KNOWLEDGE SHARING AND COMMUNICATION TOOLS FOR DIALOGUE ISSUES ON PRODUCTIVITY OF WATER IN AGRICULTURE: CASE STUDY OF MKOJI SUB CATCHMENT IN USANGU PLAINS, TANZANIA

BY

KASELE SYDNEY STEVEN

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ABSTRACT

This study investigated knowledge sharing and communication tools suitable in facilitating dialogue among different stakeholders of productivity of water in agriculture in Mkoji catchment in the upper part of the Rufiji Basin, Tanzania. The specific objectives of the study were:

i) Describe how different stakeholders conceive and understand productivity of water in agriculture;
ii) Identify the type and form of knowledge sharing tools suitable for each type of stakeholders; and
iii) Evaluate the knowledge sharing tools for communication and dialogue on productivity of water in agriculture.

The study is based on a survey of multiple-stakeholders of water in the study area, including direct water users in agriculture namely farmers, water resources and agricultural experts, and water managers especially in irrigated systems. The survey of smallholder farmers covered 6 villages and 248 households selected randomly The experts' category was formed by agricultural village extension officers, MATI Igurusi tutors, Zonal irrigation officers, researchers from SHARDI Uyole, Rufiji basin water resources officers and local government leaders. Data were collected using structured questionnaires, focus group discussions and key informant's interviews. Data collected were summarized, coded and entered in a computer and the Statistical Package for Social Science (SPSS) computer software was used to analyze the data. Cross tabulations were used to determine the relation between the variables. Descriptive statistics such as frequencies, means and cross-tabulations were used to present the data.

A high proportion (87.5%) of the smallholder farmers indicated low awareness of the concept of productivity of water in agriculture as universally defined. The closest farmers come to deal with the issues of productivity of water is when practicing minimum tillage, early planting, mixed cropping and planting drought resistant crops.

The experts are aware of the basic definition of productivity of water as the ratio of total crop yield to the volume of water used. The main limitations were found to be there was lack of technical know how and equipment's for measuring the volume of water used for crop production. Given the past experiences in the study areas knowledge sharing through demonstration plots and poster will assist in increasing the understanding of different stakeholders and thus improve dialogue.

To achieve a common understanding of the productivity of water in agriculture the study make the following recommendations: (i) Farmers training, demonstration plots, radio and field visits should be employed as knowledge sharing tools for creating awareness of PWA. (ii) Dialogue should be held between other stakeholders from village level to national level to get common understanding of the description of PWA.

DECLARATION

I, KASELE SYDNEY STEVEN do hereby declare to the Senate of the Sokoine University of Agriculture that the work presented here is my own, and has not been submitted for a higher degree in any other University.

Signature………………………..

Date……………………………

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DEDICATION

To the Only Almighty, Our God, who is the source of wisdom; in whom dwell the true hope, meaning and destiny of our human life.

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DFID	Department for International Development of United Kingdom
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GRRB	Great Ruaha River Basin
IWMI	International Water Management Institute
MATI	Ministry of Agriculture Training Institute
MWALD	Ministry of Water and Livestock Development
PWA	Productivity of Water in Agriculture
RBMSIIP	Rufiji Basin Management Small Irrigation Improvement Project
RBO	Rufiji Basin Water Office
RBWB	Rufiji Basin Water Board
RBWO	Rufiji Basin Water Office
SHARDI	Southern Highland Agriculture Research Development Institute
SMUWC	Small Scale Water Management and Catchment
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package For Social Sciences
SUA	Sokoine University of Agriculture
SWMR	Soil and Water Management Research Group
URT	United Republic of Tanzania
VEOs	Village Extension Officers
WUA	Water Users Association

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CHAPTER ONE

INTRODUCTION

1.1 Role of Knowledge Sharing and Dialogue

Productivity of water (PW) has been defined differently by different authors (Seckler *et al.,* 1998); (Bastiaanssen *et al*., 2003). But can simply be described as the ratio of benefits obtained to the amount of water that is quantitatively or qualitatively depleted during the process. The benefits may include biomass produced, the economic value of the produce or the value attached to the social benefit, e.g. good health resulting from sanitation made possible by the use of water (Dong *et al.,* 2001).

The concept of productivity of water in agriculture is new and understood differently by different stakeholders. Yet, to apply it all stakeholders require a common understanding. Currently, there is a very limited understanding of how the concept can be communicated to different stakeholders. This limits the potential for dialogue to enable concerns to be resolved (FAO, 2001). Dialogue is the interaction between people with different viewpoints, intent on learning from one another (Phillips, 1984). The purpose of this learning is to lay the foundation for creating new solutions. Dialogue differs from discussion, which focuses on each person presenting, advocating, or selling his or her point of view to others. The intent of discussion appears to be winning, or convincing others of your view. Each side tends to dig in deeper and hold more firmly to their view. Simultaneously, each side becomes more and more convinced that the other's position is untenable. Rigidity creeps in, polarization occurs and the distance between the viewpoints increases. Taken to a logical extreme, discussion can escalate to litigation. Dialogue cannot occur when some people believe they have "the word" and that others do not. Therefore, the purpose of this study was to assess the knowledge sharing and communication tools for facilitating dialogue on issues of productivity of water in agriculture.

1.2 Statement of the Problem

Water is a migratory and shared resource, which require a lot of social capital in all aspects of its management. If water especially for agriculture is to be managed for increased productivity stakeholders must dialogue on the basis of common understanding. When it comes to productivity of water, currently there is a limited and different understanding among the stakeholders. Furthermore, there is a little understanding of what kind of tools should be used to improve the situation.

1.3 Significance of the Study

The switch from thinking in terms of yields per unit of land to one per unit of water is not easy to make. One is inclined to think that a trade-off exists between the two, i.e., higher productivity per unit of water is perceived to come at the cost of lower yield per unit land. Where water is scarcer than land, expressing yield per unit of water is the right thing to do in economic terms, but it needs to be explained to the farmers and other stakeholders. Where measures are not ready yet for adoption, more work needs to be done before they are introduced to farmers and other stakeholders, and they should be involved during the development stage. This study is therefore designed to investigate the knowledge sharing and communication tools for facilitating dialogue on issues of productivity of water in agriculture.

1.4 Objectives

1.4.1 General objective

The main objective of this study was to investigate the knowledge sharing and communication tools for facilitating dialogue on issues of productivity of water in agriculture.

1.4.2.Specific objectives

The specific objectives were as follows:

1. To describe how different stakeholders conceive and understand the concept of productivity of water in agriculture
2. To identify the type and form of knowledge sharing tools suitable for each type of stakeholders
3. To evaluate knowledge sharing tools necessary for communication and dialogue on issues of productivity of water in agriculture in a catchment level.

CHAPTER TWO

LITERATURE REVIEW

2.1. Overview

This chapter reviews literature-covering descriptions by different stakeholders on how they conceive and understand the concept of productivity of water in agriculture. Furthermore, the types and forms of knowledge sharing tools suitable for each type of stakeholders are given. The evaluation of knowledge sharing tools necessary for communication and dialogue on issues of productivity of water in agriculture in a catchment level are presented.

2.2 Descriptions of the Concept of PWA by Different Stakeholders

a) Communication Stakeholders on PWA

Stakeholder are those persons and organizations that should benefit from, or at least engage with, a project either directly through their involvement in the research or indirectly through the communication and scaling-up of PWA research products (DFID/NRSP, 2002). These are further sub-divided into target groups and end-users who are individual, households, communities and associations that are engaged with the PWA; for example farmers, water managers and irrigation managers, planners and water allocators, policy makers in various institutional settings. Second groups are partners those with whom the PWA research is conducted. Third groups are target institutions those that should use the products of PWA research beyond the term of the research project. Fourth group are intermediaries those who use PWA research products to deliver information, provide access to technology and generate more products such as those needed to create favourable institutional /policy circumstances for end-users. Intermediaries can be development practitioners, other researchers in national agricultural research systems (NARS) or international agricultural research systems (IARS), NGOs, Private sector, policy makers and bilateral and multilateral donors (DFID/NRSP, 2002).

b) Knowledge, altitude and practice of stakeholders on PWA

Traditionally, agricultural productivity is measured with respect to land and rarely with respect to water (Perry, 1999). Today, water is the most critical limiting factor and therefore, the concept of crop-per-drop is an important indicator of performance (Perry, 1999). The most serious problem with this concept is the lack of common understanding among the different stakeholders. For example, in many irrigation schemes in Tanzania water permits are given in the form of volume per unit time, while re-allocation and payment by individual users within a Water User Association (WUA) is by size of land being irrigated.

Furthermore, actual water is given to farmers not in terms of volume but allocated hours of access to irrigation water and according to frequencies of irrigation decided by WUA (Tarimo *et al.*, 2004). In this case, only when water is applied by sprinkling cans or buckets, then it is possible to have a sense of quantity of water used to irrigate and produce crops. Some experts would prefer to gauge productivity of irrigation investment in terms of yield of crop per unit area (URT, 2001). Such investment was meant to deliver specific scheme hydromodule, it should have been more logical to measure investment performance per unit hydromodule (i.e. kg/l/s/ha).

2.2.1. Application of the productivity of water concept to rainfed agriculture

Productivity of water in rainfed agriculture is dependent on rainfall water use and in some cases supplementary water from irrigation. Since only about 200,000 hectares out of 10 million hectares are estimated to be under irrigation in Tanzania (URT, 2002), productivity of water in rainfed agriculture is important to water resources development. In sub-Saharan Africa, approximately 95% of agricultural land is under rainfed agriculture (FAO, 2000). Rainfed agriculture is a risky enterprise because it is characterized by highly variable low and erratic rainfall (Mahoo *et al.*, 1999) and long dry spells (Barron *et al.*, 2003). Low yield and uncertainty of rainfed crop production affects adversely lives of 43% of the world population, which is engaged in agriculture (Saxena *et al.*, 2004). Increasing the productivity of rainfed agriculture, which still supplies some 60 percent of the world’s food, would make a significant impact on global food production (FAO, 2000). Both FAO (2000) and United Nations applies the concept of productivity of water to rainfed system in terms of more crops per drop, which means producing more crops per each of drop of rain. The emphasis is to meet global food security and better livelihood. Rainfall productivity to these global institutes is food for all by effectively utilizing the current levels of rainfall (FAO, 2000).

Presentation of productivity in rainfed agriculture is in terms of either gross or effective rainfall and rainfall use efficiency. Rainfall Use Efficiency (RUE) is widely used to explain productivity of rainfed agriculture (Prince *et al.,* 1998, Diarra and Breman, 2004). Due to high uncertainties in rainfall distribution in semiarid regions, probabilities of rainfall, or amount of rainfall that is considered dependable rather than the absolute means of rainfall totals and rainfall productivity is therefore more logically presented as biomass or yield per effective rainfall (Doorenbos and Prutt, 1984).

2.2.2 Application of the concept to irrigated and interacting system

In most irrigation schemes, irrigation water supply project often provides water for more than just crop production. Water is used for domestic purposes, fisheries, and livestock, as well as for wildlife habitat, and environmental preservation and enhancement (Renwick, 2001). This is the situation in the Great Ruaha River Basin (GRRB), where non-irrigation activities at the GRRB include domestic water use, fishery, livestock watering, brick making and power generation. Therefore, assessment of productivity of water in irrigation systems requires adequate accounting for non-agricultural water uses (also referred to as interacting systems). Failure to recognize the non-agricultural uses of water have had serious implications for irrigation project management, water rights, and the economic appraisal of the project themselves (Renwick, 2001).

SMUWC (2001) as an environmental development project viewed productivity of irrigation water beyond the irrigation scheme. SMUWC's concept was that irrigation water produces crops and other interacting products within the irrigation system. Furthermore, the drain water is used down stream in the flood plains and swamps to enhance environmental productivity. The notion was picked up by RIPARWIN project which went further to assess the productivity of irrigation water in its multiplicity of uses within the schemes together with the productive roles of the water in the wetlands downstream (Mdemu *et al*., 2004; Kadigi *et al.,* 2004). RIPARWIN has also measured all possible benefits from use of irrigation water of the Kapunga water system, using the water accounting components as proposed by Molden *et al*., (1997).

In many cases productivity concepts are not directly considered when designing irrigation systems. In practice, irrigation efficiency rather than irrigation productivity is considered in irrigation design (Halcrow *et al*., 1992; FAO, 2001; Republic of Kenya, 1990). Also performance of an irrigation system is focused on efficiency of water use (i.e. ratio of volume of water required by plant to volume of supplied water (Bos, 1982; Chancellor, 1997). But, Irrigation Situation Efficiency (ISE) as developed by RIPARWIN incorporates some factors of crop water productivity (i.e. time delay in accessing irrigation water and price of rice) (Magayane *et al.,* 2004; Magayane, 2003). ISE is claimed to take care of two factors. However, ISE was developed based on reuse of drainage water of Kapunga water cascading system which may not be directly apply to other irrigation systems in the country.

Managers of gravity irrigation systems care little of the amount of water they divert from the rivers since there is little direct cost incurred in terms of manpower to open and close the gates. Annual water user fee is seldom paid and the monitoring system for water abstracted is not efficient enough (SWMRG-FAO, 2003). Productivity of water in such farms is gauged by cost benefit analysis, which considers annual water user fee as a minor component cost in the analysis (James, 1988). It is in pumped systems such as Kilimanjaro Agricultural Training Centre and Bagamoyo Irrigation Development Project in which cost of pumping water is a high input in the farm cost. The cost of water is included in the land rent and farmers normally measure productivity mainly as per combined cost of land and water (Kapilima personal communication, 2003).

2.2.3 Methodological tools used to assess productivity of water in agriculture

Assessment of productivity of water entails estimation of the two main components of productivity of water: the physical mass of production or the economic value of produce and the unit volume of water used. The question arises on what is the methodological procedure adopted in estimating/measuring the numerator and denominator of the of water productivity. Physical benefits such as yield, bricks, fish catch may be simple to measure. However some benefits are not easily recognizable and even complex to numerate (e.g. social amenity, employment, environmental sustenance). As such, methods and tools to assess are not quite evident, and for those present there is no stakeholder consensus.

The most important task is numeration of quantity of water used in producing the benefits whereby, water accounting procedure is used. This can be achieved through direct field measurements of various water components used to produce a certain benefit. This is however complex and tedious and thus water balance models are used. Many crop growth simulation models also incorporate soil water balance. The different methodological tools used to estimate the two components of water productivity include empirical, statistical and simulation models.

Water accounting provides a means to generalize about water use across scales and to understand the denominator of water productivity better (Molden and Sakthivadivel, 1999). Molden *et al.* (2003) asserts that water accounting requires the definition of a domain of interest with boundaries in terms of space and time, then the task is to estimate the flows across the boundaries during the specified duration of time. Water accounting is based on the water balance approach and classifies inflow and outflow into their different components in the defined system. It attempts to capture the effects of different crop and cultural practices on how water is used and depleted at the different scales. Under the framework, water consumption referred to as depletion is divided into process and non-process (Molden *et al.,* 2003). The process depletion is that amount of water diverted and used to produce an intended good. The non- process depletion referred to water depleted by uses other than the purpose that the diversion was intended for, e.g. the evapotranspiration from trees, shrubs, and evaporation from fallow lands, etc.

2.2.4 Productivity of water to improve food security

Different people have different views on the aspect of increasing agricultural production by increasing physical output per unit of water, but the challenge is to grow more food with less water and improving livelihoods of the poor. Water can be used as a tool for increasing agricultural production. In order for the increase to take place there are three major applicable paths:

i) Developing more supplies by increasing storage and diversion facilities like dams, ponds, canals and reservoirs; etc.

ii) Deplete more of the developed primary water supply for beneficial purposes through water saving practices; and

iii) Production of more output per unit of water depleted.

Water production is one of the ways of using water as a resource of food security i.e.” increasing physical output per unit of water depleted by agriculture.” Producing more crops from the same amount of water “more crop per drop.” is also a way of expressing the physical productivity of water in agriculture.

According to Shah *et al.* (2000), a useful way to be termed when we think of productivity of water is in terms of welfare per drop. However, reduced consumption of rural households in areas of strong water competition can be a practical means of saving water by good management of the infrastructures used for diverting water. Moreover, water has to be reallocated to those who can pay or secure control over more. Here private investors can take advantage of their ability to pay for the water fees and other costs alike. Rijsberman and Molden *(*2001) reported that, in situations where water resources are being developed, it is the wealthier segments of society that is able to capture the benefits of the resources. Special attention must be to assist the poor gain and maintain the used of water (water rights) for food security. Molden *et al.(*2002) argue that for a farmer with a scarce supply, strategies to increase the productivity of water can lead to more income and better nutrition.

Ways of increasing productivity of water for a farmer can be having more yields using the same amount of water through the use of improved seed varieties, improved soil and fertility management practices that save water that can be transferred to additional uses. Real water saving means allocation or transfer of water from low value activities to higher value activities (from non-benefit to benefit use). Water can be redistributed may be from irrigation to domestic water supply. According to IWMI (2001), means of saving water and increasing the productivity of water can be through:

(a) Increasing the productivity per unit of water consumed, which involves

i. Changing crop varieties: to new varieties that can provide increased yields for each unit of water consumed, or the same yields with fewer units of water consumed.

iv. Crop substitution: by switching from high to less water consuming crops, or switching to crops with higher economic or physical productivity per unit of water consumed.

iii. Deficit, supplemental or precision irrigation: with sufficient water control; higher productivity can be achieved using irrigation strategies that increase the returns per unit of water consumed.

iv. Improved water management: to provide better timing of supplies to reduce stress at critical crop growth stages leading to increased yields or by increasing water supply reliability so farmers invest more in other agricultural inputs leading to higher output per unit of water.

v. Optimizing non-water inputs: in association with irrigation strategies that increase the yield per unit of water consumed, agronomic practices such as land preparation and fertilization can increase the return per unit of water.

