are late, once the top-end farmers have finished transplanting their rice 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 sometimes 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 the fields of other farmers rather than directly through tertiary canals. When an allocation schedule is put in place, it is followed, although farmers reported that by the time an allocation schedule was put in place, it was usually too late and the water would not reach the tail-end of the furrow.

For an improved irrigation system, the introduction of a water allocation system was usually an integral part of the project. Under this system farmers are grouped according to which secondary or tertiary canal they normally use. Farmers are informed of the days each secondary or tertiary canal will receive water, so that they know when to plant their nursery fields and when they should transplant. Under this system of allocation, farmers do not receive the 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 rice paddy, but not any surplus. Because water should be equitably distributed along all parts of the furrow, tail-enders would also receive 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 the allocation schedules is to maximise yields and the irrigated area, and not to maximise the profit of the individual farmers. However, for the irrigation scheme visited, it was found that these proposed allocation schedules were not followed, and water users had removed the control gates from the diversion structures so that it was not possible to divert water from one particular area to another area. As with the traditional system, allocation schedules were only implemented at times of great water scarcity. Instead they were following the natural staggering system that is found in the traditional system, with some formal allocation system if the rains finished early.

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

a) Farmers like to see a constant flow of water through their fields, as this prevents weed growth. They see the allocation of water as water rationing and therefore as limiting their freedom.
b) Farmers like to plant their nursery fields and transplant as soon as the available water supplies allow them since an early harvest results in good prices.
c) Farmers usually live far from their rice paddy fields, which makes it difficult to 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.

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

4.1.3.2 Allocation of Water for Dry Season Crops

In areas where many farmers were found growing dry season crops, there was some basic system of allocating water. Again, water was not allocated to individual farmers but allocated by area or secondary canal. For example, the top-end farmers could irrigate on Tuesdays, Wednesdays and Thursdays, while the tail-end farmers could irrigate on Fridays, Saturdays, Sundays and Mondays.

Farmers reported that the allocation systems were being followed, and that very few farmers took water out of their turns. Even when water was scarce, people were more likely to go out at night (when water was not formally allocated) to try to obtain the water their crops need rather than break the allocation sequence. Farmers were 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 constant supplies of water, therefore the farmers did not mind waiting a day or two before irrigating their crops. Also, they did not live far from the areas where they grew their dry season crops, so it was easy to check on the state of the plants and if they needed water. If necessary they would go out after dark to irrigate.

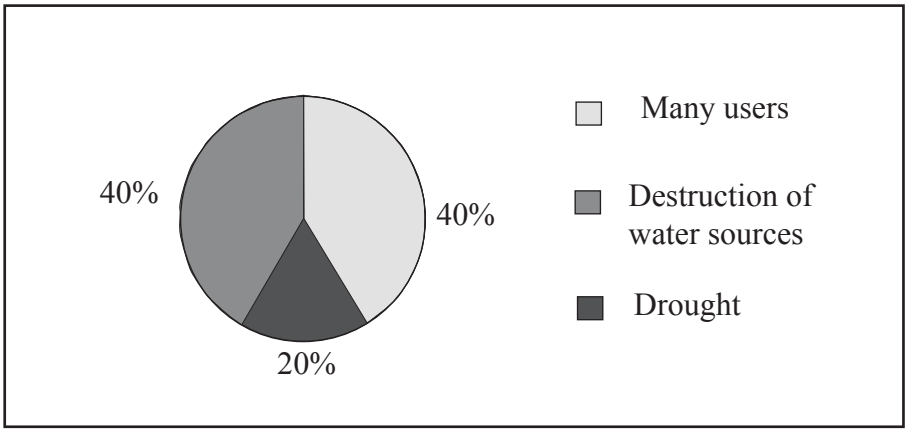
4.1.3.3 Irrigation Efficiency and Poverty

Irrigation efficiency here refers to the net water evapotranspirated from the crop as a percentage of gross water diverted into the fields (*Jaruba*). Due to limited resources, our study did not manage to conduct an experimental study of irrigation efficiency. However, based on the SMUWC study (2001), it shows that irrigation efficiency on the Usangu plains varies from one plot to another. This is an indication of different water management among individual farmers in one system. The levelled plots indicated a high value of efficiency (up to 66 per cent), which is a sign of good water use/distribution. On the other hand, unlevelled plots had very low efficiency (down to 21 per cent), an indication of poor water management. With these results it can be implied that high irrigation efficiency results in good crop production, leading to improved household income and poverty alleviation. On the other hand, it implies that unlevelled plots are a sign of relatively poor farmers who are unable to hire labour and use farm machinery/ equipment to prepare and level their plots.

4.1.4 Causes of Water Use Conflicts and Resolution

From the farmers' perceptions it was observed that water shortage was a great bottleneck to crop production, due to a number of reasons. Most farmers pointed out that the major reasons for water shortages were the many water users, drought and destruction of water sources (Figure 4.3).

Figure 4.3: Root Causes of Water Shortages for Agriculture



This resulted in water use conflicts among irrigators. As shown in Table 4.1, 70 per cent of respondents reported on the existence of conflicts over water use.

Table 4.1: Responses on Water Use Conflicts

Response	Frequencies	Percentage
Existence of conflicts	35	70
No conflicts	5	10
No response	10	20
Total	**50**	**100**

Source: Field data

As Table 4.2 below shows, conflict over water use is a sign of water scarcity in the community, and this contributes much to increased poverty due to poor crop production. This implies that if water was well managed in terms of its use and distribution, water could be applied to the cultivated land at the right time and right amount. Management of this kind could lead to improved crop yield and household income and hence poverty alleviation.

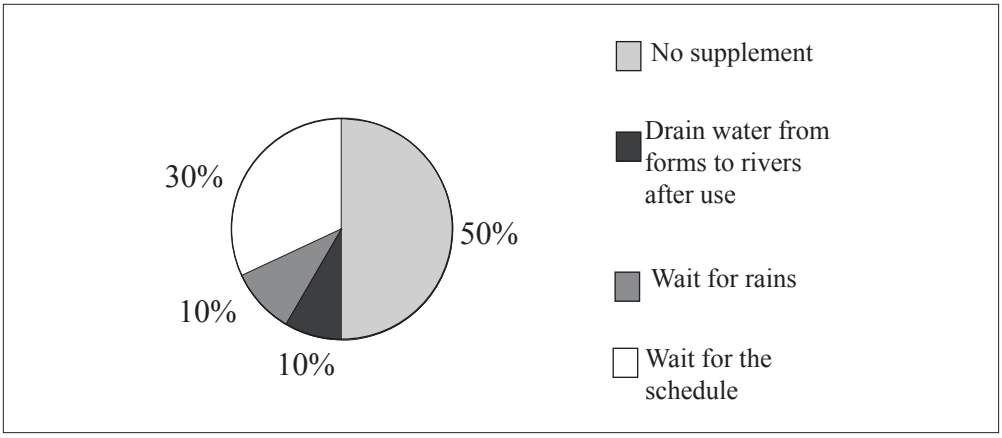
Table 4.2: Root Causes of Water Use Conflicts

Causes	Frequency	Percentage
Water insufficient	20	40
Unequal water distribution	15	30
Water mismanagement	15	30
Total	**50**	**100**

Source: Field data

However, in order to reduce the water scarcity problem, it was noted that some farmers used other alternatives to supplement water for their crops as depicted in Figure 4.4.

