PROMOTING UP SCALING OF WATER SYSTEM INNOVATIONS: THE CASE OF MAKANYA WATERSHED, SAME, KILIMANJARO, TANZANIA.

BY

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ABSTRACT

Many innovations have shown to be effective in pilot studies, but the adoption of most of these technologies on a wider scale has always been a concern. In the uplands of the Makanya river watershed, terraces have higher extent of diffusion than in midland. The reasons behind the high extent of adoption of terraces in the uplands were not clearly known. However, these suggested that there could be special strategies behind the diffusion of terraces, which when explored would help to develop strategies for wider adoption and diffusion of water system innovations (WSIs) in the area. A questionnaire survey was used in conjunction with qualitative approaches such as focus group discussions, key informant interviews, and semi structured interviews. Descriptive statistics were the main tool used for data analysis. The findings made on the adoption and diffusion of terraces technologies revealed that time factor, sufficient communities' awareness on terraces, and intervention by NGOs and development projects were major factors for wider diffusion of terraces technology. Terraces were introduced in the area by the colonial government in 1930s, and in 1980s, NGOs with intervention in soil and water conservation started working in the area. Time factor provided enough opportunity to build sufficient communities' awareness on terraces. Interventions by NGOs and development projects in the1980s, underlined the reason for increased uptake of terrace innovations from 1980s though the technology was long before introduced in the study area. The understanding of the diffusion of terraces technology enabled the study to develop a framework that could promote up scaling of water systems innovations (WSIs) at watershed level. The framework could not be tested due to limitation by resources. However it is recommended that it should be tested and improved for successful scaling up

of WSIs at watershed level. This will bring improved livelihood of people in the watershed. Key elements of the framework are: validation of innovation to be scaled up, introduction to authorities, identification of potential local change agents, establishment of local change agents, employment of appropriate diffusion pathways, and evaluation of the scaling up processes.

DECLARATION

I, Mcdardi Mukulasi Byakugila, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that it has not been submitted to any other University for award a degree.

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DEDICATION

To my beloved family, which not only withstood my absencc and long working hours, but also generously gavc from thc little family moncy to sponsor my study; I dedicate this work.

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CHAPTER ONE

1.0 INTRODUTION

1.1 Background information

Accelerating technology development is one central factor to agricultural transformation and integration with the global economy (Howard *et al.*, 2000). Technology development by itself contributes to knowledge and knowledge is power – but the question here is who controls, owns, and has access to that knowledge? It might therefore be comprehensible that, it is not enough merely to develop technologies: they need to reach those who can benefit from them. The challenge might be not only to develop technologies that are appropriate and which respond to local needs, but also to ensure that the uptake pathways for these technologies function effectively (Adolf, 2005).

Ensuring a thriving and sustainable agricultural development is critical for reducing poverty; enabling food security, support broad-based rural development and managing natural resources in a sustainable fashion. According to the World Bank (2003), agricultural development can only be achieved through large-scale scaling-up of agricultural technologies and improved practices to farming communities, especially in the developing world.

Large numbers of people live in the arid and semi-arid belts of the world where rainfall is limited and very irregular (FAO, 2001). It is estimated that in most semi-arid tropics, the time when it is actually raining is about 100 hours per year, out of the 8,760 hours of the year (McHugh *et al.*, 2005). The study by Rockstrom *et al.* (2000) reported that dry spells in rainfed agriculture of arid and semi-arid regions, which occur frequently, are responsible for a decrease in yield by about 70% or even sometimes a total crop failure. Most of the people living in these areas remain poor agro-pastoralists who depend totally on the renewable natural resources for their livelihoods (Hatibu, 2004). Their poverty is partly caused by inadequate availability of water for crops, livestock and other enterprises. However, the shortage of water is not caused by low rainfall as normally perceived but rather by lack of capacity for sustainable management and use of the available rainwater (Hatibu, 2004).

According to Hatibu (2004), the most critical management challenge is how to deal with the poor distribution of rainwater leading to short periods of too much water and flooding, and long periods of too little water. The question is, "can better management of the available rainwater help to reduce the occurrence of droughts and mitigate the impact during periods of low rainfall or in places with low rainfall?".

Over the past 20 years, it is estimated that, Africa has spent about US$4 billion on agricultural research (SWMRG, 2004). The region has also a long history of natural resources interventions and there is a large reserve of technologies to address issues of natural resource management (Boyd *et al.*, 2000). However, according to Ekop and Osuji (2003) only a few improved technologies have been adopted. This indicates that there are abundant agricultural innovations available, but what is missing or needed are innovations in scaling up these technologies to end-users.

As African agriculture remains largely rainfed and as water scarcity issues continue to receive much more prominence, more work on technology development and adoption studies in this area is anticipated (Place *et al.*, 2002). Extensive research indicates that integrated soil and water management and technological innovations in water management can contribute to significant upgrading of rainfed agriculture, which is the dominant livelihood base in large parts of Sub-Saharan Africa (SSA) (Rockstrom and Falkenmark, 2000; Hatibu *et al.*, 1999; Agarwal and Narain, 1997), cited by Masuki *et al.* (2004).

A study by Sivanappan (1999) indicates that, Tanzania, Malawi, Zambia, Zimbabwe, and Mozambique experience rainfall failure once every 3 to 5 years and during that period the rainfall is usually below 50% of the average annual rainfall of the region. The many research and development programmes and projects on natural resources management (NRM) conducted in Tanzania to address problems of declining natural resource productivity has led to development of water system innovations (WSIs) (Lutkam *et al.*, 2005). The best coping strategies to tackle these drought situations would be adaptation and adoption of these WSIs, which can ensure optimum resource use in the watershed without adversely affecting the soil and water base or life supporting system. When these technologies are adopted, diffused and utilized at large scale by communities especially in semi arid areas, the drought effects can be managed (Lutkam *et al.*, 2005).