(b) Reducing non-beneficial depletion

i. Lessening of non-beneficial evaporation- by reducing:

-Evaporation from water applied to irrigated fields through specific irrigation technologies such as drip irrigation, or agronomic practices such as mulching, or changing crop planting dates to match periods of less evaporative demand.

-Evaporation from fallow land, decreasing area of free water surfaces, decreasing non- or less- beneficial vegetation, and controlling weeds.

ii. Reducing water flows to sinks: by interventions that reduce irrecoverable deep percolation and surface runoff.

iii. Minimising salinization of return flows: by minimising flows through saline soils or through saline groundwater to reduce pollution caused by the movement of salts into recoverable irrigation return flows.

iv. Shunting polluted water to sinks: to avoid the need to dilute wit freshwater, saline or otherwise.

v. Reusing return flows.

(c) Reallocating water among uses

Reallocating water from lower to higher value uses: reallocation will generally not in any direct water savings, but it can dramatically increase the economic productivity of water because downstream commitments may change. However, reallocation of water can have serious legal, equity, and either social consideration that must be addressed.

(d) Tapping uncommitted outflows

i. Improving management of existing facilities: to obtain more beneficial use from existing water supplies. A number of policy, design, management, institutional interventions may allow for an expansion of irrigated area, increased cropping intensity, or increased yields within the service areas. Possible interventions are reducing delivery requirements by improved application efficiency, water pricing (Rosegrant *et al.,* 2002), and improved allocation and distribution practices.

ii. Reusing return flows: through gravity and pump diversions to increase irrigated area.

iii. Adding storage facilities: so more water is available for release during drier periods. Storage takes many forms including reservoir impoundments, groundwater aquifers, small tanks, and ponds on farmers' fields.

2.2.5 Productivity of Water in agriculture in Tanzania

Globally, productivity of water (both blue and green water) for cereals in the period 1995-2025 are estimated to be in the range 0.7-1.1kg/m^3 with productivity values of 0.15 to 0.60 kg/m^3 for rice (Rosegrant *et al*., 2002). However, for sub-Saharan African countries levels of productivity of water for cereals are very low in the range 0.10 to 0.25kg/m^3 for rice and 0.30kg/m^3 for other cereals on average. For developed countries productivity of water is in the range of 0.4 to 0.6kg/m^3 for rice and 1.7 to2.4kg/m^3 for other cereals (Rosegrant *et al*., 2002) which is higher compared to sub-Saharan African countries.

In Tanzania., productivity of water of 0.1-0.14kg/m^3 for rice and 0.22-0.32kg/m^3 for other cereals are even much lower when compared to the global water productivity situation(SMUWC, 2001b). In the Usangu plains, productivity of water to rice is estimated to be in the range of 0.2 to 0.35 kg/m^3 (SMUWC, 2001b) at field scale, which is almost 50% higher to the National figures. For example, for a wet year in Usangu with a maximum irrigated area of 45,000ha and a gross water demand of 1800 mm and an average yield of 2.5 tons per hectare, the productivity of water becomes 0.14 kg/m^3 much lower than field level values. This shows that the unaccounted other water use or the average yield per hectare is higher than 2.5 tons.

Most irrigated water systems also include water uses, among others, such as domestic, livestock, fishery, brick making, environmental water use. The aggregated levels of water productivity has many omissions in terms of actual amount of water use due to unaccounted for water by different sectors, especially from scheme/system and basin levels. For example, even the factors used to estimate the national levels of productivity of water of 1.4 metric ton yield per hectare in Tanzania is against the current levels of 2 to 2.5 metric tons per hectare. These figure are for the productivity of water to cereals but none in terms of other water use such as vegetable production, number of households benefiting from a given water source (Rosegrant *et al*., 2002). This is mainly due to lack of tools for assessing the productivity of water in irrigated water systems.

In Tanzania, there has been an effort to increase efficiency of water use in the traditional irrigation schemes, generally presumed to be low. The RBMSIIP project has been implementing a number of donor-funded projects in the Usangu plains aimed at improving the indigenous irrigation schemes through physical works. These were geared towards improving irrigation efficiency, reduced water use and increased yield. However, these efforts did not consider the complex issues of valuing water in the competing uses. Neither did the RBMSIIP attempt to define or measure the improved efficiencies. Water use efficiency or productivity was typically based on water use or production per water input into the system. However, yield based measures of efficiency may not be appropriate in indigenous schemes where inputs, labour and other constraints may also affect crop yield. Other scenarios such as field-to-field irrigation and water reuse that logically increases water use efficiency and productivity have not been considered.

2.2.6 Formation of Water User Associations in Mkoji Sub catchment

The New Water Policy (2002) recognizes Water User Associations as the lowest level of water management organization and promotes formation of the WUAs. WUAs are also expected to own water right. With exception of the ongoing WUA formation in upper and middle zone of the Mkoji sub catchment, there are still very few WUAs in the Usangu basin, most of which have been formed through top-down influences. Conventionally, irrigation committees have been referred to as WUAs although they do not operate as WUAs. The primary tasks performed by WUAs are: (i) collection of water fees; (ii) maintenance of the infrastructure; (iii) scheduling and distribution of water, in particular during periods of water scarcity when water has to be rotated. In essence these form the three basic water management tasks for a water users organisation

The background of WUA formation goes back to 1997 when the RBWO carried out water resources survey and cooperate plans in the villages that are in the Mkoji sub catchment mostly in Mbeya rural district. In 2002, the RBWO carried out an intensive exercise for formation of WUAs in 24 villages, which went hand in hand with the formation of the Apex Organization for the sub catchment. Both processes are underway. Generally, Mbeya rural district is somewhat ahead in awareness and formulation of WUAs compared to Mbarali district. Figure 1 shows the formation process of the WUAs.

While there is a lot of thrust towards WUAs as a remedy to majority of water management problems, there are few reservations that need to be taken on board in the formation and operation of WUAs. WUAs are not a panacea to water management problems. Experiences from elsewhere have shown that WUAs may inculcate inequalities in water allocation especially when they are dominated by village-level elite's who can read and write and are capable of explaining themselves better. Such local bureaucrats have attracted popular support and have been elected WUAs leaders.

The nature and composition of the WUAs may also raise some challenges. Currently, all villagers are members of WUAs provided they all use water in one form or another. With this orientation, in the long run when many WUAs has been established, we may end up having as many WUAs in the district as we have villages. This would craft a new institution that is as huge and demanding as the government itself. Seemingly, WUAs tend to follow village boundaries than the hydrological ones, phenomena that are discouraged by river basin management approach.

Water users associations also need to be strengthened to cater for the identified drawbacks. In the mean time, the RBWO should encourage formation of the WUAs in the upper catchment and in the lower plains. Other water users such as pastoralists should be encouraged and supported to form WUAs. Water saving techniques should be sought: farmers should be taught on crop choice, timing, variety selection etc, a combination of crop cultivation which would result in less water for more yield. Increasing yield per unit area would reduce the area for cultivation hence water demand for productivity of water in agriculture.

The current formation of WUAs is a lengthy, time consuming and expensive exercise. Under the present arrangements, an awareness meeting is called for all villagers, and representatives are identified for a PRA exercise. The PRA exercise is done for some days followed by writing a draft constitution, which is then read, to all villagers for comments before it is submitted for approval.

From drafting constitution to the acquisition of registration, the document passes through a bureaucratic layer of district officials up to the ministry level. This exercise also costs money and resources in terms of facilitating PRA experts to the villages, carrying the documents to the appropriate levels and paying for appropriate registration fees. Figure 1 below shows the process.

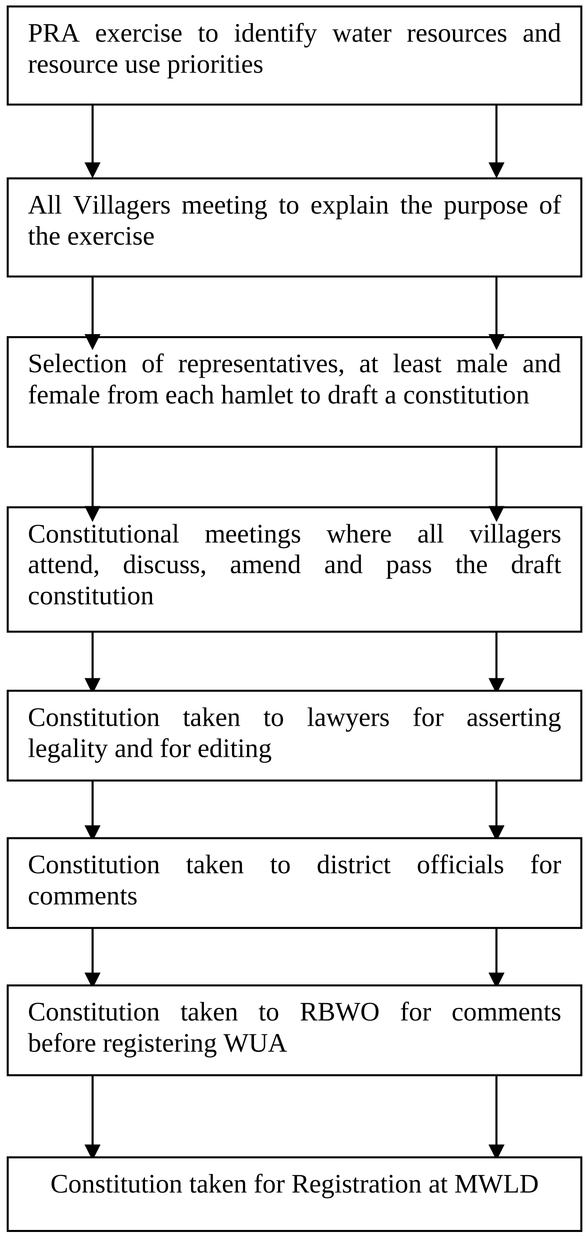

Figure 1: WUA Formation Process

The primary motive of the water users associations is to ensure equity of water supply to all members of the association. The secondary concern is to ensure that individual users get adequate yields to enable them pay for water user fees and maintenance cost of the irrigation canals. Therefore for WUA's water is productive enough if it satisfies farmers water demands equitably and ensures high crop yields. The concern of managers of irrigation schemes is to supply water to meet crop water demand and disregard the productivity of water in agriculture. The secondary concern is to ensure there is high productivity of land in agriculture.

2.5 Types and Forms of Knowledge Sharing Tools Suitable for Each Type of Stakeholders

Knowledge consists of facts, concepts, theories, heuristic methods, procedures and relationships (Turban and Aronson, 1998). It is information organized and analysed for understanding and for application in problem solving or decision making. Knowledge functions in description and explanation of phenomenon. It is also used in prediction and in understanding the causal relationship of events (Boisot, 1995, Draft, 2000). Knowledge makes ability to recognize and classify concepts, things and states of the world. It is the tool of understanding of an appropriate sequence of events or the ability to perform a particular set of actions. Knowledge functions in the understanding of why something occurs, it can be formally represented by describing the causal links among a set of factors (Boisot, 1995, Draft, 2000).

According to Nonaka and Takeuchi (1995), often the preferred way of transferring any information is through face – to – face communication using voice and body language (socialization). This is especially true in forms of education or learning that depend on apprenticeship. Much learning, however, makes use of explicit knowledge, again in the form of documents and tools, in order for somebody to assimilate the associated knowledge into the worldview (Nonaka and Takeuchi 1995). Complementary to this form of learning is apprenticeship system whereby a junior acquires tacit knowledge by working alongside an ‘expert’. This form of learning has long been recognized in consulting engineers and other organizations.

Although we benefit from explicit knowledge in our individual learning process, it is also true that we are heavily dependent on each other. Learning is as much a group processes as an individual process, and is also heavily dependent on accumulated knowledge of previous generations in all part of one or more communities, whether of interest, practice or intention. This shows the importance of knowledge sharing culture. A knowledge sharing culture is an environment where individuals are willing to disseminate information regardless of the size of the organization or company. In order to do so, individuals must adhere to the norms, values, attitudes and beliefs established by the organization. When these aspects of the knowledge sharing are breached, information will not reach the intended audience and will thus cause a knowledge-transfer bottleneck. (Jarvenpaa and Staples, 2000).

Today, knowledge - sharing is widely held to be inherently necessary to the health of most enterprises. Research shows that a "willingness to share" is positively related to profitability and productivity and negatively related to labour cost (Jarvenpaa and Staples, 2000). Focus group members believe that knowledge sharing is positively linked to growth and innovation, bottom line savings, increased customer satisfaction, increased shareholder value and learning (Jarvenpaa and Staples, 2000). Culture is a term that encompasses the values, attitudes and behaviours of an organization. Culture is important in organisations because it can powerfully influence human behaviour and because it is extremely hard to change (Kotter, 1996).

Participants in focus group discussions described a knowledge sharing culture as one where people share openly; there is a willingness to teach a mentor, where ideas can be freely challenged and where knowledge gained from other is used. Knowledge sharing can occur through many different media: conversation, meetings, and processes best practices, databases and questioning. According to Gupta and Gonvindarajan, (2000) knowledge sharing should be a corporate value, which defines how work gets done and how everyone thinks. In short, a culture of knowledge sharing goes deeper than superficial behaviours and captures the heart and minds of the people in an organization. There wide agreement that most organisational cultures currently act as barrier to knowledge sharing and need to change to become more supportive of it (Gupta and Gonvindarajan, 2000). Different stakeholders can understand the knowledge of PWA by adopting the knowledge sharing culture and dialogue among stakeholders. Furthermore, appropriate communication tools are needed to enhance the sharing of knowledge.

Communication is the process of sharing or conveying information while scaling up aims to provide’ more quality benefits to more people over a wider geographical area more quickly, more equitably and more lastingly (IRR, 2000; Gundel *et al*., 2001). Scaling – up can be a geographical expansion to more people and communities within the same sector or stakeholder group, as well as institutional, involving expansion to other stakeholder groups and sectors. For scaling up to occur, sufficient attention must be paid within a research project, to the development and implementation of a sound communication strategy. Generally, there are two types of communication tools known as synchronous and asynchronous communication tools. According to Kaplan and Ashley (2003), synchronous and asynchronous communication tools can be used to create a full, rich learning experience and sense of community for their members. Synchronous tools enable real-time communication and collaboration in a "same time-different place" mode. These tools allow people to connect at a single point in time, at the same time. Synchronous tools possess the advantage of being able to engage people instantly and at the same point in time (Kaplan and Ashley, 2003). The primary drawback of synchronous tools is that, by definition, they require same-time participation -different time zones and conflicting schedules can create communication challenges. In addition, they tend to be costly and may require significant bandwidth to be efficient. Examples of synchronous tools are shown in Table 2.

Table 1: Synchronous communication tools

Tool	Useful for	Drawbacks
Audio conferencing	Discussions and dialogue	Cost, especially when international participation is involved
Web conferencing	Sharing presentations and information	Cost, bandwidth; may also require audio conferencing to be useful
Video conferencing	In-depth discussions with higher-touch interactions	Cost, limited availability of video conferencing systems
Chat	Information sharing of low-complexity issues	Usually requires typing, "lower touch" experience
Instant messaging	Ad hoc quick communications	All users must use compatible system, usually best for 1:1 interactions
White boarding	Co-development of ideas	Cost, bandwidth; may also require audio conferencing to be useful
Application sharing	Co-development of Documents	Cost, bandwidth; may also require audio conferencing to be useful

Source: Executive update online (http://www.centeronline.org)

Asynchronous tools enable communication and collaboration over a period of time through a "different time-different place" mode. These tools allow people to connect together at each person's own convenience and own schedule. Asynchronous tools are useful for sustaining dialogue and collaboration over a period of time and providing people with resources and information that are instantly accessible, day or night. Asynchronous tools possess the advantage of being able to involve people from multiple time zones. In addition, asynchronous tools are helpful in capturing the history of the interactions of a group, allowing for collective knowledge to be more easily shared and distributed (Kaplan and Ashley, 2003). The primary drawback of asynchronous technologies is that they require some discipline to use when used for ongoing communities of practice (e.g., people typically must take the initiative to "login" to participate) and they may feel "impersonal" to those who prefer higher-touch synchronous technologies

Table 2 Asynchronous communication tools

Tool	Useful for	Drawbacks
Discussion boards	Dialogue that takes place over a period of time	May take longer to arrive at decisions or Conclusions
Web logs (Blogs)	Sharing ideas and comments	May take longer to arrive at decisions or Conclusions
Messaging (e-mail)	One-to-one or one-to-many communications	May be misused as a "collaboration tool" and Become overwhelming
Streaming audio	Communicating or teaching	Static and typically does not provide option to answer questions or expand on ideas
Streaming video	Communicating or Teaching	Static and typically does not provide option to answer questions or expand on ideas
Narrated slide Shows	Communicating or teaching	Static and typically does not provide option to answer questions or expand on ideas
"Learning objects" Web-based training)	Teaching and training	Typically does not provide option to answer Questions or expand on ideas in detail
Document libraries	Managing resources	Version control can be an issue unless check-in / check-out functionality is enabled
Databases	Managing information and Knowledge	Requires clear definition and skillful Administration
Web books	Teaching and training	Not dynamic and may lose interest of users
Surveys and polls	Capturing information and trends	Requires clear definition and ongoing Coordination
Shared Calendars	Coordinating activities	System compatibility
Web site links	Providing resources and References	May become outdated and "broken"

Source: Executive update online (http://www.centeronline.org)

2.6 Evaluation of Knowledge Sharing Tools Necessary for Communication and Dialogue on Issues of PWA in a Catchment Level

The concept of Dialogue is not totally new in the Great Ruaha River. Recently, some actors in water management have noted the role of negotiations and consensus building in water resource management. This has been propelled by the fact that unlike the expectation of majority, the hardware-oriented techno-hydrological solutions have not worked to the best of water management. New challenges such as underrating of the marginalized groups, widening of the socio-economic gap, which is associated with class dichotomy and increased conflicts, have characterized some of the water development projects.