Figure 4.4: Supplement for Water Needs



Furthermore, during fieldwork it was established that there were different channels and levels through which resource conflicts could be expressed and addressed. These channels range from the informal ones to formal court chambers.

4.1.4.1 Informal Conflict Settlement Channels

Discussions with key informants revealed that many villagers would rather settle their conflicts through informal channels, by taking their complaints for mediation by tribal elders, or sub-village chairpersons. In a previous study (Maganga and Juma, 1999) it was reported that the Maasai normally reconcile crop losses from animal grazing without compensation because "it could happen to you tomorrow". It was also reported that the Baluch immigrant farmers never took their disputes outside their communities, but preferred to settle them according to Islamic Law.

4.1.4.2 Official Conflict Settlement Channels

The main responsibility of the ward tribunals is the maintenance of law and order within the ward and reaching a compromise and reconciliation between the disputing parties. The tribunals are encouraged to first try to reach a compromise before resorting to its mandatory powers. Exercising its criminal jurisdiction, a ward tribunal can exact a fine not exceeding Tshs. 10,000/=. In civil cases the tribunal can award damages of up to Tshs. 10,000/=. A village government can be a complainant to a criminal or civil proceeding.

4.1.5 The Role of Irrigated Agriculture in Poverty Alleviation

From interviews and discussions with farmers, it was noted that many farmers owned their own plots acquired by either buying or allocation from the village government. But, as land suitable for rice paddy irrigation had been allocated, new arrivals and young people had to rent land (see Table 4.3). The cost of hiring a rice paddy plot varies according to the location of the irrigation system and the relative location along the furrow (top-end or tail-end). Farmers often lived away from their rice paddy plots, preferring to live on the higher, upper alluvial fans. During the growing season they built temporary houses close to their rice paddy plot and stayed overnight at times of peak labour demand (transplanting and harvesting).

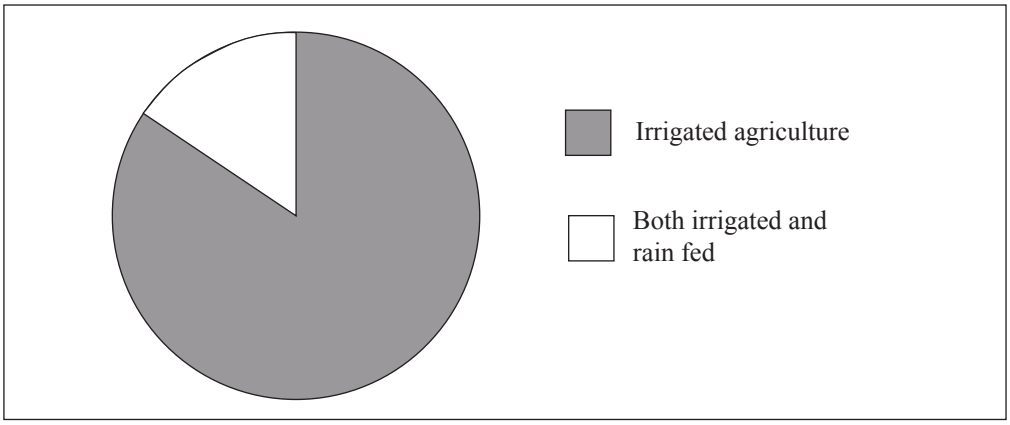
Table 4.3: Methods of Land Acquisition in an Irrigated Agriculture System

Methods	Frequencies	Percentage
Bought	15	30
Hired	12	24
Allocated by village government	14	28
Inherited	9	18
Total	**50**	**100**

Source: Field data

Most of the respondents (79 per cent) practiced irrigated agriculture for rice paddy production while the remaining (21 per cent) practiced rain fed agriculture for maize and other crops as portrayed in Figure 4.5. 40 per cent of households that practice irrigated agriculture harvest their rice paddy twice per year, implying that farmers receive a higher crop production per year, resulting in higher household income. 30 per cent of those households using rain fed agriculture which harvest once per year and are at high risk due to low and unreliable rainfall distribution. Insufficient rainfall leads to low crop production per unit area resulting in low household income and hence poverty.

Figure 4.5: Irrigation Practices



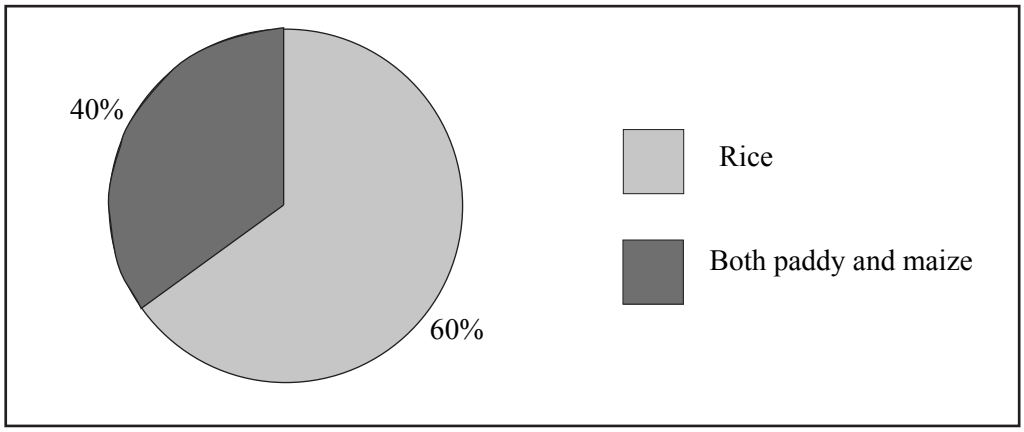
Since a rice paddy requires on average about 1,000 mm of water for crop production, irrigated plots produce more yields than rain fed plots, and therefore, contribute more to the household income thus helping to alleviate poverty. Rain fed plots produce less because they are only planted once a year and in most cases under insufficient rainfall.

Households with access to irrigation water are therefore, likely to be in a good position to produce enough food, even a surplus. As surplus is sold, families are able to pay for school fees, pay for health services and prepare their farms well for the following season. It is also noted that households with access to irrigated water are able to prepare farms for early planting. This contributes to good performance of their plots and therefore high production. Availability of water for irrigation therefore increases household food security, incomes and finally alleviates poverty.

Water scarcity for crop production causes family food insecurity and threatens household income flows which could ultimately make farmers unable to send their children to school. From a broader perspective this could cause an increasingly hungry and ignorant community and therefore increase poverty levels. Any effort proposed to increase water availability for irrigation is therefore advocated for poverty alleviation in the study area.