Innovations that improve productivity and/or conservation of water for crop production are defined as water system innovations (WSIs) (Unesco-IHE and IWMI, 2003). Water system innovations (WSIs) are understood in a wide sense, to include all indigenous and novel technologies for improved agricultural water management, covering both crop and livestock production (Unesco-IHE and IWMI, 2003). Such innovations include deep tillage, mulching or crop covers, terraces, water storage reservoirs, water harvesting and drip irrigation. These innovations aim at improving water productivity (increasing water use efficiencies) while conserving resources and they are appropriate innovations for smallholder farmers. Most of the WSIs have been developed and tested with success in several tropical savannah countries of the world. These techniques despite being well tested (in one area with a certain hydro-climatic and socio-economic setting) are still often novel to the communities where they are promoted (Unesco-IHE and IWMI, 2003). Site adaptations of such technologies are therefore generally required.

Despite the huge efforts and potential for improving productivity, uptake of soil and water conservation technologies to wider areas remain low and thus limited impact on farmer livelihoods (Lutkamu *at el.,* (2005). What is left is rich knowledge base of promising innovations in water management for rainfed agriculture, including a broad spectrum of water harvesting practices, water conservation techniques and integrated soil fertility management. However, very few WSIs show relatively high rate of adoption and diffusion. At present this poses big frustration as little continues to be known on what are the strategies for larger scale adoption, and the preconditions that need to be in place to enable it.

1.2 Statement of the problem and justification of the study

Many restorative technologies have shown to be effective in pilot studies, but the adoption of most of these technologies on a wider scale has always been a concern (Lutkamu, *et al.*, 2005). The report by SWMRG (2004) on the extent of adoption of WSIs in Makanya watersheds indicates that, terraces innovation had only relatively higher adoption rate in the uplands compared to midlands and lowland areas. It was further shown that the terraces innovation was known in the study areas before 1950s, but its adoption involved only few innovators up to the early 1980s. The reasons why terraces had relatively higher diffusion after 1980s are yet to be known. However, this suggested that there could be some strategies or driving forces that motivated them. Hence, this study sought to understand which driving forces or strategies facilitated increased adoption rate of terraces, so that the same strategies could be used to develop new strategies for increased up scaling of other water system innovations.

The knowledge and understanding of the factors or strategies behind the increased rate of terraces adoption would be essential in designing and developing appropriate up-scaling strategies which can bring about high diffusion rate, especially of exogenous (innovation originating from research institutions) WSIs. This could lead to improved livelihood of people in the watershed as Rockstrom *et al.* (2004) argue that there are large opportunities to improve rural livelihoods through adaptive adoption of water system innovations.

According to Due and Gladwin (1991) and Pretty (1995), the greatest challenge for improving water management especially in the semi-arid areas is not so much technical innovations, but rather innovations in the approaches that facilitate adoption of well tested techniques. This study is aimed at filling that knowledge gap by improving the understanding of the factors that facilitate adoption.

This study contributes to the knowledge and understanding of crucial conditions that influence adaptive adoption of water systems innovations by communities in the Makanya watershed. The knowledge obtained is expected to contribute to the planning for promotion of innovations to enhance faster and sustainable adoption at basin level particularly the Pangani River basin. Through adapting water system innovations, farmers will effectively conserve and profitably utilize the soil and water resource, hence increased agricultural productivity and improved livelihood of people in the watershed. This is in line with Tanzania's National Strategy for Growth and Reduction of Poverty (NSGRP) and it will also contribute positively to the aspirations of Tanzania's Development Vision (Vision, 2025). Additionally it will facilitate the implementation of the National Water Policy (URT, 2002) which advocates sustainable water resources management.

1.3 Objective of the study

1.3.1 General objective

The main objective of the study was to examine measures for promoting up scaling of water system innovations at watershed level, by studying diffusion of terraces in the Makanya river watershed.

1.3.1 Specific objectives

(i) To determine extent of diffusion of terraces and extent of terraces' knowledge and awareness in the midland and upland areas of the watershed.

(ii) To explore the driving factors behind high adoption of terraces.

(iii) To determine factors for effective diffusion of WSIs in the Makanya river watershed

(iv) To propose a framework for improved up scaling of WSIs at Makanya watershed.

1.4 Research questions

This study was guided by the following research questions:

(i) What is the extent of terrace technologies diffusion in the midlands and uplands areas of the watershed?

(ii) What are the driving factors behind high and low diffusion of the terraces innovation?

(iii) What are the factors for effective diffusion of WSIs?

(iv) How can increased understanding of terraces technologies diffusion be applied to develop a framework for up scaling of WSIs in the Makanya river watershed?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The history of adoption of innovations

Drawing on the "actor-oriented perspective" in rural sociology, it is argued that successful examples of adoption at higher level result from a complex conjunction of people and events, with outcomes that may have been quite unanticipated at the outset (Cramb, 2001). From this perspective, research and extension projects, circumstances and programs are viewed as arenas in which social actors–village leaders, farmers, researchers (local and international), NGOs, municipal agents, extension workers, and traders–pursue their own short- and long-term objectives and strategies. To this end, they maneuver, negotiate, organize, cooperate, participate, coerce, obstruct, form coalitions, adopt, adapt, and reject the idea, all within a specific geographical and historical context. Out of this process, technology may be developed, disseminated, and adopted. However, there is nothing predetermined about this outcome. Hence, a detailed, case history approach is needed to understand and explain the patterns of success in achieving beneficial technical change.

Sociologists describe adoption as a gradual process that involves sequential stages (Masuki *et al.,* 2004) and innovations have adoption paths with time lag between initial awareness of technology to actual use of the innovation by the adopter. The history of terraces in the western Pare lowlands, as reported by Hatibu *et al.* (1999) and Tumbo *et al.* (2004) indicates to have started as far as the colonial era. Such a long period of time might have facilitated the rise in communities' awareness.