Dialogue would receive a warm welcome among local water users in the Great Ruaha River. Available data has shown that local communities have been able to organize themselves, discuss and come out with solutions on how to allocate and manage water among them. RIPARWIN, a river basin research project based at the Ruaha River Basin has, employed River Basin Game as a role-play tool for facilitating discussion and arriving at consensus among stakeholders. This is a role model game, which allows various water users to position themselves in different parts of the river basin and negotiates for their water. Water users therefore feel the effects of scarcity that one would face as he misses water because another user upstream has diverted it all. The River Basin Game has been quite instrumental both in probing honest views and deriving active participation of stakeholders in water management discussions and in developing local consensus- based solutions for allocating water (Lankford and Sokile, 2003:forthcoming).

At the macro economic level, the policy and political environment in Tanzania is encouraging negotiations in resource use planning, including water. The new National Water Policy (MWLD, 2002) has categorically underscored the need full involved of stakeholders in management of river basins, which we believe in, most achieved through

Dialogue. The River Basin Water Office, which is the implementing agency of the water policy, has shown some positive responses on the on going discussions on water management.

Important to note is the fact that the awareness of water scarcity and challenges is growing among the civil society in Tanzania, and that the latter have to the best of our advantage, chose to intervene through public debate. Some civil society groups, especially in Dar es Salaam have shown interests in Organizing debates and discussions on water resource management. In June 2002, TANGO, the National umbrella NGO organized a public debate on institutional challenges that face Tanzania with a sub theme on water management. About 200 stakeholders from different parts of Tanzania participated in the forum. (TANGO, 2002). In April 28, 2003, TRACE, an NGO in Dar es Salaam organized a public debate on water policy, implications in allocation and management The session was attended by different stakeholders, including government Ministries, High Commissions, NGOs, Donor communities, private sector and interested individuals. Although the forum lacked some Dialogue expertise and sufficient information base, it shows how stakeholders are willing to come together to discuss issues of water.

The Dialogue would explore several options available for sound management of water. It is imperative that the stakeholders' discussions are widened beyond the narrow rhetoric thinking of ‘mere sharing or reallocating water’; which by and large, is focused on one option of responding to growing water needs and is a last-resort and a very unpopular solution that already proved to be anti-poor.

The dialogical model of extension rests on the idea that the basic aim of education is to develop people as a goal in it, while increasing productivity, the development of new ideas and the development of agricultural sector. This is not suggesting that material change is not important even from an educational point of view. Freire (1970) suggests that real learning can only result from praxis: from the union of reflection and action or thinking and doing. As Blakely (1971) points out the most effective teaching and learning takes place in the context of action. The traditional extension approach can perhaps be faulted from an over-emphasis on changing ideas, attitudes and skills without testing these in practice together with learners.

A second basic concept, directly related to the idea of developing people is Freire's concept of dialogue, from which the name of the model was taken, or the idea of open two-way communication. Dialogue is the horizontal sharing of ideas between teachers/learners and learners/teachers in a process of reflecting and acting on the world in order to understand it and change it (Freire, 1970). It is based on a faith in people, in their ability in co-operation with others to know themselves and their situation and to act on and thus change it. Freire (1970) terms this their ability to be both in the world and with it.

Dialogue assumes that both the teacher and the learner know something about the subject of interest. Although one may have more knowledge or knowledge, which is better in the sense that it more critically reflects the situation, this does not make one superior to the other. It is the knowledge that is superior and not the person as people are seen as capable of developing within the constraints of their environment and innate abilities. While all have knowledge, this is not to suggest that all are aware of this knowledge. In fact, farmers often feel that they know nothing and are helpless creatures because they have constantly been told that they are backward, lazy and ignorant (Freire, 1970). The teacher’s role in dialogue is not to present knowledge to the learners, but to lead the learners in an examination of problems, to ask learners to critically reflect and act on problems (problem posing) and knowing or learning is not a static state of being, but active process of continuous reflection and action (Blakely, 1971). Dialogical agricultural extension is based on a relationship of trust and equality between extension officers and farmers (Freire, 1970). According to Freire (1970) dialogue is not just to "persuade" or "convince" it assumes that you are open to others ideas, and ideally, it is to seek explanation, to educate or to seek a resolution to a concern. It is to express and seek collaboration and not hostility. Basically, it is to relate and communicate using free flowing ideas.

Communication is the exchange of symbolic information, which is partly, consciously, given, received and interpreted between people who are in one way or another aware of each other (Oomkes, 1986). The way language communication takes place is culturally determined, and different cultures, languages and symbols with disparate meanings and associations are used. The way communication takes place also differs between ethnic communities (Eisstadt, 1955; Hyman, 1966). Dialogue is important in interpersonal communication between actions of equal standing, where there is the possibility of exchanging arguments and contra arguments. It involves constant feedback in order to find out if the actors have understood the information they have exchanged. This makes it possible to arrive at complete mutual understanding and possible consensus (Reimann, 1974). This contrasts with ‘ Socrates dialogue’ (Popper, 1968), where the main speaker has superior intellect and other partners are only asking questions for clarification. Yet it is ‘Socratic dialogue’ that often characterizes the communication between agriculture extension officers and farmers.

In Mbarali District the SMUWC library contains books, articles, reports, videos, and photos from over the past 40 years, along with reports and field information from the special studies. The River Basin Water Office management now holds the library. This is a knowledge-sharing tool whereby different stakeholders get new knowledge. Computerized databases of information both for the project and for Mbarali District were developed and used during the SMWUC project but now are shared by other stakeholders. These contain information collected by SMUWC, and from the district’s information records. District staffs have been trained to access and maintain this information.

The Geographic information system (GIS) stores information that can be described by a location e.g. villages in Mbarali District that have schools. In this way, information can be displayed on maps. This has been done for the SMUWC study area and started for Mbarali District. The GIS has now been transferred to the RBWO in Iringa. The RBWO received training in maintaining and updating GIS systems (SMUWC, 2003).

Key information from SMUWC was also stored on the Usangu website, and can be accessed worldwide web (www.usangu.org) as typical example of knowledge sharing tool. Another knowledge sharing tool was the reviewed existing data: Since the 1940s, many people and organizations have studied Usangu. These studies provide a good base of information and can be used to see how Usangu has changed over the last 60 years. There is also general government information on the area - population and animal censuses, health statistics, land use, and so on. There are also maps and aerial photographs, which go back to the late 1940s, and these too can help us see how the area has changed.

Story telling is simply the use of stories in organisations as a communication tool to share knowledge. Traditionally, organisational communications have had a tendency to be somewhat dry and lacking in inspiration. Story telling uses a range of techniques to engage, involve and inspire people, using language that is more authentic (everyday language as opposed to ‘textbook buzzword speak’) and a narrative form that people find interesting and fun (Ashley, 2003).

Storytelling has of course existed for thousands of years as a means of exchanging information and generating understanding. Similarly, it has always existed in organisations – otherwise known as ‘the grapevine’. However, as a deliberate tool for sharing knowledge it is quite recent but growing very rapidly, to the extent that it is becoming a favoured technique among an increasing number of management consultants.

According to Ashley (2003), when used effectively, storytelling offers numerous advantages over more traditional organisational communication techniques. Stories communicate ideas holistically, conveying a rich yet clear message, and so they are an excellent way of communicating complicated ideas and concepts in an easy-to-understand form. It allows people to convey tacit knowledge that might otherwise be difficult to articulate; in addition, because stories are told with feeling they can allow people to communicate more than they realise they know. Furthermore, it provides the context in which knowledge arises as well as the knowledge itself, and hence can increase the likelihood of accurate and meaningful knowledge transfer.

Listening to people and story telling from elders were types of knowledge sharing tools adopted by SMWUC project .To build on this information, many people, government officials, local leaders, farmers, other local resource users, and interest groups were asked to give their views on Usangu. These people give us a feeling for what Usangu was like in the past and how they see it has changed.

SMUWC project gathered new information that is the information base, a number of special studies were carried out to collect new information on different issues where there is uncertainty. These studies have looked at land use; local livelihoods; conflict -

causes, and approaches to resolving them; water systems - rainfall, river flows, water quality, and groundwater; irrigation - water use and management systems; livestock - numbers, carrying capacity, condition of the pastures, and management systems; and biodiversity. A variety of approaches may be required to manage information. Traditional ways of managing information, in libraries, should not be overlooked, and are normally within the means of districts and communities. For example, districts could support communities to develop a photo library to show how their area is changing.

Computer-based approaches to information management - database and GIS - offer many advantages. GIS is very powerful, as complex information can be visually presented. Looking to the future, there is great potential to take simplified GIS systems to district levels. However, currently such systems may be beyond the capacity and the means of districts and institutions. Although a database has been developed for Mbarali District, many district officials have yet to see it as a first source of information. Time and support are required for people to see the benefits of managing and maintaining information in this way.

To make data management easier, and to make sure that different data sets can be compared to one another, it is important to standardise systems of data collection and organisation. To be kept up to date and useful, districts need to ensure that their information management systems can accommodate data from all their sources (government and projects). Information management and maintenance requires resources and skilled staff. Currently, these are mostly only available within higher level institutions. Even here, resources may not be available to maintain information networks, or these may not be seen as a priority. Key organisations, like the RBWO and the districts, do not currently have the resources to maintain data networks essential to informing decision making in Usangu.

2.7 Summary

This chapter has described how different stakeholders conceive and understand the concept of productivity of water in agriculture. Further, it identified the types and forms of knowledge sharing tools which current exists for each type of stakeholder Section five described the importance of knowledge sharing tools necessary for communication and dialogue on issues of productivity of water in agriculture in a catchment level.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter presents the methodology used in the study. It covers the main sampling techniques used, data sources, and method of data collection and analytical techniques employed in this study.

3.2 Conceptual Framework of the Study

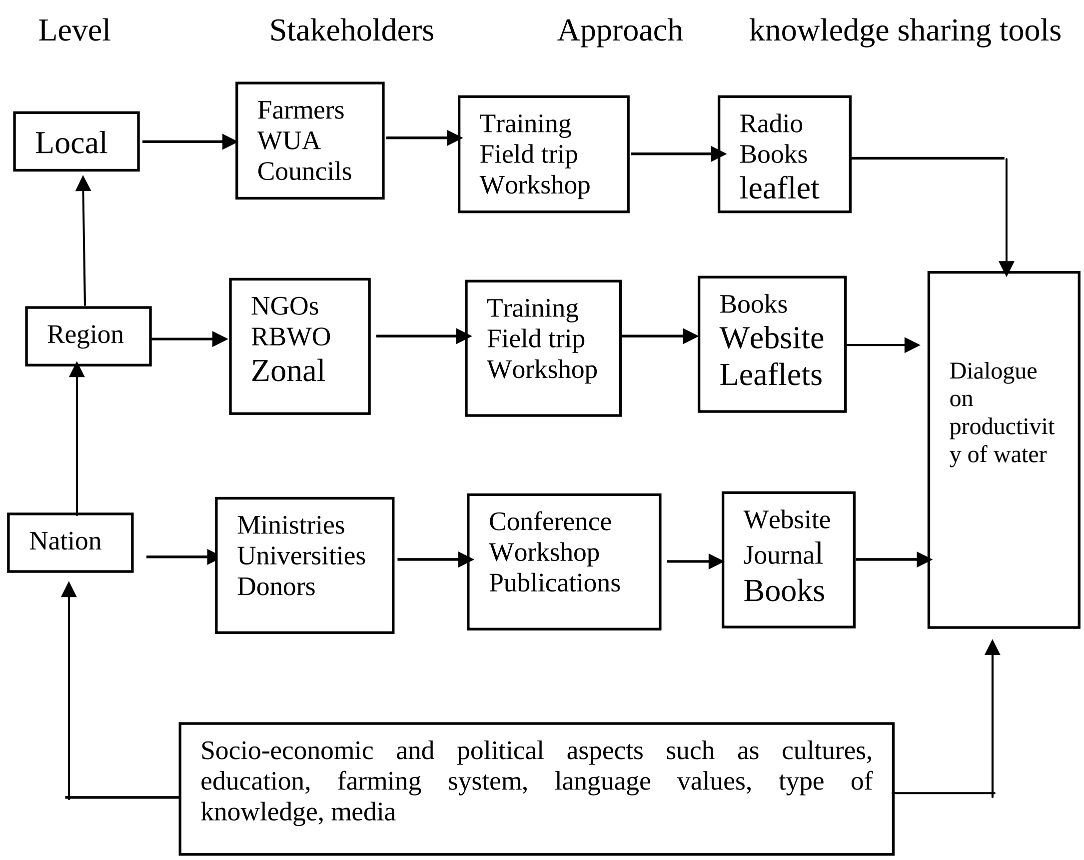

Figure 2: Conceptual Framework of the study

The framework considers the importance of knowledge sharing and communication among stakeholders. It shows the process of sharing or conveying information and knowledge from the local level to national level. Similar argument are also asserted by IRR (2000) and Gundel *et al.*, (2001) that effective communication means process of sharing or conveying information while scaling up aims to provide' more quality benefits to more people over a wider geographical area more quickly, more equitably and more lastingly.

In exchange of agricultural knowledge, a crucial issue is the mode of communication between farmers and scientists (van Dusseldrop, 1992). Farmers and scientists have fundamentally different cultural backgrounds and symbolic systems, different socio – economic positions, and different appreciation of risk. They have to exchange information that is difficult to fit in their respective worldviews and knowledge systems. A real dialogue is only possible when in the scientific knowledge system an intimate relationship has been developed between contributing disciplines (van Dusseldrop, 1992). Similarly, a sensible dialogue can only take place when effective knowledge network link farmers, allowing them to exchange experience and information.

3.3 Description of the study area

3.3.1 Location

The Mkoji sub-catchment is drained by the Mkoji River and is located in the southwest of Tanzania, between latitudes $7^{0}48'$ and $9^{0}25'$ South, and longitudes $33^{0}40'$ and $34^{0}09'$

East (Figure 1). It is a sub-catchment of the Rufiji River Basin and covers an area of about 3,400 km^2. Most of the sub-catchment lies within Mbarali and Mbeya Rural Districts, while smaller portions of the sub-catchment lie within the Makete and Chunya Districts in Iringa and Mbeya Regions, respectively. According to the 2002 population census, Mkoji sub-catchment had a population of about 146,000 people with an average annual growth rate of 2.4%. The highest population density is found along the Tanzania-Zambia Highway and in the Southern highlands. Scattered villages are located in the plains.

The study area receives a unimodal type of rainfall starting from early November and ends in June. The annual rainfall is about 1500 mm in the highlands and ranges from 600 – 800 mm in the lowlands (SMUWC, 2001). There are five major perennial rivers and several seasonal streams, all of which drain in to the central plain. Over time, these surface flows have been used for both domestic and agricultural purposes in this area. According to Lankford (2000), the use of ground water is not commonly used in this area.

3.4 Design and Sampling Procedures

The research involved a sub catchment level household survey and a Participatory Rural Appraisal (PRA) amongst the communities in the study area. A cross section research design was used in which data were collected at a single point in time without repetition from the target population using questionnaires and checklists. The design was used because it uses minimum time and resource (Bailey, 1978; Babbie, 1990).

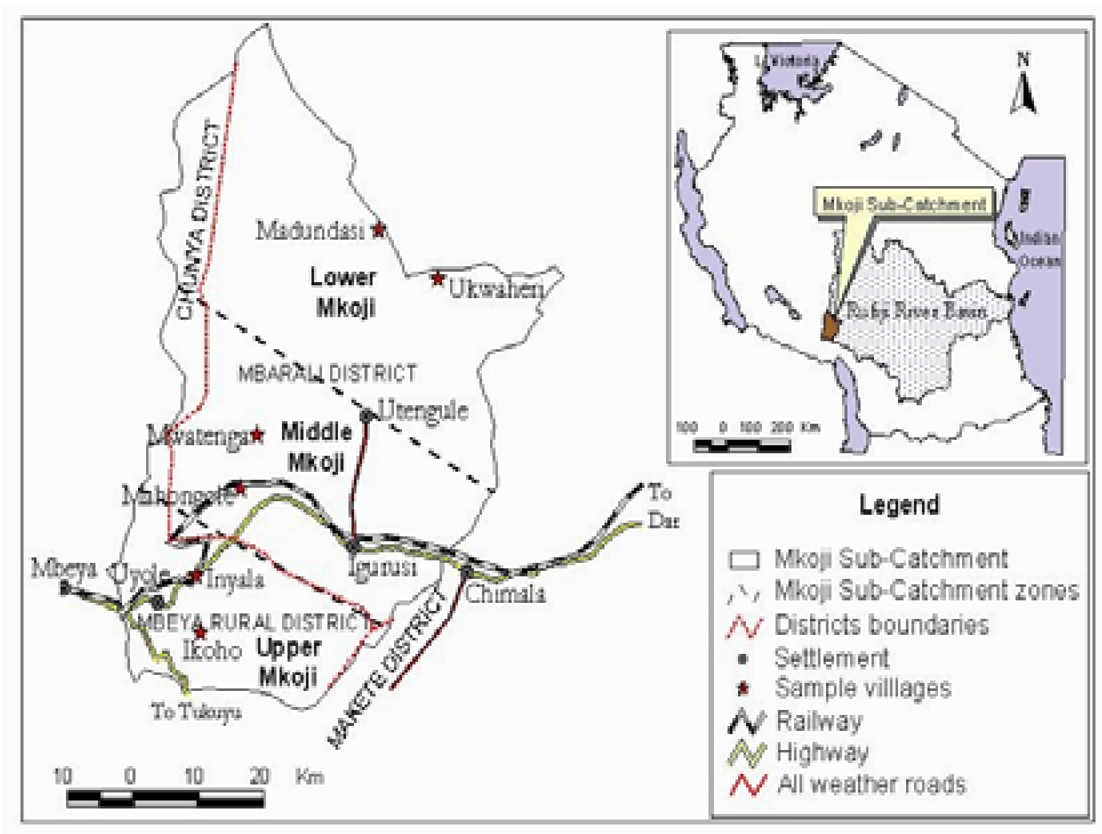

Figure 3: Location map of the Mkoji sub-catchment and studied villages

3.4.1 Selection of sub-catchments and villages

The GRRB is made up of eleven sub-catchments. Table 3 summarizes the description of irrigated area and river water use distribution among sub-catchments in the study area. Including all the ten sub-catchments in this study would clearly be the best option, but due to the practical reality much attention was given to the Mkoji sub-catchment. The villages included in this study were mainly selected from the Mkoji sub-catchment and only a few from Mbarali. The Mkoji sub-catchment alone had 70 intakes with a capacity of abstracting 12 cubic metres of water per second with 100% abstraction efficiency (SMUWC, 2001). Mbarali sub-catchment was sampled to provide a comparative picture on water use for improved and small-scale irrigation agriculture.