It was reported that the key crops grown in the study area included rainy season paddy rice and maize. Paddy rice 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 sandy loam soils have less clay in them and are more suitable for crop such as maize and vegetables. The two main crops are paddy rice and maize crops, since they are the crops that require irrigation. Wet season maize is rain fed and is important to local people as it is their staple food, while paddy rice is a cash crop. However, most farmers (both men and women) state that paddy rice is the most important crop, and if they were to focus on only one crop, it would be on paddy rice . This is because of the cash income that paddy rice provides, which is sufficient to meet the household maize requirements and other expenses such as school fees. This is illustrated in Figure 4.6.

Figure 4.6: Major Types of Crops



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 with. A fine seedbed 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 rice 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 a plough pulled by oxen. After ploughing, the farmers try to get about 6 cm of water onto their plots. From this point until two weeks before harvesting, farmers will try to keep 6 – 10 cm of water in their fields. After this "puddling" and before transplanting the farmers would go through each basin checking that the water levels are constant within each basin, and making any necessary adjustments. Once the water level is 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 include checking 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, thus increasing the weed problem. Six weeks before harvesting, bird scaring becomes 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 get drained. Once harvested, the paddy rice is threshed and then sold.

Average yields for smallholder farmers range between 3 tons per hectare 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 good prices for their paddy rice. Tail-end yields are relatively low because of insufficient water supplies and late planting. Because of the low use of fertilisers and manure, farmers reported that yields were falling. Despite this they continued to cultivate their land every year. If they left their fields to lie fallow at all it was because of the 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 to lie fallow, but were hiring them out to people who do not own a paddy plot. Once harvested, the paddy rice is sold by the sack load to independent traders, who usually visit the area to buy the paddy rice directly from the fields. One sack weighs 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 6,000. 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 centers such as Dar es Salaam and Mbeya. Very few farmers are able to store their paddy rice until the price rises again at the end of the dry season.

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 hectare (ha). Many farmers in the upper alluvial fans rent these plots as they only have paddy rice plots, and do not own land in a suitable location for dry season crops. Dry season plots are rented between TSh 10,000 – 15,000 per acre (to between TSh 25,000 – TSh 37,500 per ha). Dry season crops are often grown on ridges of soil. When the crops are irrigated, the water flows down the furrows between the ridges and allowed seeps into the soil. This is done slowly with careful control of the amount of water used, in order to maximise saturation 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) and prevailing weather conditions (the hotter it is, the more frequently irrigation is required). It takes up to 90 minutes to irrigate 0.1 of a hectare. Farmers try to irrigate dry season crops in the late afternoon and evening. This is when evapotranspiration levels are falling and this also minimizes the 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 during the middle of the day. For dry season crops there is a greater use of inputs such as manure, fertilizers and pesticides. Because the crops are high value, the inputs are only required over a small area where much of the land is continually cropped in both dry and wet season, and it is easier to get manure to these places. 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 center (often Chimala, Igurusi, or Mbeya) for sale.

4.2 Productivity of Irrigation and Profit Margins for Poverty Alleviation

4.2.1 Production Costs

Paddy rice production may involve the use of a number of inputs including seeds, tools/equipment, labour, fertilisers/manure and water, to mention but a few. In Usangu, however, very few inputs are used, apart from labour and irrigation water. Some farmers use improved seed varieties, but these are relatively expensive, and new seeds need to be purchased at the beginning of each season, when farmers usually have little capital remaining. Most farmers keep a small proportion of each year's harvest for next years' seed, so that new seeds do not need to be purchased at the beginning of every season.

The use of fertilisers, pesticides, herbicides or manure is rare. Of the interviewed farmers, only 3.3 per cent reported applying fertilisers. Artificial inputs are commonly not used because they are too expensive. Even if many farmers can afford to purchase them, the extra financial investment involved may expose them to greater economic risk should the rains, and therefore their paddy rice crop, fail. Use of manure is also uncommon because it is difficult to carry sufficient quantities to the distant paddy fields.

Land renting is common with the cost varying depending upon the location of the irrigation system and the relative location along the furrow (top-end or tail-end). For example, a top-end plot can cost up to Tsh 30,000 per acre, while a tail end plot costs Tsh 20,000. Dry season plots are rented for between Tsh 10,000 - 15,000 per acre.

Farmers who have the required capital will hire cattle to undertake ploughing work, and labour for 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).

4.2.2 Irrigation Water Use and Productivity

Summarized in Table 4.5 are the parameters and procedure applied to estimate the amount and productivity achieved from using irrigated water for rice paddy production and hence the amount of water which can be saved under the second scenario of "*without irrigated paddy"*. Under the alternative scenario of "*with irrigated paddy"*, the productivity of irrigation water is estimated at 0.18 per m^3 or Tsh 28.13 per m^3 (equivalent to US $ 0.027 per m^3 of irrigation water). In other words this is an estimate of the opportunity cost of irrigation water if the *"without irrigated paddy"* option is chosen.

4.2.3 Comparative Analysis of Profit Margins for Rain-fed and Irrigated Cultivation

In this part, returns to labour, profit margins and productivity of irrigation water are compared for three systems of paddy rice production in Usangu using both primary and secondary data collected during the study. The results are as depicted in Tables 4.4, 4.5 and 4.6 and summarised in Table 4.7.

Table 4.4: Calculation of the Amount and Value of Water Used in an Irrigated Paddy

Estimated water abstraction for paddy irrigation	= 46 m^3/s
Average annual depth of water applied in paddy field	= 1,850 mm
Mean annual rainfall	= 669 mm
Effective annual rainfall	= 479 mm
Irrigation annual demand	= (1,850 – 479)
	= 1,371 mm
	= 1.371 m
Annual volumetric demand (water use) per hectare	= 1.371m X 10^4 m^2 = 13,710 m^3
Average yield per hectare	= 2.5 tonnes = 2,500kg
Estimated irrigation paddy productivity	= 2,500kg /13,710 m^3 = 0.18 Kg/m^3
Estimated average price per kg of paddy rice	= 159 Tsh/kg
Estimated Productivity (value) of irrigation water	= 159 Tsh/kg= 159Tsh/kg X 0.18 kg/m^3
	=Tsh 28.44

Source: Own calculation and SMUWC (2001) data

Table 4.5: Costs and Margins for Smallholder Farmers from Rain-fed Paddy Rice Cultivation using Hand Hoe and Family Labour

	Units	Price/unit(Tshs)	Total Value
REVENUE:			
Yield (Kg/Ha)	788	159.00	123,125.00
Total revenue			123,125.00
COSTS:			
Seeds (Kg/Ha)	33	200.00	6,600.00
Bags and twine	10	700.00	7,000.00
Transport			8,000.00
Total costs (Tsh/Ha)			21,600.00
GROSS MARGIN (Tsh/Ha)			101,525.00
Average farm size (Ha)	0.3		
Family labour (man days/Ha)	207		
GROSS RETURN TO AN AVERAGE FARM (Tsh)			30,457.50
RETURNS PER MAN DAY (Tsh/man day)			490.46
RETURNS PER MAN DAY (US $/man day)			0.48

Source: Field data

Table 4.6: Costs and Margins for Smallholder Farmers with Rain-fed Paddy Cultivation using Tractor, Fertilisers and Hired Labour