Different opinions are given to explain the impediment of terrace technology adoption. Kauzeni *et al.* (1987) and IFAD (1992), blame the colonial rulers for poor dissemination approaches of the technology. However, the study by Hatibu *et al.* (1999) opposes this opinion and in its place extolled colonial rulers for playing an important role of introducing and disseminating the terrace technology. Hatibu *et al.* (1999) puts the responsibility of drastic slow uptake of terraces technology to the Arusha Declaration era in the 1970s. During this period there was a collapse of the crop marketing system and farmers got so little income from selling their crop that they could not invest in terraces construction.

2.2 Barriers to adoption of agricultural innovations

Agricultural research systems in developing countries are generally responsible with generating and developing innovations for increasing agricultural productivity. However there are several reports, which show that some of these promising innovations are insufficiently taken up by farmers (Knox and Meinzen-Dick, 1999; Sheikh *et al.*, 2002). A study by Meinzen-Dick *et al.* (2003) provided a deep insight of these kinds of innovations. Meinzen-Dick *et al.* (2003) explored the impact of agricultural technology on poverty, with seven case studies, from different developing countries (India, China, Kenya, Zimbabwe, Mexico and Bangladesh) and each with different technology package. Among their observations, they reported that, the impact of agricultural technology on poverty was affected by the rate and pattern of the adoption of that technology. If an agricultural technology was not adopted, it was unlikely to have an effect on poverty. From this study they urgued that the prevalence of poverty, hunger, and poor economic growth rate of most African countries was because of insufficient up take of agricultural innovations by its farmers. This necessitates an urgent thorough understanding of barriers to adoption of agricultural innovations.

The adoption of new ideas and technologies is affected by at least five factors (Rollins, 1993). The factors are; i) type of decision involved in adoption; ii) perceived attributes of the innovation; iii) communication channels used; iv) nature of the client system; and v) the extent of the practitioner's effort. This is so because some innovations relate to the community or individual, some to the situation community or individual is in, and some to the nature of the practice. Some innovations are subject to the control and manipulation of change methodology while others are not (Lionberger and Gwin, 1991).

Several studies have shown significant effect of extension education on adoption of land-improving technologies (Jamison and Lau, 1982; Feder and Slade, 1984; Jamison and Moock, 1984; Rahm and Huffman, 1984) cited by Baidu-Forson (1999). However, some extension agencies are reported to ignore aspects of social and cultural values (e.g. taboos and norms) of a particular society before communicating any agricultural information (Vanclay and Lawrence, 1994). The failure to recognize and address the psycho-social component of technology adoption as part of the educational process has served to illustrate that generating knowledge is not always synonymous with diffusing and adopting knowledge (Rollins 1993). Riesenberg and Gor (1989) cited by Rollins (1993) found that knowing farmers' social and cultural preferences for receiving information would help program planners transfer information about innovative farming practices more effectively. Therefore, in order for extension agents to be effective channels for the diffusion of information, they must be aware of their clients' innovativeness.

Farmers' attitudes toward dissemination institutions and trust in the institutions are some of the key factors in facilitating or hindering dissemination process (Meinzen-Dick *et al.*, 2003). In many cases, there is low level of confidence in public agencies and officials, including those responsible for dissemination of agricultural technologies. Moreover, government's agencies sometimes pay insufficient attention to the role of women in agriculture and their specific extension needs. In general, the study by Meinzen-Dick *et al.* (2003) identified three main factors affecting adoption namely: i) whether the technologies were expected to increase or decrease farmer vulnerability, ii) whether the poor have the requisite assets to make technology adoption worthwhile, and iii) the nature of mediating institutions.

The growing literature on resource conservation and adoption behaviour provides insights into institutional, socio-economic and attitudinal variables which can explain adoption and intensity of use of specific technologies (Nowak and Korsching, 1983). Farmers have identified attitudes to risk/ vulnerability, institutional contacts and farm size as having significant bearing on conservation decisions. Also farmers exhibit reluctance to adopt technologies that expose the farm enterprise to greater risks and they must also be convinced that technical change will indeed bring about greater reward than existing practices (Napier *et al.*, 1991). Attitudes and context factors such as income and the nature of farm terrain were also found to affect conservation behavior (Baidu-Forson, 1999).

Two important observations on adoption barriers can be drawn from a study by Maredia and Minde (2002) cited by Mazuze (2004). They examined the relationship between profitability of agricultural technologies and its adoption by farmers in Eastern Africa. The first observation made was that in Africa, non-technological constraints (e.g. poor infrastructure, bad policies and poor input/output markets) reduce farm profitability and adoption of new technologies. These were also reported by TECA (2005) to be barriers to adoption. The second observation asserted that, there are insufficient continuous efforts to supply technologies that could be adapted with regards to prevailing environmental conditions. Therefore this makes technologies less relevant to farmers to be adopted.

A study by Rahm and Huffman (1984), designed to evaluate the role of human capital and factors that affected the adoption of tillage in corn production, found that farmers' education and experience played a crucial role in enhancing the efficiency of the adoption decision. The same was also reported by Bengesi *et al.* (2004) who conducted a study on farmers' utilization of agricultural innovation in Mwanga District, Kilimanjaro Region. In addition Bengesi *et al.* (2004) identified age, gender, farm size and annual income, as factors that determined adoption.

Further analysis of the reasons for the failure of farmers to adopt new practices reveals the following factors; i) complexity of the technology, ii) institutional factors, iii) conflicting information, iv) risk associated with the new techniques, v) implementation costs in terms of both capital outlay and intellectual outlay, vi) lack of flexibility, and vii) incompatibility with other aspects of farm management or farm objectives, physical and social infrastructure (Farming subculture or farming style), (EPA, 2000; Vanclay and Lawrence, 1994).