Table 3: Description of surface water flows in the study area

Sub-catchment	Max irrigable (ha)	Wet year (ha)	Dry Year (ha)	Dry season (ha)	Number of intakes in rivers	Total abstraction (cumecs)	Abstraction efficiency. (%)
Ndembera	7,623	4,502	3,165	449	6	4.30	65
Kyoga	14,646	5,461	3,075	164	11	7.00	100
Mbarali	8,403	9,367	3,634	240	3	8.50	100
Mlomboji	0	20	0	0	1	0.10	50
Kimani	3,666	2,269	849	46	5	4.00	95
Ruaha	5,432	4,525	1,964	28	1	5.00	85
Chimala	2,115	2,769	566	202	7	2.75	100
Mkoji	12,600	12,675	3,316	1,388	70	12.00	100
Mjenje	657	270	92	0	12	0.60	70
Kimbi	60	28	11	0	3	0.20	70
Total	55,202	41,883	16,670	2,517	119	44.5	835

Source: SMUWC, 2001.

3.4.2 Selection of villages

The Mkoji sub catchment is large (about 3400 Km^2) and can only be studied through random sampling of the villages and then the households within the villages. The sub-catchment was therefore purposefully divided into three zones – upper (27 villages), middle (19 villages), and lower (7 villages). Two villages were purposively selected from each zone, to capture the variability in livelihood and production systems among the water users in the catchment. The most important criteria used for selecting the villages were: (i) Sub-zonal representation within the major zone;(ii) Inclusion of a wide range of production systems (including irrigated and rain- fed crop production), and (iii) Availability of secondary data.

Table 4: Selected study villages

Name of village	1st criterion	2nd criterion	3rd Criterion
Ikhoho	Upper	Rain-fed (maize, potatoes and wheat)	RIPARWIN database and SHARDI reports
Inyala	Upper	Dry-season irrigation (maize, beans, potatoes, vegetables)	RIPARWIN database and SHARDI reports
Mahongole	Middle	Dry season irrigation (maize, beans, vegetables) and wet season irrigation (paddy)	SMUWC and RIPARWIN Databases
Mwatenga	Middle	Wet season irrigation (paddy)	RIPARWIN database
Ukwaheri	Lower	Rainfed (maize, sorghum/millet) and livestock	SMUWC and RIPARWIN Databases
Madundasi	Lower	Rainfed (maize, sorghum/millet) and livestock	SMUWC and RIPARWIN Databases

Source: SWMRG, 2001.

3.4.3 Household sampling

The sampled households were drawn from the registers of the study villages on the basis of vulnerability/poverty groups. For each village the sample included about ten percent of the total households as well as ten percent of each vulnerability/poverty groups. The selection was random within each category. The total sampled household was 248. Table 4 shows characteristics of the wealth categories that emerged from the exercise.

Table 5: Characteristics of wealth groups in the study area

Variables	Poor	Middle	Wealth
Total land irrigable (ha)	<0.4	0.3 –1.2	>1.2
Livestock owned	Cattle:0 Chicken 1-5	Cattle: 1-5 Shoats: variable Chicken: 8-24	Cattle: >8
Farm tools used	Hand hoe	Hand hoe	Hand hoe and ox-plough
Type of labour used	Family labor	Family and casual labour	Family labour, casual labor

Source: Survey data, 2003.

3.4.4 Selection of sample households in the sampled villages

A sample of 248 households was randomly drawn from the list of stratified households in each village included in the study. The total sample contained 109 households from the poor wealth group, 122 households from the middle group and 17 households from the well-off group. The distribution of households by wealth rank in the catchment is shown in the Table 5 below.

Table 6: Distribution of households by wealth rank

Location	Poor	Middle	Well-off	Total
Upper zone villages	38	42	6	86
Mid-zone villages	32	36	4	72
Lower zone villages	38	46	6	90
Total	108	124	16	248

Source: Survey data, 2003.

3.4.5 Respondents Characteristics

The study is based on a survey of multiple-stakeholders of water in the study area, including direct water users in agriculture namely farmers, water resources and agricultural experts, and water managers especially in irrigated systems. The survey of smallholder farmers covered 6 villages and 248 households selected randomly The experts' category was formed by agricultural village extension officers, MATI Igurusi tutors, Zonal irrigation officers, researchers from SHARDI Uyole, Rufiji basin water resources officers and local government leaders. Table 6 shows the farmer's distribution by geographical location.

Table 7: Farmers' distribution by geographical location (N = 248)

Location	Number	Percent
Upper	86	34.7
Middle	72	29.0
Lower	90	36.3
Total	248	100.0

Source: Survey data, 2003.

Other stakeholders included village agriculture extension officers, MATI Igurusi tutors, southern highland zonal irrigation officers, SHARDI Uyole researchers, Rufiji basin water officers and local government leaders who were considered as indirect water users. Table 7 below shows indirect water users distribution (stakeholders) most of whom were extension officers, trainers of extension officers, irrigation technician, researchers and water managers.

Table 8: Distribution of other stakeholders' and their institutions (N = 95)

Institution	Number	Percent
MATI Igurusi tutors	16	16.8
MATI Igurusi students	20	21.1
SHARDI Uyole	20	21.1
Zonal irrigation office	15	15.7
Agricultural village Extension officers	14	14.7
Water managers	10	10.6
Total	95	100

Source: Survey data, 2003.

3.4.5 Distribution of respondents by gender

The switch from thinking in terms of yields per unit of land to one per unit of water requires knowledge and skills, which may be acquired by both male and female water users. As such, gender is among variables that were given due consideration in the study. Gender approach in research is an aspect that is increasingly gaining attention in contemporary research studies especially social sciences. That is based on the assumption that both male and females genders, given their social roles, needs and history, are likely to perceive social phenomena differently. Table 8 below shows the distribution of respondents by gender in Mkoji sub catchment.

Table 9: Distribution of respondents by gender (N=343)

Category of Respondents	Male	Female	Total	Percentage		Total
				Male	Female	
Water users in MSC	212	36	248	85.5%	14.5%	100%
Other stakeholders	70	25	95	73.6%	26.4%	100%
TOTAL	282	61	343	82.2%	17.8%	100%

Source: Survey data, 2003.

Table 9 above shows that out of 343 total number of respondents from both water users and other stakeholders, sixty one (17.8%) were females and two hundreds and eighty two (82.2%) were males. Among the 248 respondents selected from water users in Mkoji sub catchment, thirty-six (14.5%) were females and two hundreds and twelve (85.5%) were males; while for respondents from other stakeholders twenty-five (26.4%) were females and seventy (73.6%) were males.

3.4.5 Data collection

For the three specific objectives, Participatory Rural appraisal, Focus group discussion and household survey were employed for data collection as follow:

3.4.5.1 Participatory Rural Appraisal

a) Focus Group discussion for farmers

The study employed qualitative approach through focus group discussions with key farmers. The sub catchment was divided into three zones namely upper, middle and lower. Preliminary visits were done to the six sampled villages. Ikhoho and Inyala in the upper zone; Mahongole and Mwatenga in the mid zone; and Ukwaheri and Madundasi in the lower zones. The purpose of the visits was to explain to the villagers and representatives the purpose of the study and to ask them join the focus group discussions. The criteria for the selection of the village representatives was to have equal representation of village clusters, water users, wealth categories based on their ages and gender. Representatives, who were also key informants, were selected on their being knowledgeable on issues of water management.

b) Focus group discussion for stakeholders

The study employed qualitative approach through focus group discussions with key informants and Districts Officials. Different FGD were held from MATI Igurusi tutors, SHARDI Uyole, water managers from RBWO office and irrigation managers.

3.4.5.2 Establishing validity and reliability

The first draft of the questionnaires was pre- testing at Mahongole village, one of the villages under the project. Ten farmers and two agriculture extension officers participated in the pre-test. After pre testing, the instruments were submitted to SUA experts, who read it and made necessary changes before producing the final draft of the questionnaires.

3.4.5.3 Data collection from sample households

Structured questionnaires were used in data collection for the sampled households, and the household survey that was conducted between November and December 2003.. The questionnaire (Appendix 1) included both open and closed end questions, and the intended respondents were household heads for the selected villages. But, for the purpose of clarity for some issues that required recalling from memory, the presence of other members of household were allowed to answer questions to clarify certain issues.

3.4.5.4 Secondary data

Secondary data used in this study included quantities of water, river flows, rainfall data and volumes of abstraction. Methods included reviewing reports of previous studies conducted in the study area. Major sources of secondary data were the Soil Water Management Research Group (SWRMG) offices in Morogoro and Igurusi Mbeya, Sokoine National Agricultural library (SNAL) SUA, Morogoro and Ministry of Water and Livestock Development (MWLD), the river basin offices (RBO) in Dar-es-salaam and Mbarali and Iringa. Further, the method was employed to get different description on how different stakeholders conceive and understand the concept of productivity of water in agriculture

3.5 Data analysis

3.5.1 Quantitative analysis

Data collected using questionnaires were first summarized and a database template containing the collected information was made using Statistical Package for Social Science (SPSS) computer software. Descriptive statistics such as frequencies, means and cross-tabulations were used to display data. Structural analysis was employed in the analysis of documented information and qualitative data collected during the PRA sessions.

3.5.2 Qualitative analysis

According to Kanbur (2001), there is a growing recognition that sensible combination of qualitative and quantitative methods can help solve problems that are associated with each type of method taken separately. Booth *et al.* (1998) urged that qualitative method in particular, are often more appropriate for capturing the social and institutional context of people's lives than the quantitative methods. In view of these considerations, the study employed the qualitative method and quantitative component to assess the stakeholders' understanding of PWA.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

This chapter presents the study findings as collected from respondents, key informants and focus group discussions from November to December 2003. The presentation of the findings is thematically organized into three sections. Section one, presents how different stakeholders understood the productivity of water in agriculture. Section two identified types and forms of knowledge sharing tools suitable for each type of a stakeholder and section three presents the evaluation of the knowledge sharing tools used in for communication and dialogue issues on productivity of water in agriculture.

4.1 Respondents' Understanding of PWA by Their Ages

Cross tabulation between respondent's age and perception of stakeholders on PWA was done. Table 10 below show that, out of 248 respondents, 69 (27.8%), 70 (28.2%), 76 (30.6%) were less than 20, between 21 and 40, between 41 and 60 and above 60 years old, respectively. The study found that 217(87.5%) respondents had no knowledge on PWA, implying that most smallholder farmers possibly had their own ways of describing the PWA. The other implication could be that there was lack of agriculture extension services in the study area to teach PWA. As such, the productivity of water in agriculture remained low because smallholder farmers lacked of improved techniques. However, there was no significant difference between means of the groups ($P<0.05$).

Table 10: Relationship of respondents' age by perception of PWA%(N = 248)

	Understanding of PWA				
Age of respondent	Yes	No	Total	Chi value	P value
< 20	10(4.0)	59(23.8)	69(27.8)	1.513	0.679
21 – 40	6(2.4)	64(25.8)	70(28.2)		
41 – 60	11(4.4)	65(26.2)	76(30.6)		
> 60	4(1.6)	29(11.7)	33(13.3)		
Total	31(12.5)	217(87.5)	248(100.0)		

Source: Survey data, 2003 Figures in parentheses are percentages and those out of parentheses are frequencies, Not Significant at (P< 0.05).

Focus group discussions were held for the selected village. Box 1 abstract views of the water users in Mwatenga village (mid- zone of Mkoji sub catchment) during the FGD session on how they understood the productivity of water in agriculture.

Box 1: Mwatenga village focus group discussion views on perception of PWA

The concept of PWA is new, most participants said. I remember to have learnt PWA in the farmers' training seminar that PWA is the crop profit obtained out of water use, one participant commented. This farmers' seminar was conducted by Ministry of Agriculture and Food security for all irrigation schemes including Ipatagwa irrigation scheme, he added. That meant the volume water supplied is considered when measuring the crop harvested. In the village, farmers normally ask themselves whether there is progress forward or backward. The Sangu ethnic participants said *'Mwagka ughu matile deni'* or *'ikienye ikhi ngavile fijo'* (there was few harvests this season). Productivity of water is explained by referring to good rainfall year, participants' common description. Description by the Sangu *ethinic participants, "mwaka gwanu mwaka mnofu a malenga enonya ninji"* meaning that year there was good rainfall and plenty water.

4.1.1 Education of respondent's by their description of PWA

The results in Table 11 shows the responses on education level by smallholder farmers understanding of productivity of water in agriculture in percentage. Out of the 248 respondents, 242 (97.6%) gave their responses, and 212(87.6%) indicated that did not understand the concept of PWA. Of the 212 respondents, 72 (29.8%), 32 (13.2%), 128 (52.9%), 5 (2.1%), 4 (1.7%), 1(0.4%) indicated that had non formal education, standard four, standard seven, standard eight, form four, and higher education level, respectively. There was no significance difference between group of means of education level and perception (P<0.05). However, the study found that those with for standard seven level of education were in the majority who did not understand PWA.

Table 11: Education level by smallholders farmers understanding of PWA%(n= 242)

	Knowledge on Water productivity in agriculture				
Education of respondents	Yes	No	Total	Chi value	P value
No formal education	6(2.5)	66(27.3)	72(29.8)	5.422	0.367
Standard four	4(1.7)	28(11.6)	32(13.2)		
Standard seven	17(7.0)	111(45.9)	128(52.9)		
Standard eight	2(0.8)	3(1.2)	5(2.1)		
Form four	1(0.4)	3(1.2)	4(1.7)		
Higher education	0(0.0)	1(0.4)	1(0.4)		
Total	30(12.4)	212(87.6)	242(100.0)		

Source: Survey data, 2003 Figures in parentheses are percentages and those out of parentheses are frequencies, Not Significant at (P< 0.05).

The reason for low knowledge on PWA might be twofold. First, those who were aware of PWA had attended farmers training courses conducted by the Ministry of Agriculture and Food Security, and smallholders had the courses. This further implied that few respondents were aware about the scientific knowledge theory and practices of PWA. Second, there was lack of agriculture extension officers in the study areas. Furthermore, the study found that respondents showed willingness to learn about PWA from the experts and wanted the government to employ more village agriculture extension officers to advise them. Figure 4 shows the study results and that there was little understanding of PWA for respondents having above standard seven level of education.

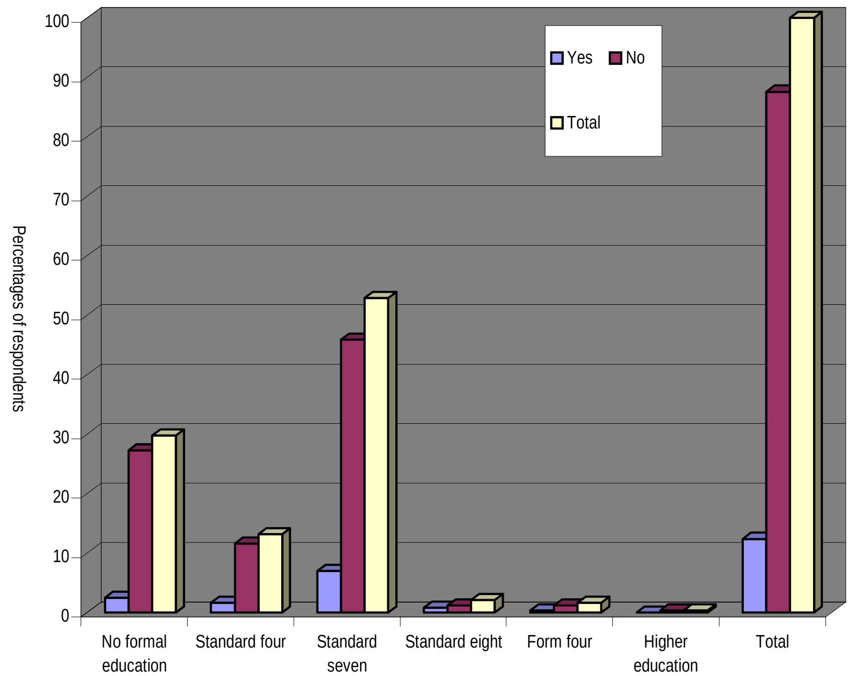

Figure 5: Percentages of respondents by educational level

This was because of the fact that most of the respondents had standard seven education level and most might had attended farmers training courses to learn about PWA. Box 2 abstract views of the water users in Mahongole village (mid- zone of Mkoji sub catchment) during the FGD session on how meant to them

FGD participants said that in the past there was no need for considering productivity of water because there was sufficient rainfall and soils were fertile. They said that water use for agriculture differed by spatial and temporal, and the crop stages some villages could harvest much and others not and there are good years and bad years in terms of crop harvests. Participants also said that because there was enough water some farmers allowed water to flow to their neighboring crop fields, which lowered filed temperatures and lowered paddy yield.