	Units	Price/unit	Total Value
REVENUE:			
Yield (Kg/Ha)	1,500	156.25	234,375.00
Total revenue			234,375.00
COSTS:			
Seeds (Kg/Ha)	34	200.00	6,800.00
Fertilizer (bags/Ha)	2	15,000.00	30,000.00
Tractor hiring charge (Tsh/Ha)			30,000.00
Hired labour (days/Ha)	39	1,500.00	58,500.00
Bags and twine	10	700.00	7,000.00
Transport			8,000.00
Total costs (Tsh/Ha)			140,300.00
GROSS MARGIN (Tsh/Ha)			94,075.00
Average farm size (Ha)	0.5		
Family labour (man days/Ha)	183		
GROSS RETURN TO AN AVERAGE FARM (Tsh)			47,037.50
RETURNS PER MAN DAY (Tsh/man day)			514.07
RETURNS PER MAN DAY (US $/man day)			0.50

Source: Field data

Table 4.7: Costs and Margins for Smallholder Farmers with Irrigated Paddy Cultivation using Tractor, Fertilisers and Hired Labour

	Units	Price (Tsh/Unit)	Value(Tsh)
REVENUE:			
Yield (Kg/Ha)	3,000	156.25	468,750.00
Total revenue			468,750.00
COSTS:			
Plot renting (Tsh/Ha)			30,000.00
Seeds (Kg/Ha)	24.00	200.00	4,800.00
Fertilizer (bags/Ha)	2.00	15,000.00	30,000.00
Tractor hiring charge (Tsh/Ha)			30,000.00
Hired labour (days/Ha)	52.00	1,500.00	78,000.00
Bags and twine	10.00	700.00	7,000.00
Transport			8,000.00
Total costs (Tsh/Ha)			187,800.00
GROSS MARGIN (Tsh/Ha)			280,950.00
Average farm size (Ha)	1.25		
Labour (man days/Ha)	113.00		
GROSS RETURN TO AN AVERAGE FARM (Tsh)			351,187.50
RETURNS PER MAN DAY (Tsh/man day)			2,486.28
Estimated annual volumetric water demand (use) (m^3 per ha)	13,731.00		
Estimated annual volumetric water demand for the average farm size of 0.7 ha (m^3)	17,163.75		
Productivity (value) of irrigation water (Kg/m^3)	0.22		
Productivity (value) of irrigation water (Tsh/m^3)		156.25	34.14
Productivity (value) of irrigation water (US $/$m^3$)		0.15	0.03

Source: Field data

Table 4.8: Comparison of Profit Margins, Returns on Labour and Values of Irrigation Water in Paddy Rice Production

Activity	Farm size (ha)	Paddy yields (ha)	Gross margins		Return to labour (Tshs/man day)	Irrigation water productivity (Kg/ m^3)	Irrigation water value (Tsh/ m^3)
			Tsh/ha	Tsh/kg			
A	0.3	788	101,525 (98.57)	128.84 (0.13)	490.46 (0.48)	NA	NA
B	0.5	1,500	94.075 (91.33)	62.72 (0.06)	514.07 (0.49)	NA	NA
C	1.25	3,00	280,950 (272.77)	93.65 (0.09)	2,486.28 (2.41)	0.22 (0.03)	34.14

Source: Field data

Notes:

*Activity A: Smallholder farmer cultivating rain fed paddy rice, using hand hoe and family labour
*Activity B: Smallholder farmer cultivating rain fed paddy rice, using tractor, fertiliser and hired labour.
*Activity C: Smallholder farmer cultivating irrigated paddy rice, using tractor, fertiliser and hired labour.
Numbers in brackets represent equivalent values in US$, calculated using August 2003 exchange rate of 1 US$ = Tsh 1,040.
NA refers to not applicable.

As depicted in Table 4.8, there are variations in returns on labour and profit margins for the three systems of paddy cultivation. On average, the return to labour in paddy production for smallholder farmers who irrigated their paddy fields and used tractors, fertiliser and hired labour during the 2001/02 season was higher (Tsh 2,486.3 or US $2.4 per man day) than any of the remaining paddy production systems. They also obtained the highest gross margin (Tsh 280,950 or US $272.8) per hectare. The smallest return to labour (Tsh 490.5 or US $0.5 per man day) was obtained by an average smallholder farmer who cultivated rain fed paddy rice using hand hoe and family labour. When gross margins per hectare are compared, the differences among the above three production systems are determined more by the extent to which commercial inputs were used and less by the differences in economies of scale. As the evidence from this study indicates, commercial inputs were relatively very expensive and their use might have eroded a large share of profit margins.

4.3 Rural Livelihoods Strategies and Poverty

The research has attempted to focus on the *processes* involved in constructing rural livelihoods rather than simply enumerating the outcomes in terms of productivity of crops. Investigating the processes allows us to widen the focus beyond the primarily productive/ economic towards one in which social concerns are integral to the shaping of rural livelihoods. Our main focus is the on combinations of irrigated agriculture and

other activities as dominant livelihood strategies. We have been particularly concerned with identifying differences in livelihood between the rich and the poor.

4.3.1 Diversification and Risk Management Strategies

'Rural livelihood diversification" is defined as "the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and to improve their standards of living." (Ellis 2000)

The study specifically concentrated on identifying those aspects of diversification that might be seen as risk management strategies; averting or minimising in advance the risks inherent to rural livelihoods. Many of the risks include those which arise from climatic variations, changes in access to natural resources, fluctuations in prices and markets and changes to social structures which result in pressures on livelihoods.

A wide variety of diversification and risk management strategies were identified during the research and can broadly be clustered into three categories:

Farming practices:

Planting of different crops, cultivating plots in different areas, investing in small and large livestock as security, drawing on collective and hired labour arrangements to ensure timely inputs, increasing or decreasing land under cultivation.

Business and market relations:

Establishing small businesses (kiosks, shops, brokering), making handicrafts (mats and pots), selling labour, storing and selling produce at high prices, brewing and selling beer, collecting and selling natural resources.

Social and cultural relations:

Marriage as a strategy for increasing labour power and livestock, joining clubs and groups, joining churches, developing good reciprocal relations with neighbours and relatives, maintaining traditional practices and ceremonies.

4.3.2 Risk Management, Wealth and Poverty

There is a clear differentiation between socio-economic groups in their ability to diversify and manage risk (See Table 4.9). The rich can combine livelihoods in order to spread risks, for example growing both rain fed and irrigated crops, or combining agriculture with pastoralism. By contrast, the poor are more limited in the livelihood choices available to them; being confined, for example, to measures such as intercropping drought resistant crops and selling their labour. The poorest exhibited a 'retreat into subsistence' strategy.

Notably, and contrary to much of the current literature on social capital (see Narayan 1997), the poor were unable to substitute lack of assets and inability to diversify with resources drawn from social interaction. For example, poor people were not significant users of

collective labour arrangements, these requiring the provision of hospitality which few of them could afford. Certain strategies such as: the hiring of labour to ensure timely cultivation of fields and marriage as a way of consolidating family assets, were available only to the middle income and wealthy households. Generally, the social networks of poor people were very limited and they had difficulty on drawing on them to enhance their livelihoods in any meaningful way.