According to SWMRG (2004), factors affecting adoption of WSIs can be grouped into four major categories. These are: social factors, biophysical, institutional and technical. Generally, factors affecting adoption of technologies can be grouped and referred to depending on the following: communication methods, technology pathway used, and nature of technology, institutional factors, geographical and different socio-economic-cultural factors of the society. The current study gave much consideration of these factors in an effort to formulate a framework for wider scaling up of WSIs at a catchment level.

2.3 Preconditions for adoption of innovations

Rogers (1995) suggests that certain innovations will be adopted more rapidly than others if they have the following characteristics: greater relative advantages, compatibility, trialability, visibility of the results to others and lack of complexity. According to Rogers (1995) innovations are diffused more readily if individuals in the community perceive them as having greater relative advantage. They also need to be compatible with existing values, past experiences, and needs of potential adopters. Widely diffused innovations are marked by "trialability;" i.e., they may be experimented within a limited basis. The results of the innovation need to be visible to others. Finally, such innovations are marked by a relative lack of complexity and are perceived as easy to understand and use. This framework also suggests that choice of channels for communicating an innovation is a key to its successful diffusion. Most individuals evaluate an innovation on the basis of the experience of peers who have adopted it or people perceived as influential and not on the basis of scientific research by experts (EPA, 2000).

Although the economic theory provides limited guidance on variables that can explain resource conservation actions of farmers (Norris and Batic, 1987) it is known that population growth stimulates adoption of intensification of technologies (Baidu-Forson, 1999). According to Baidu-Forson (1999) as the population density of a river basin increases, the adoption and diffusion of WSIs should also increase.

An interesting observation is given by Perret and Stevens, (2003) who said that; the adoption of conservation practices may not be perceived as a priority for farmers until evidence of deterioration of the environment or alarmingly declining yields are visible.

Most farmers choose between a vast range of options that highlight some of the key performances and attributes of innovations. These include economical, technical, financial, social and environmental (TECA, 2005). In theory, a way of facilitating technology adoption is to make sure that research priorities are in line with farmer's needs and expectations. If the adoption of an innovation does not provide a perceived advantage for some farmers, then it is unlikely to be robust. In addition, according to Perret and Stevens (2003) farmers cannot adopt technologies if they do not have all relevant information about the technology and what scope of returns could be expected after adoption. This second condition is often overlooked. The former is often incomplete, focusing on the technical aspects and overlooking some key criteria from a farmer's point of view (e.g. labour requirements and social aspects). Furthermore, Perret and Stevens (2003) comment that, farmers' organizations should be recognized as the main vehicles for conveying farmers' needs and for technology development and dissemination.

Further analysis shows that other precondition factors for innovation adoption include: the policy environment, regulations, institutional support and outreach, farmer's capacity for adoption of the technology (i.e. the technology is easy to use), cost effectiveness (i.e. benefits of technology transfer exceed its costs), technology performance, and ownership by end users. Access to inputs, incentives, credit and markets, often-technical advice and infrastructure also play essential role, (TECA, 2005; SWMRG, 2004). Additionally, replicability (i.e. adaptability to different geographical and socio-economic-cultural settings) and administrative burden (i.e. institutional capabilities to undertake necessary information collection, monitoring, and evaluation) are equally important.

Pannell (1998) identified three broad conditions that are necessary for an individual farmer to adopt a farming-system innovation These are i) awareness on the innovation, ii) perception that it is feasible and worthwhile to try the innovation, and iii) perception that the innovation promotes the farmer's objectives. On the other hand, Lazaro *et al.* (1999) identified factors influencing adoption to be in three major groups namely technology characteristics, field characteristics and farmer characteristics. These factors also relate to the flows of information between people (e.g. the strength of social networks) and the characteristics of the innovation itself (e.g. easy observability of trial results) (Pannell *et al.*, 2005.

In summary, it is apparent therefore that in order for the transfer of WSIs to be effective, the transfer strategies should meet several pre-conditions which can be grouped into three categories; (i) geographical and environmental factors; (ii) economical, social and cultural acceptable factors; (iii) institutional and administrative viable factors.

2.4 Approaches to technology development

Historically, researchers and change agents have been primarily responsible for identifying and incorporating economic and environmental factors in the process of developing and introducing agricultural innovations (Robert and Timothy, 1999). This research/change agent centered process, usually referred to as a transfer of technology approach is typically characterized as a top-down process where researchers develop the innovation, change agents promote its use, and farmers either adopt or reject the innovation (Robert and Timothy 1999; Selener, 1997). This is also referred to as the Linear-Extension –Model.

In contrast, participatory processes are farmer-centered processes that seek to ameliorate economic and environmental factors that may influence the behaviour of researchers, change agents, and farmers during the development process and to determine the technical knowledge necessary for an innovation's use and adoption (Robert and Timothy 1999; Selener, 1997). Researchers, change agents, and farmers can share their perceptions and gain new insights into the development and subsequent use of an innovation. By using this formative evaluation as part of the participatory process, an end user's satisfaction and adoption is likely to be increased (Robert and Timothy, 1999).

In the 1970s, farming system research (FSR) emerged as an alternative to commodity-oriented research. However, in the second half of the 1980s critics saw that FSR was not delivering the expected results (Tulu, 1998). A series of new methodologies arose – e.g. farmers' participatory research (FPR) - with two main characteristics. First of all, farmers were seen as active experimenters. Secondly, indigenous knowledge was considered crucial. The idea of the 'green revolution' was denounced; local differences were actively identified and used as an entry point for discussions. Coping with ecological uncertainty was a major theme. In practice FPR was done more via development projects than via research institutes (Tulu, 1998).