Box 2: Mahongole villagers' views about perception of the knowledge of PWA

The concept of PWA is new, participants said. We have heard from you for the first time. It is related to application of less water for more paddy yield, one participant said. But, with paddy farming flooding the filed is inevitable to control weed, soils have been exhausted one need to put more water to suppress weeds. Because of weeds, we are compelled to allow water for some days in the paddy basin. This increases the amounts of water used in paddy production and hence reducing productivity of water in agriculture, narrated by Mr Mwamabalaswa in Mahongole village

Most of farmer's fields in the village are not well leveled and not square as those from Kapunga rice farm. It is difficult to measure the volume of water used in this cascading pattern of field whereby the paddy field for individual smallholder farmers are linked with small water canals. It is difficult to measure the volume of water used for paddy harvest. The PWA concept is good but the government should construct water reservoir and bring agriculture extension officer to advise smallholder farmers, the chairman for Mahongole village commented, Mr Juma Mwakanyamale.

Another focus group discussion was conducted at Ipatagwa irrigation scheme. Three hundreds and thirty (330) members formed the association in 1997. Female members are ninety-one (91) whereas male members are two hundreds and twenty nine (229) todate. According to the chairman, the reasons for formation were construction of modern intakes instead of dindilo (traditional intake), rectification of irrigation canals and direct into the field, farmers joined so that can obtain government assistance, facilitation of getting water and to get loans. Regarding the perception of PWA, some members had idea following farmers training conducted by the Ministry of Agriculture and Food security last year. In dry season, members of the association practice bottom valley farming. Watering maize plants in a plot during dry season was done using a bucket of twenty litres, thirty (30) buckets of water per day per plot for 30 days. The crop harvest for maize would be one bag of 100 kgs per plot. Box 3 shows the abstracts of the Ipatagwa irrigators associations FGD participants' views describing their understanding of PWA.

Box 3: Ipatagwa irrigators' association views about perception of the knowledge of PWA

This concept of PWA is not new for members of Ipatagwa irrigators association. Productivity of water in agriculture is understood as the crop yield obtained after proper use of water. In this irrigators association proper use of water is critical in crop production. It is important for proper use of water, poverty alleviation and food security. However, farmers do not measure the volume of water used for crop production. Narrated by the chairman of Ipatagwa irrigation association, Mr Issa Kyando

4.1.2 Respondents gender by their understanding of PWA

Cross tabulation was done between gender and their understanding of PWA. The study results in Table 12 show that out of the 248 respondents, 217 (87.5%) indicated that they did not understand PWA. Of the 31 (12.5%) respondents who indicated that they understood PWA, 28 (11.3%) and 3 (1.2%) were males and females respectively. Furthermore, out of the 217 (87.5%) who did not understand PWA, 184 (74.2%) and 33 (13.3%) were males and females respectively. There was no significance difference between means of the groups ($p < 0.05$) while the statistical value was very low implying that no relationship existed between gender and their understanding of PWA.

Table 12: Gender of respondents by understanding of PWA in %(N= 248)

Gender	Knowledge on Water productivity in agriculture				
	Yes	No	Total	Chi square	P value
Male	28(11.3)	184(74.2)	212(85.5)	0.587	0.306
Female	3(1.2)	33(13.3)	36(14.5)		
Total	31(12.5)	217(87.5))	248(100.0)(		

Source: Survey data, 2003. Figures in parentheses are percentages and those out of parentheses are frequencies, Not Significant at ($P < 0.05$).

The study found that very few females 3 (1.2%) understood the PWA. The implication was most females were not aware of the concept of PWA, which might have been due to lack of agriculture extension officers to teach them. Though it was possible that most females measured the crop harvested but not measured the volume of water used to produce it. It also implied that probably females' respondents did not access some of the interventions sent in the villages. However, respondents and other informants agreed that they had indigenous knowledge related to PWA. Box.4 shows the abstract of the key informants' interviews in Ukwaheri village in the lower Mkoji sub catchment, which shows that they used indigenous knowledge to improve the productivity of water during the water scarcity periods. Adoption of minimum tillage, early planting, mixed cropping and planting drought resistant crops indicated awareness to concept of PWA

Box 4: Ukwaheri villager's views on perception of PWA

In dry season there is no flow of water in river Mkoji, but in the past water could flow through out the year, explained by Mzee Edson Komidhimbile. This is due to many abstractions in the upper and middle sub catchment that is why dry season agriculture is not possible in the lower zone, he added. The concept of PWA is new in the village, but the soils in the lower zone are fertile because we have been harvesting 10 to 15 bags of maize per acre without fertilizer, narrated by Mrs. Bertha Edison. Due to unreliable rainfall, we have some coping strategy like planting mixed crop (sorghum, groundnuts and green gram). Also planting of drought resistant crops like sorghum and cassava, further in this area we have been practicing flat cultivation in order to increase crop yield. We are still growing local crop varieties because is high yielding, early maturing varieties and drought resistant, explained by Willium Mgwadila the village executive officer for Ukwaheri village. Recently, the Sukuma ethnic people have introduced new technology of planting leguminous plant known as chicken peas 'dengu' immediately after paddy harvest to exploit the available moisture content, the village executive officer added. Apart from food, the crop produce is sold at high price (Tshs13, 000/= per 20 kg) during the dry season, other ethnic groups have started adapting it, narrated by Mr. Japhet Shilunga in Ukwaheri village.

4.1.3 Understanding of PWA by other stakeholders

Different FGD sessions were held to capture the understanding of other stakeholders of PWA, and these include included MATI Igurusi tutors, village agriculture extension officers, water managers from RBWO, and local village government leaders. Sixteen agricultural tutors from MATI Igurusi were involved in the FGD session. The institute trained irrigation technicians and smallholder farmers in good water management. Out of the 16 tutors, 4 (25%) indicated that they understood the concept of productivity of water in agriculture and 12 (75%) said that it was new knowledge to them. MATI tutors described PWA as the amount of crop harvest per volume of water used, but indicated that it was difficult to quantify the volume of water used in the crop production, especially in the rain-fed agriculture. Furthermore, there was lack of technical know how and equipment's for measuring the volume of water used for crop production. Tutors mentioned that the concept of productivity of water in agriculture was new to them and was not included in the syllabi for both irrigation and land use planning diploma courses at the institute.

Furthermore, some tutors from MATI Igurusi related the concept of productivity of water with irrigation efficiency, which was described as the ratio of amount of water required for an intended purpose, divided by the total amount of water diverted. Such description was similar to that given by Wolters and Bos (1989) and Jensen (1980). Other defined PWA as the amount of crop harvested per unit volume of water used. FGD participants agreed that definition of PWA, a similar description given by Viets (1962), Tabbal *et al* (1992), Molden (1997) that productivity of water in agriculture was the amount of food produced per unit volume of water used. This implied that water used in crop production had various components (evaporation, transpiration, gross inflow, and net inflow) hence it was important to specify which component was included when calculating productivity of water (Tuong and Bhiyan, 1997, Molden, 1997). Hence, water efficiency and productivity concepts should be used in conjunction to assess water management strategies and practices to produce more food with less water.

Mkoji sub catchment had few agriculture village extension officers. Out of the six sampled villages, only two villages had agriculture village extension officers, which included Inyala and Mahongole from upper and middle zones, respectively. Of the two VEO's none of them had understood the productivity of water in agriculture. Box 5 shows the abstracts of the VEOs views describing their understanding of PWA.

Box 5: Inyala village extension officer views on perception of PWA

This concept of PWA is new in the village, Mr. Patrick Mwangobe said. We are not measuring the volume of water used from crop production, but traditionally the cultivated area is measured and every one can tell how much is harvested per acre. Crop harvest per unit land have been improved because new agronomical practices had been adopted by farmers, these include early planting, use of improved seeds, application of fertilizer, timely weeding, proper spacing, use of insecticide and fungicide, and adoption of dry season farming. These practices were adopted from agriculture extension officers, narrated by Mr. Mbwega Kanjanja in Inyala village.

Participants from Southern highland agriculture research development institute (SHARDI) Uyole described productivity of water in agriculture as the ratio of total crop harvested to the volume of water used. Other SHARDI Uyole participants in the FGD said that productivity of water in agriculture could be increase yield per unit land, by using better varieties or agronomic practices, or by growing crops during the most suitable periods. The implication of such explanation was that productivity of water could be determined by factors other than water management. This implied that productivity of water alone would not be particularly useful in identifying saving opportunities of the system under consideration. Basically, researchers conceptualize the knowledge productivity of water in agriculture as all benefits obtained per water depleted to produce them. The benefits include biomass and are classified as food grain, fodder and crop residues. The purpose is to meet household food security and sustainable maintenance of soil fertility. Further, participants said researchers have attitudes that assessment of productivity of water entails estimation of the two main components of productivity of water: the physical mass of production or the economic value of produce and the unit volume of water used. Researchers acknowledge the multiple use of water in irrigated water system, but most of these uses are not accounted for in many irrigated water systems even though the users claim a large amount of water. The simple reason being that some of these uses are not easy to quantify. Box 6 shows the abstracts of the researchers views describing their understanding of PWA.

Box 6: Researchers views on perception of PWA

Productivity of water in agriculture is the ratio of crop benefit to the volume of water used, one participant explained. Researchers record irrigation flow diverted for crop production, weather data, evaporation pan data, soil hydrologic properties and crop water requirement to determine the denominator of productivity of water. Direct measurement of water used/depletion from irrigated field and productivity of water can be done on the field by quantifying water accounting components such as transpiration or evapotranspiration, runoff and drainage from the crop field, narrated by a participant in focus group discussion at SHARDI Uyole.

River basin water office (RBWO) was responsible for water management, granting water rights, and allocation and collection of water user fees and co-ordination of stakeholders towards better water management. The RBWO has established a sub office in the Mbarali district, which among other things, monitors river water levels, collects water use fees, and arbitrate conflicts that arise from water uses. With regard to their understanding of productivity of water in agriculture few of the RBWO officers understood it. The areas and amounts of water under different agricultural domains in Mkoji sub catchment were provided. Figures 5 and 6 shows the area under different agricultural domains and the corresponding amount of water used for each production domain in Mkoji sub catchment. The area under rainfed production was lager in lower Mkoji sub catchment followed by middle and upper Mkoji sub catchment, respectively.

The volume of water consumed by crops was also comparably higher in the lower part of the sub-catchment. The area under dry season irrigation was higher in the upper Mkoji sub catchment than in the middle Mkoji sub catchment (FNPP, 2003). For example, paddy is cultivated under irrigation supplemented with rainfall in the middle Mkoji sub catchment. Crop water use for the middle part of the sub-catchment was 14.55Mm^3 while for the lower part were 20.52Mm^3 and the total water use for Mkoji sub catchment was estimated at 35.52Mm^3 (FNPP, 2003). The total area for paddy rice production in mid zone was 2194 ha and for lower zone was 3072 ha (FNPP, 2003).

Both formal and informal institutions in the Mkoji sub catchment regulate water use. Informal arrangements were negotiations and agreements on whom should get water, when, how. Water users themselves without influence from outside regulate water use, which was based on cultural and traditional values. For example, in the upper zone, people trust their chiefs- called *mwene*. In the past, *mwene were* used to oversee conservation of water sources by banning tree cutting and perform rituals to rainfall and extended drought periods. A Mwene was also a chairperson for the environment sub committee of village government.

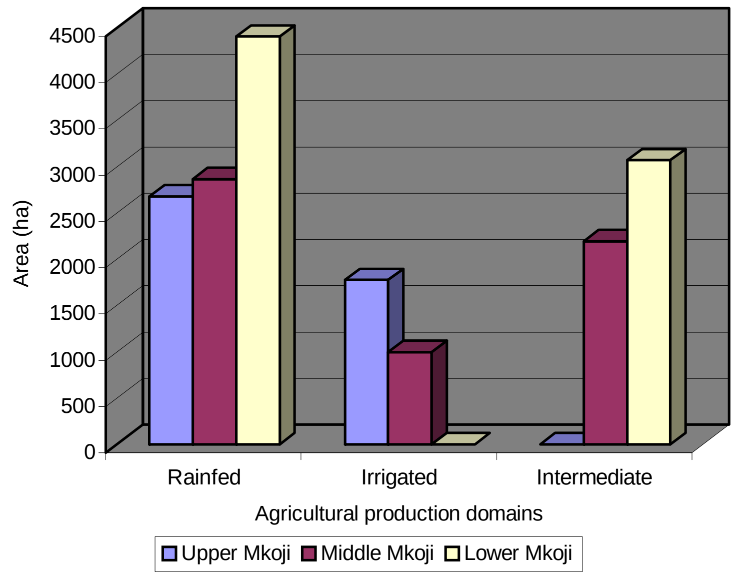

Figure 6: Area under different agricultural domains in Mkoji sub catchment

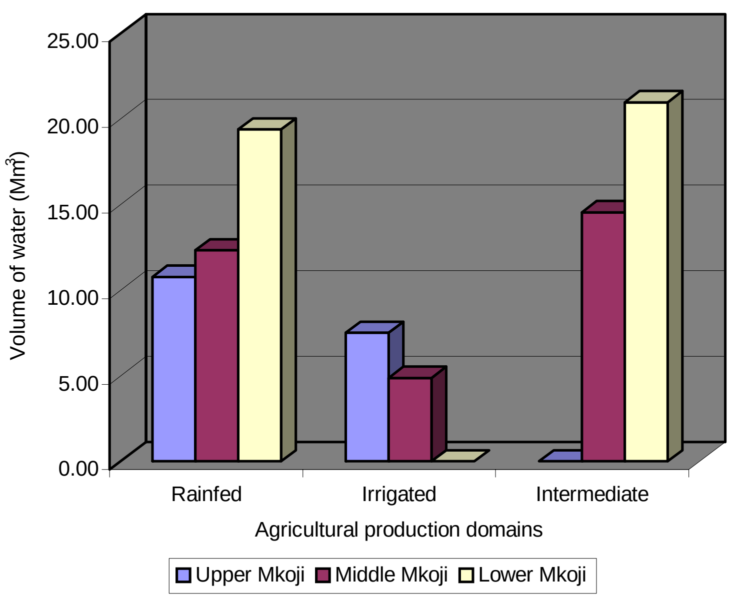

Figure 7: Crop water use under different agricultural domains in Mkoji sub catchment

The implication of this was that people might have some knowledge on the productivity of water but not able to quantify the volume used. Both formal and informal institutions in the Mkoji sub catchment were reported to regulate water use from the catchment to farm level. These institutions negotiated and agreed on who should get water, at what time, and how.

The study also found that village water committees and irrigation committees carried out the formal arrangements. The village water committees were responsible for domestic water use while the irrigation committees supervised water use oversees irrigation water. In places where there were improved irrigation schemes like in the Ipatagwa, Motombaya, Luanda majenje and Majengo the irrigation committees were more active and responsible for allocation and management of irrigation water use. The irrigation committees were referred to as Water User Associations (WUAs) although they do not operate as WUAs. Most existing irrigation schemes were in the process of forming WUAs. The water policy of 2002 recognizes WUAs as the lowest level of water management organization and promotes their formation (MWALD, 2002). The basin water offices were expected to coordinate the process of the WUAs formation in collaboration with local water users and stakeholders. This meant that there were possibilities of measuring the volume of water, which would improve the productivity of water in agriculture.

4.2 Stakeholders Knowledge Sharing Tools Suitable for Each Type of Stakeholders

Sharing knowledge is a social activity and so social implications of knowledge sharing systems need to be considered and used to help design processes and tools that are actually useful. in a complete knowledge sharing system tools to support finding the right person or group of people are required. Once "connected" people need to be able to share what they know. The information space in which knowledge is shared needs to be effective in supporting the knowledge sharing tasks. Relevant information (documents, data, etc) should be readily available and delivered in an form appropriate to the participant. Other tools to support the participant's understanding of the relationships between all participants may help. Understanding the dynamics of those relationships between participants and the knowledge or information they are sharing increases awareness and understanding. Communication practices and processes need to be designed to encourage the sharing of knowledge whether through synchronous or asynchronous communication (http: // radio.weblogs.com).

Evaluations of knowledge sharing systems in real environments are invaluable in determining what is useful, what works and what does not. Such evaluations help technologists determine what to improve. We solicit contributions and participants to examine the use of web-based technologies for sharing information and supporting people interaction with relevant information directly or indirectly through people contact and social networks. This can include new algorithms and tools, as well as their evaluation in a real environment.

4.2.1 Suitable Knowledge Sharing Tools for Smallholder Farmers

A questionnaire survey was conducted in Mkoji sub catchment to identify types and forms of the knowledge sharing tools suitable for each stakeholder for improving PWA. Focus group discussion sessions were held with other stakeholders to identify the suitable knowledge sharing tools. Furthermore, key informant interviews were conducted to capture the same information. The subsequent section discusses the results of the study findings.