Differences became apparent among the study villages. In the villages of Igurusi, middle and rich people often diversified into small businesses (tea stalls, shops, selling of natural resources and the like), possibly reflecting the roadside (or near roadside) location of the villages, their strong relationship with urban centres such as Mbeya, relatively high levels of market integration and the existence of a floating population of wage labourers to provide custom for small businesses. Storage and selling of crops when the price was high was also a common strategy among these villages.

Significantly, it was noted from the study villages that increasing the land under cultivation and diversifying the location of plots was a risk management strategy available to all categories of households, rich and poor, as they have enough labour available. (See Table 4.9).

Table 4.9: Risk Management Strategies

Villages	Farming Practices	Business and Market Relations
Majenje Rich Poor All	Increased labour power Variety and Changing Crops Irrigation	Business, Investment and Storage
Igurusi Rich Poor All	Increased labour power Variety and changing crops Irrigation	Business, Investment and Storage
Chamoto Rich Poor All	Planting in different areas Variety and changing crops Irrigation	Business, Investment and Storage
Uhambule Rich Poor All	Increased labour power Variety and changing crops Irrigation	Business, Investment and Storage
Mahango Rich Poor All	Increased labour power Variety and changing crops Irrigation	Business, Investment and Storage

Notes for Table 4.9:
"Increased labour power" could be achieved through hiring and/or collective labour arrangements.

"Business, Investment and Storage" refers to selling crops at high prices (after storage) in order to invest the proceeds in small business and farm improvements.

"Variety and Changing Crops" refers to the spreading of risks by growing a variety of different crops (maize and rice) and changing crops according to the climate conditions - e.g., switching to sorghum in response to low rainfall.
"Rich" includes households identified as: **"middle"** (earning between Tshs. 400,000/- and 800,000/- per year) and **"upper middle"** income (earning more than Tshs. 800,000/- per year).

"Poor" includes households as **"lower middle**" income (earning less than Tshs. 400,000/- per year).

4.3.3 Seasonal Stress and Gender Differentiation

High seasonal stress (defined as high demands on household resources) was experienced by all households at the peak of the rainy season, due to labour shortages, food shortages, disease prevalence and cash demands (Table 4.10)**.**

Poor households felt such seasonal stress most acutely and were more likely to have to meet basic needs by selling their labour and by taking children out of school, so reinforcing a vicious cycle of low productivity in their own fields.

Little strict gender differentiation between the livelihood activities of men and women could be observed, although gender specialisations in certain tasks were commonly acknowledged. Women had variable degrees of command over household resources and livelihood decision making, some having a considerable degree of freedom and independent command of resources, others being severely constrained by marriage and cultural norms.

Table 4.10: Household Stress Periods and Level of Stress

LEVEL / PERIOD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HIGH	F M L W	F M L W	F W L W						W	W	W	F
MEDIUM				M L	L	L	L	M L		F	F	W
LOW				W	F M W	F M W	F M W	F		L	L	L

Source: Field data

KEY: **M** = Money Problems; **F** = Food Shortage; **L** = Labour Shortage; **W** = Water Shortage.

Note: Labour Shortages in September, October and December refer mainly to households undertaking dry season irrigation.

4.3.4 Gender Divisions of Labour

From all of the study villages very little strict gender differentiations could be observed in livelihood activities. This included a high degree of gender flexibility, particularly in crop related activities. Only a tiny number of activities were specified as being exclusively carried out by men or women, and such specialisations were often ethnically specific, for example the growing of sweet potatoes by women, the cleaning of irrigation furrows by men, and the training of oxen by male youth.

Interviewees frequently referred to gender specialisation of tasks although it seemed to reflect comparative skill and competence rather than strict gender delineation. In the absence of the appropriate person, someone else of a different gender could undertake the same tasks. Thus when threshing crops, men generally prepared the threshing grounds by clearing and burning, and the women by stamping and plastering, etc. The most notable aspects of the divisions of activities by gender was the flexibility involved and circumstances, rather than strict gender norms determining who undertook which tasks and when.

4.3.5 Gendered Command of Assets and Decision Making

During the study, *gendered activities* were used to assess *gendered command* over household decision making, assets control and the carrying out of activities. Men were observed as being heads of households and the main family decision makers. However, there was evidence of high levels of negotiation and joint decision making between adult household members. Even areas which are commonly thought of as being almost exclusively male domains proved to be the subject of negotiation and there was a considerable female influence at the household level.

4.3.6 Organisation of Labour

The research repeatedly revealed the critical importance of labour availability for sustainable livelihoods in the study villages. Indeed labour availability appeared to be the major constraint on livelihoods and the major difference differentiating rich households from poor households. The structure of the family partly shapes access to labour. Small families consisting of old people, or those with very young children generally being labour poor, while polygamous families and those with older children generally being labour rich. A variety of arrangements were observed as being employed to overcome labour shortages. (See Table 4.11).

Table 4.11: Advantages and Disadvantages of Labour Arrangements

LABOUR ARRANGEMENT	ADVANTAGES	DISADVANTAGES
Collective Labour Ploughing, transplanting, weeding and harvesting.	• Increases co-operation • Simplifies work • Covers large areas in short time • Can take place in your absence (e.g. illness)	• Less efficient - eg, may weed roughly • Attendance unpredictable • Need resources to prepare food and drink • Food may be wasted if people do not turn up
Hired Labour Herding, ploughing, transplanting, weeding and harvesting.	• Timely cultivation (e.g. for rains) • Gets work done quickly (e.g. crops out of field before stolen) • Enables diverse activities in one household (e.g. hired workers working on the rice, family on the maize)	• High levels of supervision required • Money and other resources to pay for it • Availability at certain times (e.g. children may only be available at weekends and at peak growing season, labourers also have their own fields to cultivate.)
Family Labour All livelihood activities	• Availability • Extended family may help in times of stress • Good quality work - no problems of surpervision	• Depends on Life Cycle - may be too young or too old • Opportunity cost (e.g. other household activities may suffer such as businesses, schooling, participation in village activities) • Hard work and exhaustion

Source: Field data

Buying and selling of labour was common throughout the study villages. Patterns of labour hiring reflect the general points made about gendered divisions of labour above; there is little gendered differentiation apparent in hired labour and rates are generally paid for the job in hand, not according to the social characteristics of the person doing it. Individual children hire themselves out as labourers during weekends and after school hours. Mixed gender groups of young people hire themselves out as labour gangs, particularly to work

on irrigated rice. This activity seems to be an important strategy for youths to gain the much needed capital to establish their own fields independent from their families.

The sale of labour constitutes a major survival strategy for poor households. However because of the more immediate returns, it is often undertaken at the expense of cultivating their own fields.

This study could not find any social organisation for the hire of labour, most people reported that labour hiring took place on an ad hoc basis, as and when required. People hired could be local or from distant places. Payment was usually made in cash for a particular plot cultivated. However, poor people commonly mentioned that they were mostly working for food alone.