In recent years, there has been growing dissatisfaction with the slow rates of adoption of agricultural technologies in resource-poor farming systems (Horne and Stür, 1999). This low adoption has resulted partly because when agricultural technologies are developed, there is little input from farmers. Participatory technology development (PTD) offers a way forward, through active, decision-making involvement of farmers in every stage of technology development, (Horne and Stür, 1999). There is no single "right" PTD methodology and there are many tools that are suited to different situations and goals. However, a common starting point for all these approaches is problem diagnosis (Horne and Stür, 1999). The understanding of technology transfer approaches and participatory technology development (PTD) will be useful in the formulation of appropriate methodology for increased uptake of WSIs at the watershed level. Participatory technology development (PTD) is an example of FPR (Tulu, 1998).

2.5 Communication pathways

Dissemination pathways refer to how people learn about or obtain a technology (Meinzen-Dick *et al*, 2003). A technology dissemination pathway plays a fundamental role in affecting who learns about new technologies and who adopts. It is clear that it is not entirely possible to separate adoption from the nature of the dissemination process. However, dissemination processes have a significant impact on who is reached with the technology and how well they are able to take advantage of them.

Dissemination methods have been diversified and range from sole reliance on extension that uses government agents to visiting individual farmers. It involves mass media and a wide array of methods in which farmers are trained collectively, or where farmers train each other. These include farmer field days, demonstration units, seminars, meetings, training for youth in schools, farmer exchanges, and the use of farmers', women's, and church organizations for dissemination. "Model farmers" and/or "adaptive research farmers" (often better-off farmers) who serve as examples to others and adapt new technologies to local conditions participation of the private sector are also used for technology dissemination. Informal methods of exchange and learning among farmers can also play a large role in technology transfer (Meinzen-Dick *et al.*, 2003).

The findings by Meinzen-Dick *et al.* (2003) reinforce the notion that there is no one best method for dissemination. Rather, farmers prefer a diversity of methods, and indeed they are needed in order to reach different types of farmers. This leads to the importance of conducting sufficient ex ante assessment on potential dissemination options—and on the local culture and power relations that are embedded in before determining the most appropriate means of dissemination.

Initially, in Tanzania focus of extension was on human and community development. But there has been a steady progression toward technology transfer, within the policy framework of food security. The most significant recent development was the introduction of the training and visit (T&V) extension management system, in the mid-seventies (Goel, 1999).

By the early 1990's, it was realised that T&V extension approach needed to be overhauled in order to meet the needs of farmers in the 21st century (Goel, 1999). It was then recognised that extension should broaden –the base its programmes by utilising a farming systems approach. For example, attention was paid to the needs of farmers in rainfed areas and to diversify extension programmes into livestock, horticulture and other high value commodities that were capable of increasing farm income. A realisation was also dawned on issues like financial sustainability; lack of farmer participation in programme planning and the weak links with research were serious constraints facing the extension system.

2.6 Successful scaling-up process

Adolph (2005) asserts that the challenge is not only on developing technologies that are appropriate and that respond to local needs, but also to ensure that the uptake pathways for these technologies function effectively, with respect to socio-economic values of a particular area. According to CGIAR, (2000) the impact of agricultural research depends on farmers' access to new technologies and on their capacity to selectively adapt and adopt them. Understanding and establishing favourable circumstances and environments for innovation adoption are therefore crucial and should consider laying out strategies for scaling-up and up-take promotion of new technologies.

There are various sources that provide direct guidance (sometimes described as a "framework") for designing projects and programs to improve the chances for successful scaling-up process. Some of these sources include: World Bank (2003); DFID - NRSP. (2002); Guendel *at el.* (2001); Fliert *at el.* (1999). In general terms, these sources suggest strengthening different entry points in the project cycle—in particular, modifying the preparation stage to take into account scaling-up from the start, either with a sectoral or intervention-specific focus and the implementation phase. They recognize specific pathways for scaling up, starting from the identification of needs, to having people or events which serve as a 'spark' or catalysts to initiate a planning stage through to the management and outcomes of the scaling up process. They also advocate careful designing, planning and consideration of key issues necessary for wider scaling up process. Furthermore, the aspect of taking into account the issue of community participation from the start of the project, throughout the project cycle is much stressed almost in every literature. This is important for ensuring cultural, economic and social aspects are considered in the scaling up.

The World Bank (2003) developed two instruments to support the scaling-up impact for rural development agenda. These are: an analytical checklist to help rural development practitioners and their partners think systematically about scaling-up impact and a list of key considerations to guide scaling-up. The instruments serve as general guide both for analytical purpose and for key considerations to effective scaling up. One of the reasons for focusing on broad approaches is that there is a need for balancing contextual approaches to scaling-up with universal approaches.

In a universal approach to scaling-up, experience provides a set of universal generalizations that can be replicated, directly expanded, or adopted elsewhere with a simple set of rules. This approach does not require identifying and dealing with local variability. In the contextual approach to scaling-up, practices to be scaled-up are tailor-made at the outset to address context-specific conditions. The contextual approach to scaling-up would be expected to take more effort than the universal approach, but it also might be better suited to a particular situation (World Bank, 2003).

Furthermore, the World Bank (2003) suggests that donors, governments, and other development agencies should keep several points in mind when considering issues related to support wider scaling-up of the impact of interventions in rural development. These are: importance of not losing sight of poor or marginalized populations, importance of understanding contextual factors when scaling-up, need to draw universal lessons when scaling-up, approaches to balancing "contextual " and "universal " approaches to scaling-up and potential value of applying lessons from a more comprehensive body of evidence on scaling-up.