Table 13: Knowledge sharing tools by respondents' village in % (N = 245)

Knowledge sharing tools	Location of the village on the toposequence				Chi square	P value
	Upper	Middle	Lower	Total		
Flip chart	35(14.1)	49(1.6)	43(17.3)	82(33.1)	174.368	0.000
Blackboard	3(1.2)	1(0.4)	15(6.0)	19(7.7)		
Demonstration plot	21(8.5)	5(2.0)	7(2.8)	33(13.3)		
Pamphlets	3(1.2)	61(24.6)	11(4.4)	75(30.2)		
Flip charts and demo plots	22(8.9)	0(0.0)	15(6.0)	37(14.9)		
Posters	2(0.8)	0(0.0)	0(0.0)	2(0.8)		
Total	86(34.7)	71(28.6)	91(36.70	248(100.0)		

Source: Survey data, 2003. Figures in parentheses are percentages and those out of parentheses are frequencies, Not Significant at (P< 0.001).

Table 13 above shows the relationship between the most used knowledge sharing tools and geographical location of respondents. Results show that there was a significance difference (P< 0.001) between the means of the group between the most used knowledge sharing tools and the geographical location of respondents. That meant there was strong relationship between the most used knowledge sharing tools and the geographical location of the respondents. The findings showed that the most used knowledge-sharing tool was flip chart 82 (33.1%) followed by pamphlets 75 (30.2%), and demonstration plots 33(13.3 %). The implication of the findings was that facilitators used much theory methods rather that practical method, which meant participants might not have understood the intended intervention. Furthermore, probably there was lack of appropriate communication skills by extension officers.

Table 14 shows the relationship between location of respondents and the best knowledge-sharing tool for farmers training. The study found that 56.3% of respondents chose demonstration method as the best method for farmers training. The second most suitable method farm visits ((18.8%) followed by radio (12.5%). The data shows that there were significance differences between the best knowledge-sharing tool and the location of the village of the respondents (P<0.01). This implied that there was relationship between location of the village of respondents and the best knowledge sharing tools for training farmers the knowledge of productivity of water.

Table 14: Relationship between location of respondents and best knowledge sharing tool when training farmers (N =16)

Knowledge sharing tool	Location of the respondents			Total	Chi value	P value
	Upper	Middle	Lower			
Farm visits	6.3	12.5	0.0	18.8	20.571	0.008
Booklets	0.0	0.0	6.3	6.3		
Demonstration	37.5	18.8	0.0	56.3		
Pamphlets	0.0	6.3	0.0	6.3		
Radio	0.0	12.5	0.0	12.5		
Total	43.8	50.0	6.3	100.0		

Source: Survey data, 200 Figures in parentheses are percentages and those out of parentheses are frequencies, Significant at (P< 0.01).

Similar results were obtained from focus group discussion sessions. Pair wise ranking for the knowledge sharing tools was conducted during focus group discussion sessions. The result in Table 15 shows the best knowledge-sharing tool for farmers training in Mahongole village mid Mkoji sub catchment. High score was recorded for demonstration methods (53.4%). That meant smallholder farmers possibly wanted to learn by doing rather than hearing and observation. Other village results for pair wise ranking had similar results. However, other participants requested books for further references in the absence of the facilitator.

Table 15: Pair wise ranking scores for best knowledge sharing tool by FGD participants at Mahongole village (N=15)

Method	Vote	Percentage	Remarks
Demonstration	8	53.4	Best bet method
Field visit	3	20.0	
Booklets	2	13.3	
Posters	0	0.0	
Pamphlets	2	13.3	
Total	15	100.0	

Source: Field survey, 2003.

Participants in the focus group discussions described knowledge sharing tools as the exchange of ideas between individual farmers or between group of people with scientist. Traditionally, farmers have their own ways of exchanging information as it was explained in Sangu ethinic '*tipelana mawazo uluhala numiayangu*' meaning that exchange of thinking from a friend.

For example, changing from cultivating one crop to another for improvement of crop yield was believed to preserve soil fertility and water. These findings implied that probably smallholder farmers had a wealth of knowledge that needed to be integrated by the scientific knowledge to improve productivity of water in agriculture. But, suitable knowledge sharing tools were needed to communicate this knowledge.

4.4.2 Knowledge sharing tools for communication and dialogue issues by other stakeholders

The in-depth interviews with trainers, researchers, extension workers and water managers from Mbarali and Mbeya rural Districts indicated that agricultural shows, campaigns, study tours, video cassettes, method and results demonstrations were useful when imparting knowledge to farmers. These group methods together with adequate and motivated agriculture village extension officers could increase the awareness on the knowledge of the productivity of water in agriculture. Stakeholders further insisted that experts should use combinations of methods and most agreed that demonstration plots were the suitable knowledge-sharing tools than others.

Furthermore, since productivity of water in agriculture a new idea, stakeholders said that reference books, leaflets, newsletters, scientific journals, and web based knowledge-sharing tools be available. However, it was difficult to secure reference books and in most cases their prices were not affordable. The cost and availability of the knowledge sharing tools was another limiting factor to using some tools. Most stakeholders showed interest on the web - based knowledge sharing tool, as it was accessible to most of them, cheaper with current information and the language was well understood.

MATI Igurusi tutors explained expressed their concern about lack of knowledge sharing among stakeholders. There was problem of lack appropriate knowledge sharing tools. The institute has obsolete books, teaching aids and equipment's, that are necessary for knowledge sharing. Further, participants said that lack of knowledge for using knowledge sharing tools like web sites. In the institute only two tutors were able to access the Internet services because of lack of knowledge. This observation is valid because in today's world of rapid and rapid change, the fast pace of knowledge development and increased availability of information has fundamental implications for education. In the past, the knowledge a professional acquired through formal training could last a lifetime. Now, getting a degree has to be just the beginning of a professional's learning career. As Rolling (1997) noted, people who had academic qualifications were something very special, elite, and above all, experts, who could solve problems for the rest of us. Alas those good old days are definitely gone. Professionals can no longer operate on the basis of acquired status. The knowledge they have gained soon becomes obsolete.

At Mbarali district participants said in a focus group discussion said that, SMWUC project developed a communications programme whereby stakeholders are involved in planning for Usangu's future, they need to have a shared understanding of the issues. They also need opportunities to discuss and debate these issues together. To support these, SMUWC project developed a targeted communication programme. They used a variety of approaches from the written word, to video, theatre, displays, workshops and talks. This approach had introduced a kind of knowledge sharing in the district. SMUWC has developed the following materials to build people's knowledge of the issues in Usangu: talking about Usangu, bilingual booklet and video: basic information on issues in Usangu, in a non-technical and visual way. The booklet contains a reply card for people to send back their views on Usangu. Talking about Usangu leaflet, a quick introduction to Usangu and its issues, and invites people to ask for more information; understanding Usangu. A series of fact sheets that explain in more depth some of the issues introduced in 'Talking about Usangu', again in a non-technical and visual way; Quarterly newsletters, which help keep people up to date on what is happening in Usangu. Recognizing the diversity of readership, separate newsletters have been prepared for communities (in Swahili) and for higher-level stakeholders (in English).

Experience documents, these discuss experiences in community-led planning by district staff and local people, at the district and sub-catchment level. SMUWC has used video to share information and ideas between different levels and groups of stakeholder. Presentation sat at all levels, SMUWC has given presentations and shown the video 'Talking about Usangu'. Travelling display: SMUWC has developed an 8-poster travelling display, which presents key information on Usangu. This was taken around ministries, regional bodies, and other interested organisations Technical reports were prepared for all the special studies that were carried out. The project had Website to reach a wider audience, all SMUWC publications were posted on Usangu's website, www.usangu.org. Meetings and workshops were held throughout SMUWC's life for government staff, local resource users, District and Regional staff, politicians, other projects, donors, and other interest groups. Through these stakeholders exchanged information and ideas, participants said.

The Rufiji Basin Water Board (RBWB) was established in 1993/4. It meets at least twice per year as mandated under the legislation, the main business of the meetings being to advise on the various activities of the Rufiji Basin Water Office (RBWO). The RBWO is authorized to grant water rights. The RBWO has established a sub office in the Mbarali district, which among other things, effects monitoring of river water levels, collection of water use fees and arbitrating in conflicts that arise from water uses.

4.5 Best Knowledge Sharing Tools for Communication and Dialogue on PWA.

Respondents and other stakeholders were interviewed on their best-bet knowledge sharing tools. Each respondent had different views regarding which should be the best tool for communication and dialogue for improving productivity of water in agriculture.

4.5.1 Best knowledge sharing tools by farmers

Farmers were asked to evaluate the existing knowledge sharing tools currently used in Mkoji sub catchment. Table 17 below show that, out of the 220 respondents, 85 (38.6 %), 9 (4.1%), 8 (3.6%), 65 (29.5%), 12 ((5.5%), 36 (16.4%), 2 (0.9%), 3 (1.4%) indicated radio, television, leaflets, reference books, cinema, video cassettes, news papers and poster as the best s knowledge sharing tools, respectively. There was significance difference between group means ($p < 0.01$) and high statistical value meaning that there was a strong relationship between a location of village and the best knowledge sharing tool when training farmers on PWA training. About one third of the respondents 85 (38.6%) showed that radio was the best knowledge sharing tool because farmers afford it. Newspapers and posters had, 0.9% and 1.4% least scores. The implication of the study findings was that because most respondents could not be reached by agriculture extension officers' radio was the best method. In addition, the radio as mass communication method reach many farmers within a short time compared to other knowledge sharing tools. But some participants in the focus group discussion objected relying on the radio programme because of the inappropriateness of the broadcasting time.

Story telling as a communication tool was mentioned as the most common knowledge-sharing tool in the six villages. Participants form each focus group discussion said that it was a most effective communication tool and most used by farmers. The finding which are similar to Ashley (2003), when used effectively, storytelling offers numerous advantages over more traditional organisational communication techniques:

Hence productivity of water in agriculture might be communicated using story telling among farmers.

Table 17: Location of respondents by the best tools for training on PWA (N = 220)

Best knowledge sharing tool for training PWA	Upper	Middle	Lower	Total	Chi square	P value
Radio	18(8.2)	23(10.5)	44(20.0)	85(38.6)	38.775	0.000
Television	7(3.2)	1 (0.5)	1(0.5)	9(4.1)		
Leaflets	5(2.3)	2(0.9)	1(0.5)	8(3.6)		
Books	19(8.6)	25(11.4)	21(9.5)	65(29.5)		
Cinema	5(2.3)	5(2.3)	2(0.9)	12(5.5)		
Videos	7(3.2	11(5.0	18(8.2	36(16.4		
Newspaper	2(0.9)	0(0.0)	0(0.0)	2(0.9)		
Posters	3(1.4)	0(0.0)	0(0.0)	3(1.4)		
Total	66(30.0)	67(30.5)	87(39.5)	220(100)		

Source: Survey data, 2003. Figures in parentheses are percentages and those out of parentheses are frequencies, Significant at (P< 0.001).

In Tanzania, mass media campaigns have been used in farmer training (Institute of Adult Education, 1973; Kauzeni; 1979). Some of the campaigns are designed to reach more farmers who are in remote areas, and are geared not only towards information but also toward changes in individual and community behaviour (Kauzeni, 1979). The radio could have a good impact, but here again, apart from problems of coverage, the programme producers have to make sure that timing is suitable for the people meant to be informed and influenced.

Furthermore, respondents were asked to give reasons for their chose of best knowledge sharing tools. Table 18 shows the relationship between location of respondents and the reasons for their choice. Out of the 212 respondents, 46(21.7%), 42(19.8%) and 36(17%) indicated that they choose the knowledge sharing tools because they were easily available, everybody could see and understand.

Table18: Respondents village by the reason for the choice of the best knowledge sharing tool % (n= 212)

Reasons for the choice	Upper	Middle	Lower	Total	Chi square	P value
Knowledge is permanently kept	2(0.9)	1(0.5)	17(8.0)	20(9.4)	47.907	0.000
Can be revised later	12(5.7)	7(3.3)	5(2.4)	24(11.3)		
Teaching like a teacher	5(2.4)	0(0.0)	11(5.2)	16(7.5)		
Everyone can see and understand	8(3.8)	14(6.6)	14(6.6)	36(17.0)		
Easily available	16(7.5)	21(9.9)	9(4.2)	46(21.7)		
Can explain briefly and understand	3(1.4)	8(3.8)	4(1.9)	15(7.1)		
Cheap price and everyone can own	5(2.4)	4(1.9)	4(1.9)	13(6.1)		
Total	59(27.8)	67(31.6)	86(40.6)	212(100)		

Source of data: Field Survey, 2003. . Figures in parentheses are percentages and those out of parentheses are frequencies, Significant at (P< 0.001).

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There was significance difference between means of the groups between location of respondents and reasons of the choice for the knowledge sharing tools. The findings meant strong relationships between the two variables. The study found that radio was the best – bet (21.7%) knowledge sharing tools because it was available, everybody could listen and understood the messages broadcast easily. In addition, the radio was cheaper, and most farmers could buy and own them. Farmers' willingness to learn innovations through the radio compared to other tools might have been due to lack of extension officers in the villages. During the focus group discussions participants agreed that it was possible to learn new ideas through radio programmes. For example, they said that HIV programmes were broadcast through the radio and many people understood the messages.

Focus group discussion sessions mentioned that formal knowledge sharing tools used for training farmers in the villages or at the agricultural institute included demonstration, field visits, meetings, seminar, study tours, farmer's field days, campaigns, and agricultural shows. Furthermore, participants mentioned that informal knowledge sharing tools included story telling by elders, exchange of ideas by fellow farmers, usually in local brew drinking places and during funeral ceremonies. Participants' comments were that the informal methods were commonly used rather than the formal knowledge sharing tools.

Table19: Pair wise ranking of the knowledge sharing tools at Mwatenga village

Tools	Radio	Television	Books	Posters	Pamphlets
Radio	XX	1	1	1	1
Television	V	XX	3	2	5
Books	V	V	XX	3	3
Posters	V	V	V	XX	5
Pamphlets	V	V	V	V	XX

Source: Survey data, 2003. XX meant tallied tool where as V meant below the tallied tool score hence not selected

The results in Table 19 above shows a pair wise ranking of the knowledge sharing tools conducted during the focus group discussion sessions and the radio scored highest. Four out of ten participants selected radio as a suitable knowledge-sharing tool for creating awareness about the knowledge of PWA. The reasons given were that radio messages were in a language that was easily understood and that most farmers had radios in the villages. Similar results were obtained in Inyala, Mahongole, Ikhoho, and Ukwaheri villages. Such findings were similar to Sadamate and Sinha (1978), and Mattee (1988) who found that the radio played an important role in imparting farm messages to the farmers in India and Tanzania.

Table 20 below show the relationship between location of respondents villages and the best knowledge sharing tool used for teaching farmers about the productivity of water in agriculture. The study revealed that, out of 217 respondents, 89 (41.0%), 47 (21.7%), 47 (21.7%), 33 (15.2%), 1 (0.5%) indicated face to face and field visits were the best knowledge sharing tools when training farmers about PWA in the villages. Yet, 47 (21.7%) and 33 (15.2%) indicated that village sessions and farmer filed schools were also important knowledge sharing tools, especially in lower and mid Mkoji sub catchment, respectively. However, there were statistical differences between group (p< 0.075) for farmers training. The study finding showed that face to face (41.0%) training of farmers was the best knowledge-sharing tool for improving productivity of water in agriculture. This implied that the contacts between farmers and agricultural experts during the training sessions and demonstration plots were important for teaching PWA.

Table 20: Location of respondents village by best methods for teaching PWA % (n= 217)

Best training Method for PWA	Upper	Middle	Lower	Total	Chi square	P value
Face to face	19(8.8)	29(13.4)	41(18.9)	89(41.0)	14.263	.075
Field visits	19(8.8)	12(5.5)	16(7.4)	47(21.7)		
Village sessions	13(6.0)	11(5.1)	23(10.6)	47(21.7)		
Farmer field schools	10(4.6)	15(6.9)	8(3.7)	33(15.2)		
Agriculture shows	1(0.5)	0(0.0)	0(0.0)	1(0.5)		
Total	62(28.6)	67(30.9)	88(40.6)	217(100.0)		

Source: Survey data, 2003 Figures in parentheses are percentages and those out of parentheses are frequencies, Not Significant at (P< 0.05.

Another aspect interviewed was whether smallholder farmers experienced constraints to measuring PWA in crop field. Tables 21 below show that, out of the 226 respondents, 148 (65.5%) agreed that there were constraints to spread of knowledge of PWA. However, there was no significance difference between the means of the groups (P<0.46). The study findings implied that location of villages had no influence on constraints to the spread of knowledge about measuring the productivity of water in agriculture. The lower zone indicated more 88(40.6%) constraints for measuring PWA compared to the others, which might be due uncertainties of getting water for irrigation. Also smallholder farmers possibly in the lower zone were reluctant because much water was abstracted in the upper and mid zones.

Table 21: Relationship between location of village and constraints to measuring PWA %(N = 226)

Constraints to measuring PWA	Village location			Total	Chi square	P value
	Upper	Middle	Lower			
Yes	49(21.7)	47(20.8)	52(23.0)	148(65.5)	1.566	.457
No	23(10.2)	21(9.2)	34(15.0)	78(34.5)		
Total	72(31.9)	68(30.1)	86(38.1)	226(100.0)		

Source: Survey data, 2003. Figures in parentheses are percentages and those out of parentheses are frequencies, Not Significant at (P< 0.05.