Those hiring labour generally did so to ensure timely planting, weeding, transplanting and harvesting of crops, in order to obtain the maximum benefit from favourable climatic conditions. Speed at getting the job done was the most commonly mentioned requirement of the employers of labour, although many also mentioned how much supervision was required to ensure the job was done well. Most employers undertook multiple livelihood strategies and the hiring of labourers enabled them to divide their labour resources among the various activities.

4.3.7 Poverty and Vulnerability

A variety of techniques were used to distinguish between households of different levels of wealth as well as understanding the factors that impoverished people helped them to accumulate wealth. Key issues which arose relating to poverty indicators included: the need to recognise different values and preferences for investment and expenditure between ethnic groups, people's own preference for identifying capabilities rather than assets as significant in determining wealth and poverty, the importance of tracking changes to household status over a lifecycle, and the difficulty of reconciling household wealth with intra-household allocation of resources.

4.3.7.1 Differences Between Ethnic Groups

In Usangu, the standard indicators used to assess poverty proved to be of only limited use, as different ethnic groups have quite different priorities about the use of assets and savings. It was noticed that there was a tendency for agriculturalists to invest surpluses in non-farm enterprises such as food stalls and shops, whereas, pastoralists tended to invest their surpluses more directly in cattle which were primarily used to reinforce family well-being through marriage and other social obligations. Another example which highlights different priorities for investments, is the commonly used wealth indicator of housing. It is often assumed that 'improved' housing built with modern materials such as a tin roof, bricks and other similar materials is a visible sign of surplus wealth. However, preferred building materials are very culturally specific, none of the wealthy Sukuma households visited used such materials but preferred pole and plaster huts thatched with grass. When viewed from a traditional perspective this type of housing could be an indicator of wealth.

For example, it was easy to distinguish between wealthy and poor Sukuma households by the number of layers of thatch and the ways in which these had been 'finished'. Other significant ethnic differences which relate to commonly used indicators of wealth and poverty, but did not hold true in Usangu include the type of clothing, and the enrolment of children in schools for formal education.

4.3.7.2 Assets, Capabilities and Quality of Life

Commonly stressed during the in-depth interviews was what one could do with certain possessions, or could not do without them. For example, cattle were important in facilitating the opening up of bigger fields (with extra draught power) and in ensuring family well-being through bride price and the ability to cope with crises through the sale of livestock. Many of the defining features of poverty identified by those interviewed related not just to basic needs of food, shelter and health, but to more qualitative and social definitions, such as the comfort of sleeping arrangements, the ability to look smart when going to town, or to assist the extended family in times of need.

4.3.7.3 Processes and Timescales

Through the use of different techniques, it became clear that understanding the processes of wealth accumulation was more useful than simply describing states of wealth and poverty. Life stories were particularly useful in identifying key events and clusters of factors that precipitate families into a downward spiral. For example, an outbreak of disease amongst a small herd of cattle in itself was not an indicator of poverty, or a sign that a family will suffer a downward livelihood spiral. However, when that disease outbreak follows a drought year and the family has no surplus to sell to pay for drugs or veterinary services, or when the animal disease coincides with death or illness of a significant family member, or with an unexpected demand for tax payments or fines, then it could indeed lead to impoverishment. It was found that such life stories of particular importance in identifying trends towards vulnerability or sustainability in rural livelihoods.

Life stories and a life cycle approach were also important in qualifying some of the oversimplifications of standard poverty assessments. For example, one might expect that newly married couples, living independently and families with small children would have relatively few assets, and would cultivate small plots of land and hire themselves out as laborers. However, they might be doing this as part of a process of establishment and accumulation, rather than impoverishment.

4.3.7.4 Life Cycles and Dependency

Small households, those with very small children and those dominated by older people were the most likely to be poor and vulnerable. The quality of extended family relationships was highly significant in determining whether households could cope with disasters.

4.3.7.5 Health

Disease and ill health place a disproportionate burden of care on poor families and compounds their labour problems. Poor families were more likely to use herbs and traditional healers rather than modern medical facilities. Repeated ill health might render a household vulnerable to suspicions that its members have been bewitched.

4.3.7.6 Poverty and the Limits of Social Capital

Poor and vulnerable households were mostly characterised by very limited social networks and a high degree of social isolation. They might have difficulty accessing help from relatives, were unable to pay entry fees of contributions to clubs and associations, and infrequently attended village government meetings.

4.3.7.7 Natural Resource Use and Poverty

It was established that poor people were unable to use the and effectively, and due to their lack of labour flexibility and scarcity of inputs, (such as irrigated water), this disproportionately affected the poor. A strategy of expanding land under cultivation to cope with changes in climate and productivity was usually only available to those with substantial labour resources, or the very young and fit.

Poor people were the most adversely affected by the treatment of natural resources such as water, firewood, thatching grass as a commodity to be bought. They may have to travel further to collect 'free' supplies, or be forced to purchase small amounts as they needed it, often at relatively expensive rates.

4.3.7.8 Coping Strategies

People employ a number of strategies in coping with disasters, and like risk management strategies, these can be categorised into those that relate to farming practices, business and market relations and social and cultural ties.

Poor people have the most ineffective coping strategies which erode their asset base. The most prominent of these include forced sales of household goods and the sale of labour. Richer people on the other hand are more likely to be able to sell stored assets (grain, livestock) to weather disasters without substantially eroding their asset base.

4.3.7.9 Profiling Vulnerable Families

According to this research vulnerable poor families could be characterised as those:

- lacking in assets and the capability to use them;
- highly dependent on, and disadvantaged by, market relations;
- relying on small and ineffectual social networks; and
- unable to respond effectively to change.

4.3.8 Policy Implications of Livelihood Strategies, Poverty and Vulnerability

The high levels of seasonal stress on households and the shortage of labour meant that the opportunity costs of participation in public decision making are high, particularly for poor people. This is a potential constraint on community engagement activities and a challenge to the development of local strategies which do not disadvantage the poor.

Due to the high opportunity costs people are likely to prefer institutional arrangements for resource management which economise on transaction costs. In designing such arrangements it should be noted that the people making public decisions about regulations (mostly adult male household heads) are not necessarily those actually using the resource (children, hired labourers, women).

Gender role flexibility suggests scope for greater women's involvement in public decision making about natural resource management. However, women are currently unlikely to substantially contribute above hamlet level, possibly because the decision making forums at village level and above are not perceived by them as being 'women-friendly'.

The labour supplied by children and youth play a major role in household livelihood strategies in Usangu but the effects of this, for example on their schooling, are unclear. In some cases the need for labour results in children not enrolling or dropping out of school; for other cases it allows children to earn the resources needed to attend school.

Improved resource management has the potential to benefit the poor (e.g. through improved supply of water to irrigation tail enders) but will not necessarily do so. Poor people are likely to be differentially affected by new resource arrangements and this should be taken into account in village level planning.

Poor people are unlikely to be able to change their resource use patterns unless their extreme labour shortages are addressed.

A useful focus of community engagement activities could be on the development of village specific poverty indicators related to natural resource use and management.