For feasible scaling-up, DFID - NRSP (2002) emphasize development and implementation of sound communication strategies as an integral part of the research process. This will ensure that new knowledge is available to users (development practitioners, planners, farmers, etc.) in the forms that they can be utilised and adapted. Eight sets of actions, to be worked through in both the design and implementation phases of research projects are identified for feasible scaling up. These are: (i) identification and participation of stakeholders; (ii) identification and understanding of the target group(s); (iii) assessment of the communication context; (iv) determination of the communication objective(s); (v) identification of, and collaboration with, partner organizations; (vi) selection of appropriate communication products; (vii) definition of the budget implications and activities for the target group(s); and (viii) development of appropriate indicators to assess the potential for scaling-up.

Guendel *at el.* (2001) proposed a framework for guiding scaling up of natural resource management research (NRM). In the framework, they recommended that many of the key strategies which have been identified as prerequisites for successful scaling up need to be addressed more extensively in the pre-project and implementation phases. The framework links chronologically seven key elements, which strengthen the likelihood of successful scaling-up. These elements are: engaging in policy dialogue on pro-poor development agendas; carrying out situational analysis to identify community, institutional and environmental enabling and constraining factors to scaling up; identifying appropriate research objectives and outputs within development processes to ensure widespread uptake; identifying indicators and planning, monitoring and evaluation methods to measure impact and process of scaling up; building networks and partnerships to increase local ownership and pathways to scaling up; and developing appropriate funding mechanisms to sustain capacity for expansion and replication. They also proposed a breakdown of key activities at each project stage and provided a set of attributes to be achieved (or aspired to) in the scaling up process.

The framework by Fliert *at el.* (1999) presents a possible route from problem definition to impact within the context of sustainable agriculture development. The framework emphasizes iterative phasing or cycling of activities and a division of major responsibilities among the various stakeholders, distinguishing three main realms of activity: research and development, extension and implementation, and monitoring and evaluation. These three realms are strongly interconnected, and their respective activities will partly overlap in time and space. Additionally, the process is not limited to a linear set of sequential activities, but allows for cycling within and between the activity realms.

2.7 Synthesis of the literature review

Scaling up is a complex process that requires consideration of socio-economic values of a particular area and the nature of scaling up environment. It can therefore be concluded that even the best guidance (sometimes described as a "framework") for designing projects and programs to improve the successful scaling-up process, will need to be modified in order to suit the environment and the socio-economic values of the particular area.

Hence, a detailed, case history approach is needed to understand and explain the patterns of success in achieving beneficial technical change for particular communities. This will call for the understanding of barriers to adoption of agricultural innovations, pre-conditions for adoption of innovations, and effective communication pathways for successful scaling-up process. This kind of understanding and knowledge will be crucial in developing a framework for successful scaling up of innovations.

According to Meinzen-Dick *et al.* (2003) dissemination pathways refer to how people learn about or obtain a technology. A technology dissemination pathway plays a fundamental role in affecting who learns about new technologies and who adopts. It is therefore clear that it is not entirely possible to separate adoption from the nature of the dissemination process. Dissemination processes have a significant impact on who is reached with the technology and how well they are able to take advantage of the technologies.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Location of the study area

The study was carried out in the Makanya River watershed, which is located in Same District (Figure 1) within the Pangani River Basin. The district of Same is located between latitude 4°8' and 4°25' South, and longitudes 37°45' and 37°54' East. The watershed lies at an elevation of between 600-2500m above mean sea level and has differential physical, socio-economic and farming conditions. The study covered five villages spread along the toposequence. Villages in the uplands included Vudee, Chome, and Suji, and in the midlands included Bangalala and Mwembe.

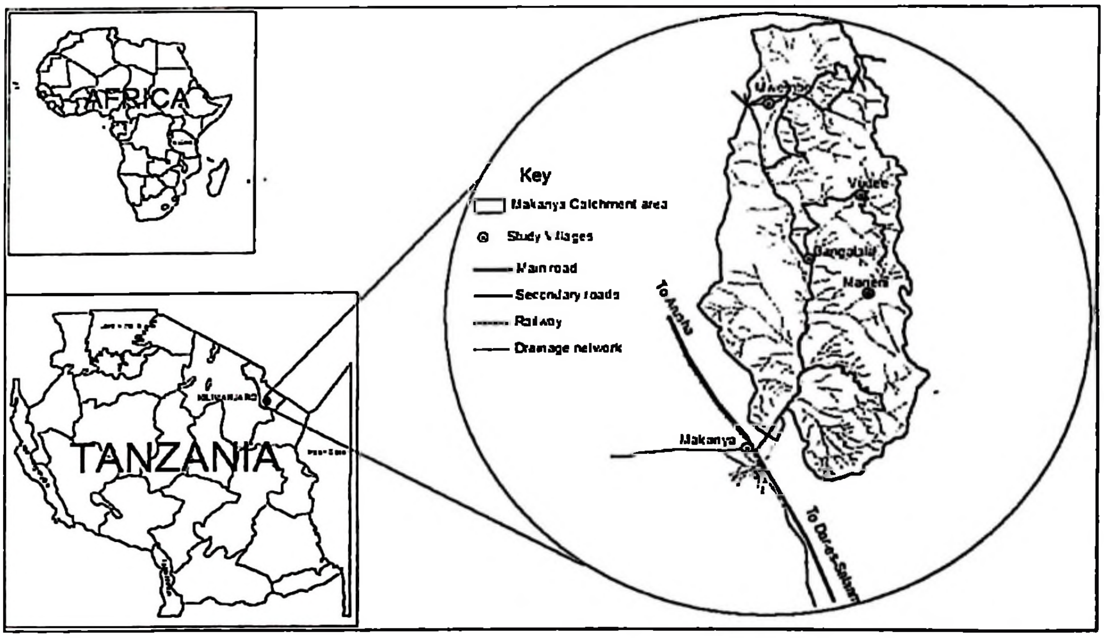

Figure 1: Location of Makanya river watershed

The rainfall pattern is bimodal, with mean annual rainfall of 400 – 600mm in the lowlands and around 800 mm – 1200 mm in the highlands. Climatically, the lowlands are categorized as semi-arid while the highlands are regarded as sub-humid. The short rains start in November and extend to January while the long rains start in March and extend to May.