Smallholder farmers were asked to mention the reasons for existence of the knowledge constraints to measuring PWA. Table 22 below shows relationship between the location of the respondents villages and reasons for constraints to measuring PWA.. Out of the 168 respondents, 43 (25.6%), 25 (14.9%), 51 (30.4%), 14 (8.3%), 24 (14.3%), 11 (6.5%) indicated no village extension officers, lack of equipment's, lack of education, poor leadership, lack of experts, far from town and poverty, respectively. There was significance difference between means of the groups (P<0.001) and high statistical value indicating that there was strong relationship between the two variables. The study found that lack of education was the main impediment (30.4%) for the spread of strategy of measuring productivity of water in agriculture. This suggested that more farmers training, other communication strategies and dialogue were important for awareness of the knowledge and improvement of productivity of water in agriculture.

Table 22: Relationship between location of the village and reasons for the constraints(N = 168)

Reason for constraints	Village location			Total	Chi square	P value
	Upper	Middle	Lower			
Lack of extension Officer	22(13.1)	10(6.0)	11(6.5)	43(25.6)	94.741	0.000
Lack of equipment	19(11.3)	1(0.6)	5(3.0)	25(14.9)		
Lack of education,	16(9.5)	28(16.7)	7(4.2)	51(30.4)		
Poor leadership	0(0.0)	6(3.6)	8((4.8)	14(8.3)		
Lack of experts	0(0.0)	4(2.4)	20(11.9)	24(14.3)		
Far from town and Poverty	0(0.0)	0(0.0)	11(6.5)	11(6.5)		
Total	57(33.9)	49(29.2)	62(36.9)	168(100.0)		

Source: Survey data, 2003. . Figures in parentheses are percentages and those out of parentheses are frequencies, Not Significant at (P< 0.001).

Of the 248 respondents, 168(67.8%) gave their responses about the constraints. And of these, 51(30.4%), and 43(25.6%) indicated that lack of formal education among smallholder farmers, and lack of agriculture extension officers in the villages were the main constraints having knowledge about measuring PWA in their fields (Table 226). Lack of formal education among smallholder farmers was more of constraints in the middle Mkoji sub catchment villages, while lack of agriculture extension officers in the upper villages. Furthermore there were high statistical significance differences of means (p< 0.000) in the three location. Few 25 (14.9%), 24 (14.3%), 14 (8.3%) and 11 96.5%0 indicated that lack of equipment, lack of experts, poor leadership and far from town as constraints for measuring PWA. The study found that lack of education and agriculture extension officers were the major reasons to having knowledge of measuring PWA. This meant that probably farmers were not measuring PWA because of the reasons

4.5.2 Best knowledge sharing tools by trainers and researchers

Focus group discussions were conducted in both agricultural training institute and research institute. The purpose was to evaluate the knowledge sharing tools suitable for communication in dialogue issues. Participants were asked to discuss the existing communication tools and evaluate them. The most common knowledge sharing tools were books, newspaper, posters, journals, leaflets, recorded video, and slides.

Participants from MATI voted for up date books, which were relevant to water management. They said that there was no up to date books in the institutes that could be used for knowledge sharing. It was further agreed that Internet services were important for getting up to date which is also worldwide. However, in a focus group discussion there was no one knowledgeable with World Wide Web. The Word Wide Web is being used as a direct teaching tool that allows virtual classrooms of interacting students and faculty to be created through ‘asynchronous learning networks’. Because the web allows a course taught at one site to be taken by students anywhere in the world, it increases enormously the ability to build scientific and technical capacity in developing nations (CGIAR Review Panel, 1998).

Moreover, participants discussed on how the knowledge could be shared. The argument was need for capacity building. Everyone recognizes the critical role played by agricultural professionals in linking technology sources to technology users. They are involved in assessing and articulating farmers' technology needs technology development, and technology transfer and technology evaluation. But there is growing concern that today's agricultural professionals do not have the knowledge and skills to be effective in the current situation. It is therefore essential that those who work with farmers to develop sustainable systems are knowlegdeable about the systems with which they work (Reeves, 2000). It follows that capacity building and professional development are fundamental prerequisites for achieving the widespread adoption of sustainable agriculture practices.

Participants from the SHARDI Uyole voted for the World Wide Web as the best knowledge-sharing tool. The pair-wise ranking was employed for evaluation of the tool. Eighty percent voted for World Wide Web. Further, most participants' had knowledge for the Internet and visited web sites. Sustainable agriculture presents a deeper and more fundamental challenge than many researchers, extensionists and policy previously assumed (Pretty, 1995). Sustainable agriculture needs more than new technologies and practices. It needs agricultural professionals willing and able to learn from farmers; it needs supportive external institutions; it needs local groups and institution capable of managing resources effectively; and above all it needs agricultural policies that support these features.

4.5.3 Best Knowledge Sharing Tools by Water Managers

Participants in a focus group discussion voted for face to face discussion through seminar and workshop as best knowledge sharing tool. Communication and dialogue should be held among organizations that are operational in the Mkoji sub catchment and those influence productivity of water and water management. The other stakeholders which need to be involved in a dialogue issues of PWA include, River Basin Management and Smallholder Irrigation Project (RBMSIIP) which is a joint World Bank funded project that brings together the MWLD and the MAF in enhancing river basin water management and improving smallholder irrigation. The RBM component is in the MWLD while the SIIP component is within the MAF. RBMSIIP is undertaking a number of relevant activities to improve river basin management. These include:

1. Improving stakeholder participation and voice in the allocation and management of water resources by broadening stakeholder representation on the Basin Water Boards,
2. Establishing democratic methods for stakeholder selection, and strengthening the administrative power of the Basin Water Board – including giving it the responsibility for the final approval of water right allocations (or modifications), as proposed by the Basin Water Officer;
3. Strengthening the Basin Water Office by enabling the Water Office to enforce and follow-up on existing legislation, regulations and operating rules governing water use;
4. Establishing the Basin Water Board as a preliminary centre for conflict resolution in water allocation and separating water use management from regulatory activities, following agreement on standard operating rules

The Rufiji Basin Water Board (RBWB) was established in 1993/4. It meets at least twice per year as mandated under the legislation, the main business of the meetings being to advise on the various activities of the Rufiji Basin Water Office (RBWO). The RBWO is authorized to grant water rights. The RBWO has established a sub office in the Mbarali district, which among other things, effects monitoring of river water levels, collection of water use fees and arbitrating in conflicts that arise from water uses.

4.5 Chapter Summary

This chapter presented results and discussions from questionnaire survey, focus group discussions, in – depth interviews and key informant interviews. Different description of stakeholders' perception and types and forms of knowledge sharing tools have been dealt and compared with other studies elsewhere. The chapter also has explored the best knowledge sharing tools for different stakeholders in communication and dialogue of improving productivity of water in agriculture. Furthermore knowledge-sharing tools have been evaluated on basis of different stakeholders' criteria

Majority of respondents showed that radio is the best knowledge-sharing tool for creating awareness of a new science. The implication of the study findings was that because most respondents could not be reached by agriculture extension officers' radio was the best method. In addition, the radio as mass communication method reaches many farmers within a short time compared to other knowledge sharing tools. But some participants in the focus group discussion objected relying on the radio programme because of the inappropriateness of the broadcasting time.

Focus group discussion sessions mentioned that formal knowledge sharing tools used for training farmers in the villages or at the agricultural institute included demonstration, field visits, meetings, seminar, study tours, farmer's field days, campaigns, and agricultural shows. Furthermore, participants mentioned that informal knowledge sharing tools included story telling by elders, exchange of ideas by fellow farmers, usually in local brew drinking places and during funeral ceremonies. Participants' comments were that the informal methods were commonly used rather than the formal knowledge sharing tools.

The study found that lack of education was the main impediment (30.4%) for the spread of strategy of measuring productivity of water in agriculture. This suggested that more farmers training, other communication strategies and dialogue were important for awareness of the knowledge and improvement of productivity of water in agriculture. The study found that lack of education and agriculture extension officers were the major reasons to lack of knowledge for measuring PWA. This meant that probably farmers were not measuring PWA because of the same reasons

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

Based on the findings from the study the following conclusions are made:

1. There was little understanding by stakeholders about the knowledge of PWA. Most farmers related PWA with scarcity of water but showed lack of awareness regarding this new science. Furthermore, water users described this knowledge by relating it to practices of planting short time varieties, high value crops, early planting, application of farmyard manure and industrial fertilizers for the purpose of increasing crop yield both in rainfed and irrigated agriculture.
2. The study found that farmers used different agronomic practices and tillage practices to improve their crop yields. For example, farmers practiced minimum tillage rather than conventional tillage that increased costs. Furthermore, they planted local crop varieties that were drought resistant in the lower zone of Mkoji sub catchment where high water stress was a common phenomenon. With regard to tillage practices flat cultivation was highly encouraged in the lower zone while in the upper zone bottom valley farming was common for soil and water conservation that increased crop yield.
3. . Farmers had positive attitude to the knowledge of PWA that had an added value to government initiative’s for agricultural training programmes to make emphasis on

good methodologies of quantifying crop harvest and the volume of water used. Furthermore, farmers suggested improvement of agricultural extension services in rural areas where not available. The findings showed inadequate extension services and sometimes completely lack of these services in the lower zone. That meant farmers were ready to learn from agricultural experts but denied because not available.

4. Farmers training, demonstration plots, radio and field visits had high score for suitable type and forms of knowledge sharing tools. This implied stakeholders' willingness to learn the scientific method through practical sessions rather than classroom sessions. Integration of indigenous and scientific knowledge needed to be underscored in pursuit of getting a common understanding and description of productivity of water in agriculture.

5.2 Recommendations

Based on the conclusions drawn from the findings, the following recommendations are made: (i) Farmers training, demonstration plots, radio and field visits should be employed as knowledge sharing tools for creating awareness of PWA. (ii) Dialogue should be held between stakeholders from village level to national level to get common understanding of the description of PWA.

REFERENCES

Ashley, J. (2003). Synchronous and Asynchronous Communication Tools. Knowledge management, Story Telling. Executive update online. http://www.centeronline.org/knowledge/article visited 16 august 2004

Axinn, G.H. (1988). Guide on Alternative extension Approaches, Rome. FAO. pp. 299.

Babbie, E. (1990). Survey Research Methods. Wards worth Publishing Company, Belmont Califonia, pp. 395.

Bailey, D.K. (1990). Methods of Social Research. The Tree Press. Collier- Macmillan Publishers, London, pp. 428.

Bastiaanssen, W.G., J.C. van Dam and P. Droogers (2003) Introduction. In Dam, J.C.Van Dam and R.S. Malik (Editors) Water Productivity of irrigated crops in Sirsa district, India. Intergartion of remote sensing, crop and soil models and geographical information systems. Pp.11-20.

Bos, M.G. and J. Nugteren. 1974. On irrigation efficiencies. International Institute for Land Reclamation and Improvement. Publ. 19, Wageningen, Netherland, 95p (Note: 2nd edition, 1978, 142p)

Blakely, R.J. (1971). The New Environment: Questions for Adult Educators, Occasional Papers, 23, Syracuse university publications in Continuing Education, Syracuse, New York: University of Syracuse

Blakely, R.J. (1971). The New Environment: Questions for Adult Educators, Occasional Papers, 23, Syracuse university publications in Continuing Education, Syracuse, New York: University of Sycuse.

Carter, R.C. (1986). Training in Irrigation Water Management. A Review of Training Activities and Approaches of the Water Resources, Development and Management Services. London. pp.56.

Chancellor, F.M. and Hide J.M. (1997) Smallholder Irrigation: ways forward. Guidelines for achieving appropriate scheme design. Vol. 2. Summary case studies. DFID. Report OD 136.

Clemmens, A. J.; and C. M. Burt. (1997). Accuracy of Irrigation Efficiency Estimates.*J.Irrigation and Drainage Eng.* 123: pp. 443-453.Colombo (Sri Lanka): International Management Institute

De Long, D. and L. Fahey. (2000). Diagnosing Cultural Barriers to Knowledge Management", The Academy of Management Executive, November 2000, V.14, No.4. pp.113-127. [http://www.bussiness.queensu.ca] site visited on 27th July 2002.

De vries, J. (1978). Agricultural Extension and Development of Ujamaa Villages in Tanzania: Towards a Dialogical Agricultural Extension Model. A thesis submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy Continuing and Vocational Education at University of Wisconsin-Madson.

DFID/NRSP (2002). Scaling – Up and Communication: Guidelines For Enhancing the Developmental Impact Of Natural Resouces Systems Research, 8pp

Diarra, R. and H. Breman L. (2004) Influence of rainfall on the productivity of grasslands Centre Pédagogique Supérieur, Bamako Mali. www.fao.org/wairdocs/ilri/x5543b/x5543b0m.htm) visited on 3/7/2004

Doorenbos, J., Kassam, A.H., 1979. Yield response to water. FAO Irrigation and Drain, Paper 33. Rome, Italy,193 pp.

Dong, B., R. Loeve, Y. H. Li, C.D. Cheng and D. Molden, (2001). Productivity of water in the Zhanghe Irrigation System: Issues of Scale. *In: Barker et al. (2001) Water-Saving Irrigation for Rice*. Proceedings of an International Workshop Held in Wuhan, China 23-25 March 2001. IWMI, 97-115 pp.

Eisstadt, S.N.(1995). 'Communication Systems and Social Structure: an Exploratory Comparative Study'. Public opinion Quarterly, 19: Pp. 153-167.

FAO (2000) Crops and Drops. Making the best use of water in agriculture. FAO Rome.Pp. 28.

FAO (2001) Irrigation Manual, Planning development monitoring and evaluation of irrigated Agriculture with farmer participation. Vol. III Module 8. Pp. 80.

FAO (2000). Renewing SARD: Further progress toward sustainable agriculture and rural development requires a radical shift in priorities towards alleviating poverty and social exclusion. In agriculture 21, March. [Online] Available: http: www.fao.org/ag/magazine/0103sp3.htm

FAO (2003). Spotlight. Raising water productivity, March 2003 Global Water Partnership (2000). Integrated Water Resources Management. Technical Advisory Committee (TAC) background paper No. 4, ISSN: 1403-5324, ISBN: 91-630-9229-8 Stockholm, Sweden. pp67.

FAO. (1979). Yield response to water. FAO Irrigation and Drainage Paper, 33 Rome.

FNPP, (2003). FAO Netherlands Partnership Program. The Comprehensive Assessment of Water Resources of Mkoji sub catchment, its Current Uses and Productivity. pp 118

Frank Tom. (2000). Livelihood Approaches What Differences do they make. A case study of Usangu, Tanzania. Bradford Centre for International Development. [http://www.bradfor.ac.uk/acad/bcid] site visited on 19 July 2003.

Freire, P. (1970).“Extension or communication.” In: Freire, P.: Education for Critical Consciousness. New York: Seabury Press, pp.91 - 164.

Guerra, L.C, S.I.Bhyuyan, T.P.Tuong, and R.Barker. (1998). Producing more rice with less Water. SWIM paper. Colombo, Sri Lanka: International Water Management Institute.

Gundel, S., Hancok, J. and Anderson, S. (2001). *Scaling –Up Strategies For Research In Natural Resources Management: A Comparative Review. Natural Resources Institute* (NRI), Chatham, UK. pp 61.

Halcrow, W. and Partners (1992) Infrastructure operation and maintenance manual: Kapunga project. National Agricultural and Food Cooperation, Tanzania.

Howell, T. A.; R. H. Cuenca; and K. H. Solomon. (1990). Crops yield response. In *Management of farm irrigation systems*, ed. G.J. Hoffman; T.A. Howell and

International Water Management Institute (IWMI). 2003. www.iwmi.org/assessment

James L. G. (1988). Principles of Farm Irrigation System Design. John Wiley and Sons, Inc. New York, pp85-99

IRR. (2000). *Going to Scale can bring more benefit to more people, more quickly*? International Institute for Rural Reconstruction (IIRR), Slang, Caveat, Philippines.

Jarvenpaa, S. and D. Staples. (2000)." The use of collaborative electronic media for information sharing an exploratory study of determinants", Journal of strategic Information Systems 2000(9), pp.129-1540. [http://www.bussiness.queensu.ca] site visited on 27th July 2002.

Jensen, M.E., (1980). The role of irrigation in food and fiber production. In design and operation of farm irrigation systems, ed.M.E Jensen. Michigan: The American Society Of Agricultural Engineers. Pp.15-41.

K.H.Solomon. St Joseph, Michigan: American Society of Agricultural Engineers.

Kauzen, A.S.(1979). "Comparative Effectiveness of Group Extension Methods in Village Farming in the Coastal Zone of Tanzania" .PhD dissertation, University of Dar Es Salaam, Tanzania, pp286

Khushalani, Kobe and Khushalani, M. Aanuhar, (1990). Irrigation practice and design direction and Distribution

Kijne, J.W, R.Barker and Molden, D. (July 2000). Water Productivity in Agriculture: Limits and Opportunities for Improvement. [http://www.iwmi.cgir.org/policybriefing] site visited on 7 July 2003

Kijne, J.W, Tuong, T.P, Bennett, J. Bouman, B and T. Oweis. (2002). Ensuring Food Security via Improvement in Crop Water Productivity. [http://www.iwmi.cgiar.org/challenge-program/pdf] site visited 18th July 2003

Knowledge Management for water sector. Http:// www.iahr.org/e-library/beijing proceeding visited on 7.03.2004

Kotter, J. (1996). Leading Change, Harvard business school press, Boston, 1996. [http://www.bussiness.queensu.ca] site visited 27th July 2002.

Lankford, B and C.S. Sokile (2003) *Reflections on the river basin game: Role-playing facilitation of surface water allocation in contested environments.* Forthcoming

Magayane M., (2004). Challenging Established Concepts of Irrigation Efficiency in a Water Scarce River Basin: A Case Study of Usangu Basin, Tanzania. A Thesis Submitted for the Degree of Doctor of Philosophy. University of East Anglia. School of Development Studies.