4.4 Arrangement of the Existing Local Institutions Towards Sustainable Irrigation

4.4.1 Irrigation Institutions

Irrigation institutions can be defined here as the collective arrangements through which irrigation infrastructure is constructed, rehabilitated and maintained and water is derived from streams and allocated and distributed and resources for these purposes are mobilised.

Irrigation institutions play a great role in the sustainability of irrigated agriculture towards poverty alleviation among farmers.

Researchers observed that, some form of irrigation committee organises the traditional

irrigation system. These committees usually have a chairperson 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, but the number usually varies from 3 to 15. In theory, irrigation committees are part of village governments, being sub-committees of the village social and economic development committees. However, although many of the committee members are also part of village government, an irrigation committee for a specific furrow, tends to act independently, and rarely needs to refer to the village government. The committee is elected at elections which vary from place to place. 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 close to 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.

For improved irrigation system it was observed that, water users were 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 Food Security. A condition for being granted a statutory water right is that the holder of the right must be a legally registered body. The establishment of an Association is simpler than establishing a Co-operative. An association is established according to the 1954 Act passed by the colonial government, 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 shareholders of the co-operative, and is very specific about the structure of a co-operative and how the constitution is to be drafted.

The leadership of these associations or co-operatives is more formal and extensive than under the traditional system. There is usually a chairperson, secretary, and 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. For the traditional system, leaders are elected and membership of the 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 members 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.

Generally, furrow leaders are not remunerated for their work, and therefore their tasks need to be kept as short and as simple as possible, which is why allocation schedules are only rarely used. People prefer the more informal practice of staggering crop production according to the availability of water. A third set of tasks is to enforce by-laws and rules relating to the use of the furrows, and to punish those who do not follow these by-laws and rules.

4.4.2 By-laws and Water Rights

The study noted that many villages had by-laws that addressed the use of irrigation furrows. The village government sometimes set them, but more often the by-laws would have been set at the ward level. Typical by-laws relating to the use of irrigation furrows cover the following issues:

Maintenance of the irrigation system

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

Allocation of water

Improved and modern irrigation systems, give some system for rotating water between secondary canals and that those who fail to follow the allocation sequence are to be fined a certain amount.

Expansion of the system

Farmers may not cut new secondary or tertiary canals without the prior permission of the leaders. Failure to ask for permission might result in a fine.

Use of water

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

Watering of Livestock

Cattle should not be allowed to trample in the furrow or damage the infrastructure in anyway. Those who are found to have sent their cattle to drink from the irrigation furrow will be fined.

The number of by-laws and rules tends to be greater and more complex in improved and modern irrigation systems compared with the traditional system. The extent to which 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 the most important laws, (suggesting that these were the ones that were actually used and enforced), but often stated that there were more complex by-laws that they could not remember off-hand (suggesting that they were rarely used or

enforced). By-laws about maintenance were most strictly enforced and followed, because maintaining the system was 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, and 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.

As far as water rights are concerned, the researchers noted that it is a legal requirement for all people who draw 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 owns the water right as a group, rather than as individuals. Water rights and the associated annual water user fees (WUF) are one of the main instruments used by the Water Office to manage water extraction. 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 the colonial times. Colonial legislation gave all pre-existing, traditional furrows a traditional water right, which was held on their behalf by the relevant district authority. Those who wanted to draw water from a new location or source had to apply for a new water right, including for those wanting to draw water from traditional 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 believed that their right to draw water was based on a combination of two things. Firstly, that they had used their own labour to build the intake and furrow. Related to this was that within a furrow system, an individual's right to use furrow was based on his or her contributing labour to maintain the system. Secondly, water was seen as a gift from God, free for all to use so that they could 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 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 issue of Water User Fees (WUF) was 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.

In terms of the economic value of water, the amount of water drawn dictates the amount of the annual payment. The less water a user draws - the less the payment a user has to

make. The idea is that the users would monitor the amount of water they draw, and would reduce the amount they take. If a user can prove that they draw less than the allocated water right they can obtain a rebate on their WUF.

4.4.3 Village Government (VG)

Local government in Tanzania is structured to allow every adult, even in the most remote parts of the country, to participate in decision making on matters of local concern. There are elected office-bearers at every level from the hamlet to the national parliament. For this arrangement to work each adult and especially those elected to hold office, needs to be sufficiently well informed and politically active to make an active contribution to the conduct of local affairs. Working against these noble intentions however, is a culture of deference to persons of influence, which discourages questioning, requests for transparency and participation in the affairs of local government. Most people in the villages are also unaware that their participation in public life is required. They are dissatisfied with all levels of local government but do not know how to bring about change - except by throwing out most of the old office holders at each election and installing new ones. Some of the advantages thus gained by this large turnover in incumbents are offset by the lack of accumulated experience in local government positions.

The VG is a legal entity, able in its own right to hold property and to run enterprises and to make by-laws which can be enforced in the courts. Its members include the elected chairperson of the constituent hamlets, and representatives of the women and youth of the village. Its maximum size is 25 members. The functions of the VG are mainly to help collect taxes, to manage, regulate and co-ordinate the development of the village, and to keep law and order. Recently, the responsibility for land and natural resource management has been added to this list. To exercise these functions each VG was originally required to have five sub-committees: Finance and Planning; Production and Marketing; Education, Culture and Social Welfare; Works and Transport; Security and Defence.

Although there is a structure for the village government, there is a general incapacity to carry out any but the most basic of its designated functions. The VG is required to convene the Village Assembly every three months to inform, consult and seek approval for its resolutions. In practice this is virtually never done. An assembly of one or two hundred people is a major event, but given the size of most village areas the full assembly could be 1,000 or more people. The impracticality of involving this number of people, or even half, in an informed discussion on village affairs, and of reaching a consensus on policies and actions that will be generally observed and upheld, is so great that decisions are either not made at all, or they are made by a few influential villagers. It is sometimes the village chairperson alone who decides on behalf of the VG and the village assembly.

Each village has to have a Village Executive Officer (VEO) who is appointed and paid a small monthly allowance by the VG. The VEO is secretary to the VG and its chief executive.

The VEO also serves as tax collector on behalf of the ward and the district council and receives some 3.5 per cent of the revenues collected. The district council returns 20 per cent of the collected taxes to the village governments. This is divided in fixed proportions between several cost headings, including allowances for the VG members, payments to the hamlet chairperson for facilitating tax collection, the VG chairperson, transport and other operating costs of the VG, and 'development'. VGs may also raise their own revenues by making levies on certain activities like *pombe* (local brew) brewing and market stalls. Some have their own *pombe* shops.

A feature of the villagers' attitude to development, often mentioned by their own leaders and by officials, is the legacy of many years of highly centralised government. It has led, according to this view, to a commonly held belief that development is something that the Central Government does to the villages, usually through the agency of the district authorities. This idea accounts for the passivity of the villagers and their VGs and their reluctance to take initiatives themselves. There may be truth in this, but it does not account for the fact that the great majority of villagers are self-supporting and not dependent on any external agency for their livelihood, or that villagers have developed large areas of irrigation with no external help. This implies that the villagers are keen to manage their own affairs and develop their own resources more effectively than they do now, and would freely give their time and energy to this end. It may be they have grown tired of waiting for government to bring 'development' to them.