3.2 Study design

The study employed cross section research design. In this type of research study, either the entire population or a subset thereof is selected, and from these individuals, data are collected to help answer research questions of interest. Time limit justified the use of this design (Casley and Kumar, 1998). The study also adopted participatory learning approach and structured interview,. to collect the information required addressing the research questions.

3.3 Data collection methods

Specific series of data collection was performed to address distinct scope of each researchable task. Both primary and secondary data was collected. Primary data was gathered by using both quantitative and qualitative methods of data collection

3.3.1 Primary data

(i) Objective one

Structured questionnaire and observation were used to collect the information to determine the extent of diffusion of terrace in the midslope and upland areas of the watershed. Respondents were required to indicate if they practice terraces technology or not. If they were practicing, they were requested to indicate what kind of terraces they practiced. In the case of collecting information for extent of terraces' knowledge and awareness: structured questionnaire, focus group discussions, key informant interviews and field observations were the methods used for collection of primary data.

Structured questionnaire was the main tool/instrument employed for primary data collection. The questionnaires were designed to include both open and closed questions and were pre-tested before being administered (Appendix 3). By using the structured questionnaire method, general and specific information were gathered.

(ii) Objective two

The study used FDGs, to discuss possible driving factors behind high adoption of the terraces. Following that FGDs, several factors were identified, these included: sources of knowledge which brought up adoption, communication methods used, and influence of farmers' groups and lastly factors that limited the adoption. Further discussions were held to identify and itemize possible underlying causes for each factor and these were listed. The FGDs, were held before developing the questionnaires. The main reason was to incorporate the inferences drawn during FGDs into the questionnaires (Appendix 2) and the respondents were required to choose on the reasons they consider significant in each factor. In addition, key informant interviews and field observations were also used for collection of information.

(iii) Objective three

A similar approach described above, was employed to collect information for determining factors for effective diffusion of WSIs. After conducting FGDs, two main factors were identified to have influence effective diffusion; (i) innovation adoption pathways. These were identified and itemized. (ii) Pre-conditions to successful adoption of new technology. In addition to FGDs, and questionnaire methods, key informant interviews and field observations were also used for collection of information.

Consultations using participatory workshop included councilors, village leaders, village extension workers and researchers, all from Makanya river watershed. Two groups were formed according to the location along the toposequence (upland and midland). The stakeholders from Vudee, Chome and Suji formed the upland group; and Mwembe and Bangalala villages formed the midland group. These were used to capture researchable issues of each study objectives. Furthermore, focus group discussions and key informant interviews were used to collect general information and historical background for the adoption conditions of terraces and preconditions for appropriate communication pathways.

Participants for key informants and FGD were strategically chosen to take care of social position, age, gender and biophysical factors. The key informants and FGDs composed 10 – 15 members. Composition of the village governments included at least 3-4 members from all the village committee. Personal observations were also simultaneously carried out during each visit to the study area.

(iv) Objective four

The information gathered in objectives one to three, were used to develop a framework for improved up scaling of WSIs in the Makanya river watershed.

3.3.2 Secondary data

Secondary data was obtained by consulting different published and unpublished documents from different sources. The main sources were the SWMRG library at SUA, the internet and research reports and proceedings from the study area.

3.4 Data analysis

3.4.1 Extent of knowledge and diffusion of terraces

(i) Determining the extent of diffusion of terraces

The analysis to determine the extent of diffusion of terrace involved cross tabulation of respondent wards against each type of terraces practiced. The results from the analysis were presented in figures.

(ii) Knowledge and practice of terraces technology

It was hypothesized that the community awareness on terraces innovation was abundant enough to influence higher extent of terraces diffusion in the area. In order to examine the influence of knowledge on the extent of adoption of terraces, respondents were required to indicate whether they were aware of terraces and if they practiced it. Cross tab analysis was done on awareness against practice of either stone, grass or bench terraces.

3.4.2 Driving factors behind diffusion of terraces

Four different factors were considered in analyzing the driving factors behind diffusion of terraces. These factors were sources of knowledge, communication methods to bring about adoption, belonging in-groups and reasons for non-adoption of technology.

(i) Sources of knowledge and communication methods to bring about adoption

Analysis of sources of knowledge to bring about adoption was done by running multiple responses, for different sources of knowledge. The same approach was also used in determining the most effective communication method for communicating new technology at watershed level.

(ii) Influence of farmers' groups

It was hypothesized that farmers' groups were one of the important factors for innovation adoption. The analysis aimed at determining if belonging in a group had impact on adoption of WSI and this was captured by comparison of technology practices with either belonging or not belonging into a farmer group. Cross tab analysis was done to group belonging against practice of terraces technology plus other WSIs.

(iii) Reasons for non-adoption of technology

Analysis for reasons that could lead to non-adoption of new technology was done by running frequency statistic. This determined the significance of reasons to non-adoption of terraces. Reasons with higher frequency were considered to be more significant for disseminating WSI at watershed level.