Mahoo, H.F., F.B. Rwehumbiza and N. Hatibu, (2000). The wasted rainwater: whose point of view? *In N. Hatibu and H.F. Mahoo (eds.) Rainwater Harvesting for Natural Resources Management*. A planning guide for Tanzania. Technical Handbook No. 22.113-114pp.

Mdemu, M (2003) Productivity of fish in the Kapunga water system. Draft report .6pp.

Molden, D. (1997). Accounting for Water and Productivity. SWIM Paper 1. Colombo. Sri Lanka. International Water Management Institute. 27pp.

Molden, D and Sakthivadiel, R (1999). *Water accounting to assess use and productivity of water*. International Journal of Water resources Development. International Water Management Institute(IWMI), Sri Lanka. Colombo. 15 (1/2):p p.5-6

Molden, D.; Sakthivadivel, R.; Habib, Z. 2001. Basin-level use and productivity of water: Examples forom South Asia. Research Report 49. Colombo, Sri Lanka: International Water Management Institute (IWMI), 24 pp.

Molden, D., Murray-Rust, R., Sakthivadivel, R. and Makin, I. (2003) A Water-productivity Framework for Understanding and Action. In Kijne, J.W., Barker, R. and Molden, D. (eds) Water productivity in Agriculture: Limits and Opportunities for Improvement. CAB International 2003, IWMI, Colombo Sri Lanka. 1-pp.

Ministry of Water and Livestock Development (MWLD) (2002) National Water Policy. Government of Tanzania, Dar es Salaam

Nonaka, I. and Takeuchi, H.,(1995) "The knowledge creating company: How Japanese companies create the dynamics of innovation", Oxford University press. (1995)

Oomkes, F.R. (1986). Communicatieleer, Meppel, Bonn

Oweis, T.; and A. Hachum. (2002). Improving water productivity in the dry areas of West Asia and North Africa. In *Water productivity in agriculture: Limits an opportunities for improvement,* ed. J. W.Kijne. Wallingford, UK: CABI (in press).

Paquet, S. (2002). Pointers and thoughts on the evolution of knowledge sharing and schorlaly communication, http: // www. Radio.weblogs.com

Pasher, E. (1998). Strategy, Knowledge, and Communication. .http://www.knowledgeboard.com visited on 17 June 2004

Perry, C. J. 1996. *The IWMI water balance framework: A Model for Project Level Analysis.* Research Report 5. Colombo Sri Lanka: International Irrigation Management Institute.

Popper, K.R. (1963). In D.L. Sills(Ed) International Encyclopædia Of The Social Sciences, Vol.12.cllier- Macmillan Press, London, pp 159-164.

Prince, S.D., Brown De Colstoun, E. and Kravitz, L.L. 1998. Evidence from rain-use efficiencies does not indicate extensive Sahelian desertification. *Global Change Biology* 4: 359-374.

Renwick, M. E. (2001). Valuing water in irrigated agriculture and reservoir fisheries: Multiple user irrigation system in Sri Lanka. Research Paper 51. International Water Management Institute. 32pp

Republic of Kenya (1990) Scheme design, manual for senior staffon gravity schemes with basic irrigation operated by farmers. Ministry if Agriculture. pp. 179.

Reuben M. J. Kadigi, Japhet J. Kashaigili And Ntengua S. Mdoe (2004) the Economics Of Irrigated Paddy In Usangu Basin In Tanzania: Water Utilization, Productivity, Income And Livelihood Implications

Rhoades, R.E. and Booth, R.H., (1982). ‘Farmer – Back-To- Farmer’. A model for generating Acceptable agricultural technology’. Agricultural administration, 11: pp. 127-137.

Rijsberman, F.R., and D.Molden. (2001). Balacing water uses: Water for food and water for nature. Thematic background paper. International Conference on Freshwater. Bonn, Germany.

Rosegrant, M.W., X. Cai and S.A. Cline, (2002). *World Water and Food to 2025,Dealingwith Scarcity*. International Food Policy Research Institute, Washington, D.C. 322pp.

Saxena, N P., M Irshad Ahmad, J C O’Toole, Murari Singh, S N Nigam (2004) Increasing efficiency of crops grown on conserved soil water and responsiveness to supplemental irrigation. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); Patancheru, 502 324 India

Seckler, D., U. Amerasinghe, D. Molden, R. de Silva and R. Barker, 1998. World water demand and supply, 1990 to 2025: Scenario and issues. Research report 19, IWMI, Colombo Sri-Lanka, 40 pp.

Shah,T.; I.Makin and R. Sakthivadiel (2000). Limits To Leap Frigging In Transposing Successful River Basin Management Institutions In The Developing World. Paper presented at the Workshop on Integrated Water Management in Water Stressed River basins in Developing Countries. In : Increasing Productivity of Water: A requirement for Food Environment Security. Working Paper 4. 8pp.

Smith, M. (1992). *CROPWAT: A computer program for irrigation planning and management*. FAO Irrigation and Drainage Paper 49. Rome: FAO.

SMUWC, (2001). Talking About Usangu Workshops, Stakeholder and Final Workshop held at the NBC Hall, Mbeya 21-22 March 2002.

SMUWC, (2001a). Final Report, *Irrigation water management and efficiency*. Supporting Report 8. Directorate of Water resources, Dar es Salaam, Tanzania. 117pp.

SMUWC, (2001b). Final report, *Irrigation efficiency*. Supporting report 10, Directorate of water Resources, Dar es salaam, Tanzania. 69pp

Solomon, K. H.; and C. Burt. 1999. Irrigation sagacity: A measure of prudent Water use. *Irrigation Sci.* 18:135-140.

Supe, S.V. (1997). An Introduction to Extension 2nd Edition. Oxford and IBH Publishing Co.PVT Ltd. New Delhi. 300 pp.

Tanzania NGOs umbrella (TANGO) (2002) Demystifying International Institutions and Conventions: Implications of AGOA, NEPAD and WTO in Natural Resource Management in Tanzania. Second National NGOs Forum 10-14 June 2002, Dar es Salaam. Unpublished Workshop Report.

Tuong, T.P., and S.I Byuiyan. (1997). Increasing Water Use Efficiency in Rice Production: Farm Level perspectives. Proceedings of the International workshop| “More from less: Better Management” 21-23 September, |Department for International development, Cransfield, Silsoe, UK.pp108-111. University press, 1995

URT (2001) Proceedings of the National Irrigation conference held on 20^{th} to 22^{nd} March 2001, at the TANESCO training Centre, Morogoro, Tanzania.

URT, (2000). Water for Agriculture and Food Security. A paper presented to a national workshop on contribution of water resources and economic growth held at golden tulip hotel Dar es salaam on 30-31 January 2003(By Wilfred Ngirwa, The permanent Secretary, and MAFS).

URT, (2002). Tanzania National Bureau of Statistics (TNBS), Household budget survey, 2002

Van dusseldorp, D.B.W.M., (1992). Project for Rural Development in Third World: Preparation and Implementation, Wangengen Agricultural University, Wagengen Pp34

Viets, F.G. (1962). Fertilizer and Efficiency Use of Water. Adv. Agron.14: pp 223-264.

Weber, M. (1980). Wirtshaft und Gesellshaft: Grundriss der verschenden socialogie, ubigen, JCB Mohr (Paul Siebeck).

Wolters, W., and M.G.Bos. (1989). Irrigation performance Assessment and Irrigation Efficiency. ILRI Annual Report.pp. 25-37.

APPENDICES

Appendix 1: Questionnaire for farmers

ASSESSMENT OF KNOWLEDGE SHARING TOOLS FOR COMMUNICATION AND DIALOGUE IN PRODUCTIVITY OF WATER IN AGRICULTURE IN MKOJI SUB CATCHMENT OF THE USANGU PLAIN

A1: BACKGROUND INFORMATION OF THE QUESTIONNAIRE AND HOUSEHOLD

A1:DATE OF INTERVIEW	A1.2 NAME OF INTERVIEWER	A1.3 NAME OF VILLAGE/SUB – VILLAGE
A1.4 NAME OF HOUSEHOLD HEAD	A1.5 FARMING SYSTEM	A1.6 HOUSEHOLD RANK
A1.7 NAME OF RESPONDENT	A1.8 AGE OF RESPONDENT	A1.9 SEX OF RESPONDENT
		1= MALE 2= FEMALE
A1.10 RELATIONSHIP WITH HHH	A1.11 AGE OF HOUSEHOLD (HHH)	A1.12 SEX OF HHH 1 = MALE, 2 = FEMALE
A1.13 ORIGIN OF HHH	A1.14 ETHNIC OF HHH IF NATIVE	A1.15 YEAR OF MIGRATING
1= NATIVE 2 =IMMIGRANT		

A1.16 LIST OF MEMBERS IN THE HOUSEHOLD

NO	NAME	AGE	SEX	RELATIONSHIP TO HHH	EDUCATION LEVEL	OCCUPATION
		YEAR	1=MALE	1 = HHH	1 = NIL	1=CHILDREN
			2=FEMALE	2 = WIFE	2 = STD IV	2 = PUPIL
				3 =HUSBAND	3 = STD VII	3=DOMESTIC WORK
				4 = CHILD	4 = STD VIII	4 = FARMER
				5 = RELATIVE	5 = STD IX	5 = FISHER
				6 = NOT RELATIVE	6 = FORM IV	6=CIVIL SERVANT
					7 = FORM VI	7=PRIVATE COMPANY
					8=HIGHER LEVEL	8=SELF EMPLOYMENT
1						
2						
3						

A1.17 OCCUPATION OF HOUSEHOLD MEMBERS

NO	NAME	AGE	SEX	OCCUPATION	1=RAINFED FARMING	YIELD PER ACRE/SEASON
					2=IRRIGATION FARMING	
					3=SUPPLEMENTARY	
					4=BOTTOM VALLEY	

B1.1 LAND OWNED BY HOUSEHOLD

NO	SIZE	OWNERSHIP TYPE	OWNED BY	FARMING SYSTEM
	PLOT SIZE IN	1=OWNED BUT NOT	1 = ALL	1=WET SEASON

	ACREAGE	CULTIVATED				FARMING
		2 = OWNED AND PLOWED			2 = WIFE	2=DRY SEASON FARMING
		3 = OWNED AND RENTED			3 = HUSBAND	3=SUPPLEMENTARY
		4 = HOUSEHOLD RENT				4=BOTTOM VALLEY
		5 = HOUSEHOLD BORROW				
A						
B						
C						
D						

C1: PRODUCTIVITY OF WATER IN AGRICULTURE
C1.1 Do you know the meaning of productivity of water in agriculture? 1= YES; 2 = NO
C1.2 If YES, explain the meaning--
C1.3 If YES, who taught you the meaning? --
C1.4 Do you measure productivity of water in agriculture? 1 = YES; 2 = NO
C1.5 If YES how do you measure? 1= traditionally 2 = using improved techniques?
C1.6 If you are using traditional methodology, how are you measuring?
C1.7 If you are using improved techniques methodology, how are you measuring?
C1.6 Which methods do you use in measuring productivity of water of your crops?
C1.7 Which tools do you use in measuring productivity of water in agriculture?
1:---2---
C1.8 Productivity of water in agriculture of each crop cultivated by the household

Crop	Wet season farming		Intermediate farming		Dry season farming	
	Yield in Kg	Water used M^3	Yield in Kg	Water used M^3	Yield in Kg	Water used M^3

C1.9 Traditional strategies in measuring productivity of water in agriculture						
Type of farming		Methodological tools in measuring Productivity of Water in Agriculture			Traditional strategy in measuring Productivity Water Agriculture for each crop	
1 = Wet season 2 = Supplementary						
C1.10 Improved strategies in measuring productivity of water in agriculture						
Type of farming		Methodological tools in Measuring Productivity of Water in Agriculture			Traditional strategy in measuring Productivity Water Agriculture for each crop	
1 = Wet season						
2 = Supplementary						
3 = Irrigation						

C1.11Which strategy of measuring productivity of water is the most suitable than other mentioned above?

C1.12 Which methodological tool for measuring productivity of water is most suitable than other mentioned above? --

D: KNOWLEDGE IN PRODUCTIVITY OF WATER IN AGRICULTURE

D1.1 Did you attend training on productivity of water in agriculture? 1 = YES; 2 = NO

D1.2 If Yes who conducted the training? ---

D1.3 Which teaching aids did the facilitator use? 1--------------------------------------; 2--------------------
--

D1.4 Did you understand well through the method used by the facilitator? 1 = YES; 2 = NO
D1.5 If NO why the method used was not well understood?

D1.6 How many irrigation agriculture training have you attended? --
D1.7 Which teaching aid was used frequently for training irrigation agriculture ------------------------------
D1.7 Which method is the best than others for training irrigation agriculture ----------------------------------
D1.8 Mention the reason which impede spread of the knowledge of PWA………………………………
D1.9 Mention the reason, which prevent water users to measure PWA for their crops?…………………
E: EVALUATION OF THE KNOWLEDGE SHARING TOOLS FOR PWA
E1.1 Which of the following teaching method is the most suitable to measure PWA?
1 = Framers training by irrigation technicians/ NGOs
2 = Field visit
3 = Training for the whole community
4= Farmer Field School
E1.2 Which teaching knowledge sharing tool is the most suitable than the other?
1 = Radio; 2 = Television); 3 = Leaflets; 4 = Books; 5 = Cinema; 6= Video
E1.3 Which knowledge sharing tool among those mentioned above is the most suitable, easily available and well understood--------------
E1.4 Mention two reason for your choice………………………………………………………………
F: IMPEDEMENTS FOR THE SPREAD OF THE KNOWLEDGE ON PWA
F1.1 Are their impediments for the spread for the productivity of water in agriculture? 1=YES; 2= NO
F1.2 If YES mention the impediments
F1.3 How did you get the knowledge for productivity of water in agriculture? --------------------------------
F1.4 If you have not knowledge for PWA, are you ready to attend the training? 1= YES; 2= NO
F1.5 If YES, what prevents you to attend the training now--
G: CONFLICTS AMONG WATER USERS
G1.1 Have you ever-participated in water use conflict? 1= YES; 2=NO
G1.2 If YES, explain briefly the source of conflict? ---
G1.3 Who was the mediator during this conflict? ---
G1.4 Are their conflicts of this nature frequently? 1= YES; 2= NO
G1.5 What are the proper strategies to prevent conflicts for water users? ---------------------------------------
G1.6 Do you have water intake in the village 1 = YES; 2= NO
G1.7 Do the water user committees assist in conflict mitigation? 1= YES; 2= NO
G1.8 If YES, explain how does the committee assist in conflict mitigation-------------------------------------
H: ESTABLISHMENT OF APEX ORGANIZATION FOR WATER USERS
H1.1 Have you heard of the idea of apex Organization for water users in Usangu plain? 1= YES; 2= NO
H1.2 If YES, who established this idea? --
H1.3 Does this apex Organization for water users exist? 1= YES; 2= NO
H1.4 If YES, what is the function of the apex Organization for water users?

H1.5 If the apex Organization does not exist what is the problem?

I: SUITABLE STRATEGIES FOR IMPROVING PRODUCTIVITY OF WATER IN AGRICULTURE
I1.1 Do you know suitable strategies for improving productivity of water in agriculture? 1= YES; 2= NO
I1.2 IF YES, mention the strategies for improving the productivity of water in agriculture
1:---2;---3;---------------
I1.3 Among the strategies, which is the most suitable than others? ---
I1.4 Give reason for your choice---

Appendix 2: Guiding questions for Focus Group discussions (FDGs)

A) Knowledge and information

Do you understand the term productivity?
What is the importance of measuring productivity?
How do you measure productivity of your crop?
Do you know productivity of water in agriculture (PWA)?
Where did you hear about PWA?
How do you measure PWA
What is the PWA of the crops grown
How do you increase PWA for you crops
Have you joined WUA
What have you learnt in WUA
Do you discuss PWA in WUA
How do you see the PWA of the crops as you compare the time before and after joining WUA

B) Farmers training needs

Is there anything you need to know about PWA?
Is there anything you need to know about water management?

Knowledge sharing tools

How do you asses these knowledge-sharing tools (Radio, newspaper, leaflets, posters, manuals, books)? In terms of the following criteria:
Content/message
Language used
Time taken to understand the message
Ease of understanding
Ease of use
Availability of materials
Places where materials are available

Appendix 3: Guiding questions for In-depth interview

Knowledge and information

Do you understand the term productivity?
What is the importance of measuring productivity?
How do you measure productivity of your crop?
Do you know productivity of water in agriculture (PWA)?
Where did you hear about PWA?
How do you measure PWA
What is the PWA of the crops grown
How do you increase PWA for you crops
Have you joined WUA
What have you learnt in WUA
Do you discuss PWA in WUA
How do you see the PWA of the crops as you compare the time before and after joining WUA

Sources of information:

How do you do in order to increase PWA
Why do you do that
From whom do you learn the practice

Training needs

Is there anything you need to know about PWA
Is there anything you need to know about water management

Knowledge sharing tools evaluation

How do you asses these knowledge sharing tools (Radio, newspaper, leaflets, posters, manuals, books)? in terms of the following criteria:
Content/message
Language used
Time taken to understand the message
Ease of understanding
Ease of use
Availability of materials
Places where materials are available
Radio as a knowledge sharing tools
Do you own radio
Have you ever heard of any water management programme through radio
Have you ever heard anything on PWA
At what time of the day the water management programs are broadcasted
At what time do you listen to radio programs

Appendix 4: Checklists for Key Informants
(WUA leaders, RBWO, Extension staff, MATI staffs, Local government leaders)
Perception of importance of PWA
Source of Knowledge
Access to source of knowledge
Knowledge of Integrated Water Resource Management
Training need
Evaluation of knowledge sharing tools
Need of dialogue