Until now there has been no formal requirement of the village government for a committee charged with the specific responsibility for managing land and other natural resources. This weakness is particularly important in view of the dependence of most villagers on these resources for the livelihoods. In many villages, permission to cultivate new land, to graze livestock and to cut trees is granted by the chairperson or VEO in return for a 'consideration'. The Department of Surveys and Lands is now encouraging villages to establish 'Land Committees'. This committee would overlap with some functions of the existing Environment Committees, and attempts are being made to remove this duplication of effort.

4.4.4 The Ward

The senior local government official in the ward is the Ward Executive Officer (WEO). The WEO is appointed and employed by the district and has judicial and executive powers. One of the WEO's most important duties is to collect taxes from the villages and pass them on to the district council. The WEO supervises a number of tax collectors and directs the collection of taxes by VEOs, even though they are not district employees. The WEOs in the project area had received no formal training in their roles and functions.

Based at the ward headquarters are staff from various district council departments including Agriculture, Natural Resources, Health, and Education. They report directly to the WEO.

The Ward Development Committee (WDC) is the body responsible for government, law and order and development within the ward. It consists of the VG chairpersons and several appointed officials, with the Ward Councillor as chairperson and the WEO as secretary. The WDC has no staff of its own and has to rely on the WEO to direct council staff to help. Nor does the WDC have any source of revenue other than that provided by the district council.

The official ward development planning procedure is as follows: the WDC receives the annual village development plans, and when it is satisfied that they represent the true wishes of the people of the respective villages, the plans are incorporated into the Ward's Development Plan. This, in turn, is sent to the district for incorporation into the District's Development Plan. The village development plans, which are to a great extent shopping lists, are reflected in the ward and district development plans.

Ward development plans are seldom more than a compilation of the ward representatives' shopping lists for items of infrastructure. The needs and ideas coming from the village level planning are poorly reflected in the plans. The district authorities tend to ignore them and to base their plans on those of departmental heads and councillors. Thus top-down planning continues, despite the intentions of the government to reverse the process.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Rice paddy production in the study area utilises too much of the available water resource, but also plays an important role in enhancing food security, income and livelihoods of the local people. However, with the current irrigation management system, there are no set specifications for crop water requirements which would enable farmers to receive the right amount of irrigation water at the right time and place. There is no provision for drainage from the current irrigation systems that would provide water to the downstream water users. This can be one of the root causes for water use conflicts, which are intensified by the mismanagement of irrigation water upstream, due to the fact that irrigators use a larger volume than required for the crop. The potential implication of the current irrigation systems is that if irrigation is managed properly it will lead to sustainable increases in the small farmers' productivity and income, thus alleviating rural poverty and enhancing environmental management objectives.

5.2 Recommendations

The key research findings of this study indicate that a considerable effort is required to make irrigated agriculture effective in improving social and economic benefits. The effort should focus on the major aspects to be discussed here forth:

5.2.1 Interventions

5.2.1.1 Irrigation Management at Farm Level

The following measures should be implemented to sustain irrigated agriculture at the farm level:

- Reducing the depth of water in rice fields from 18 cm to 12 cm;
- Using short season varieties for late transplanted rice;
- Shortening the time taken to prepare fields and transplant rice;
- Locating nurseries in upstream areas;
- Banning very late transplanting after an agreed date; to be negotiated each year, depending on the climate and river flows;
- Ceasing irrigation 3-4 weeks before the expected harvesting date;
- Utilizing smaller *vijaruba* (small holding ponds) where possible to reduce evaporation losses; and
- Reducing intake flows during heavy rainfall periods.

5.2.1.2 Intake Improvement

It is recommended that all traditional intakes be improved in order to achieve optimum water management. Community participation is important at all stages of intake improvements in order to come up with realistic design requirements which lead to sustainable irrigation management.

5.2.3 Institutional Arrangements

There is great need for clear definition and assignment of specific responsibilities, not only for the Ministry of Water and Livestock Development but for all relevant ministries/ departments which should be involved in the irrigation development programmes. There is also great need to define the roles and responsibilities of villagers in the planning, construction and management of their irrigation schemes.

Conceptually, in order to achieve the efficient management and control, minimal duplication of effort and better allocation of resources, irrigation development should be under the control of one institution. As goals or benefits are multi-sectoral, there is a great need for cooperation or participation of all relevant ministries/departments. Representatives from those institutions should work as a team at regional, district, divisional or ward levels (if any). In this way expertise and cooperation from several sources could be solicited. Only the Ministry of Water and Livestock Development should have the overall responsibility for irrigation development.

- At divisional or ward levels, there should be irrigation extension services in order:
- To help villagers to identify their water problems and formulate plans of solving them along the path of self-reliance;
- To assist with the mobilisation of villagers to fully participate in irrigation development programmes;
- To assist in the establishment and functioning of village irrigation committees;
- To educate villagers on the socio-economic benefits of having improved irrigation in the villages;
- To train and supervise irrigation scheme attendants from the villages;
- To render technical assistance to villagers for the maintenance and operation of the village irrigation scheme; and
- To form a connecting link between district authorities and villages.

5.2.4 Involvement of Women in Irrigation Planning and Management

Women, as primary users and beneficiaries of irrigation schemes, contribute greatly towards the sustainable irrigation management. Although the water policy stipulates that village water committees must be composed of not less than 50 per cent women members, the participation of women in management has been minimal in most irrigation schemes. Poor operation of irrigation schemes can be attributed to the lack of or delayed involvement of the primary users, that is the women. Also, lack of experience or familiarity with the technology can create problems for acceptance.

Therefore, more emphasis should be placed on appropriate training of women on all levels of community-based management, operation, maintenance, monitoring and evaluation. At the grassroot level training should be carried out in the village so as to encourage the participation of women who cannot leave their villages. Strong political commitment is also vital to ensure that women are empowered in the planning and management of the irrigation schemes.

5.2.5 Village Ownership of Improved Irrigation Schemes

The sense of ownership of modern/improved irrigation scheme from the village point of view must be acquired right from the inception of the irrigation scheme installation process. The way irrigation scheme is introduced to villagers, will to a large extent determine villagers' attitude towards the scheme after its completion. If the installation of the water scheme is a result of the felt need of villagers, chances will be great for villagers to have a sense of ownership for the scheme after its completion. The need of the scheme to the villagers should be created through the educational process in which social and economic benefits will have to be explained e.g. sustainable crop production and food security. The other way of creating a sense of ownership and responsibility is by involving villagers in the irrigation scheme from planning and decision-making through designing, construction, operation and management.

This kind of involvement will help to instill in their minds, a sense of local ownership and responsibility, which will ensure that they actually use the scheme, prevent damage to it, repair it when out of order and help in achieving the benefits expected from the irrigation scheme. This will ensure that the scheme functions all year around. If there is no feeling that this "scheme is ours" and that it is important that it works for the common good, there will be no one to take responsibility for its operation and management.

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