3.4.3 Factors for effective diffusion of WSIs

(i) Pathways for adoption of innovations and the pre-conditions for successful adoption

Analysis of pathways for adoption of innovations and the pre-conditions for successful adoption were done by running multiple responses for each variable. The factors with higher counts were considered to be the most important than others. The results from the analysis were presented in figures

3.4.4 Qualitative analysis

Data collected through PRA techniques were analyzed by applying the Content and structural-function analysis techniques. The components of verbal discussion held with key informants were also analyzed in detail using the content analysis method. In this way recorded dialogues with respondents were broken down into the smallest meaningful units of information or theme and tendencies. These assisted the researcher in ascertaining values and attitudes of the respondents. Structural function analysis was used to explain social facts by the way in which they relate to each other within the social system and to the physical surrounding. This type of analysis helped the researcher to distinguish between manifest and latent functions. Manifest functions are those consequences, which are intended and recognized by the actors in a system. Latent functions are those consequences, which are neither intended nor recognized (Thomlison, 1965 as cited by Kajembe and Luoga, 1996). The discussed methods were used to do data analysis for the collected information relating to each study objective.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The chapter presents results of data analysis and discusses the findings of the study. The scenarios presented are based on the important aspects that have an impact on wider scaling up of WSIs at watershed level. These aspects are like; extent of diffusion of terraces technology, farmers' involvement in different conservation project, influence of farmers' groups, soil-water conservation measures in relation to slopes and sources of water, criteria/reasons for adoption of terraces, source of knowledge for adoption of terraces, preferred communication channels for innovation adoption, reasons for non-adoption, and pre-conditions for adoption of WSI. The chapter ends by proposing a framework that could improve up scaling of WSIs.

4.1 Extent of awareness knowledge and diffusion of terrace in the midland and upland areas of the watershed

The study was on extent of diffusion of terraces aimed at determining proportion of farmers who had adopted at least one type of terraces techniques. This was achieved by looking at the percentage diffusion of terraces technology. The study also sought to determine the relationship between the extent of knowledge on terraces and the extent of practice of terraces in the midland and upland areas of the watershed.

4.1.1 Extent of diffusion of terrace in the upland and midland areas of the watershed

(i) Upland areas

The results in Figure 2 show the extent the adoption of terrace innovations has occurred in the uplands. The findings show that Vudee had the highest percentage of diffusion of grass terraces (91.%) and stone terraces (64.%) followed by Chome (75.%) grass terraces and (55 %) stone terraces. Bench terraces were the least diffused type of terraces technology in all wards in the upland areas. Steep slopes underlined reason why bench terrace were rarely practiced in the area. The results further reveal that Suji was the ward with the lowest diffusion of terraces; grass and stone terraces were 50% and 16.7% respectively.

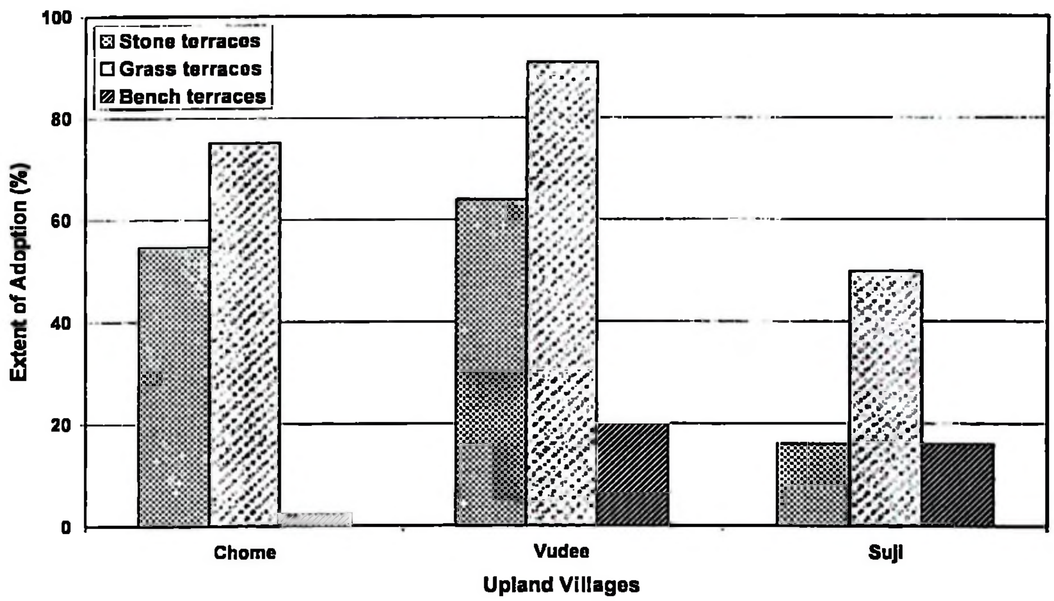

Figure 2: Type and extent of diffusion of terrace technology in the uplands

During key informant discussions and field observations at Suji, it was noted that Suji had very steep slopes compared to the other wards namely Vudee and Chome. It was further reported that it is difficult to construct terraces in steep areas because the flat part of the terrace would be very small whereas the terraces' edge will be very long. This would make the farmer's economic return to be little because of small area of cropping. It was also revealed that some areas are very stony, thus making it difficult to construct terraces. These two factors were given as reasons to explain why the ward was lagging behind in adopting terrace technology. Other reasons for low diffusion of terraces in Suji ward were lack of knowledge and sensitization of farmers and institutions such as NGOs.

(ii) Midland areas

The results for the extent of diffusion of terraces in the midland areas are shown in Figure 3. The results reveal that bench terraces had the highest diffusion (55.6%) in Bangalala. The fact that most of the areas in Bangalala are less steep makes the practice of bench terrace possible and easier. This suggests that the difference in slope (upland and midland) is the reason behind why bench terrace is widely diffused in midland than upland. From this finding it can be said that the topography will determine what type of technologies to be used at watershed level. The findings further reveal that Bangalala had also higher diffusion extent of grass terraces (40.7%) and stone terrace (18.5%) compared to Mwembe (14.3%) grass terraces and (2.0%) stone terraces. Stone terraces appeared to be the least diffused type of terraces with the lowest diffusion rate, in both villages, Bangalala and Mwembe, (18.5%) and (2.0%) respectively. Steep slopes and poor availability of stones for construction of stone terraces were among the underlying reasons why bench and grass terraces were preferred in the midland areas compared to stone terraces.

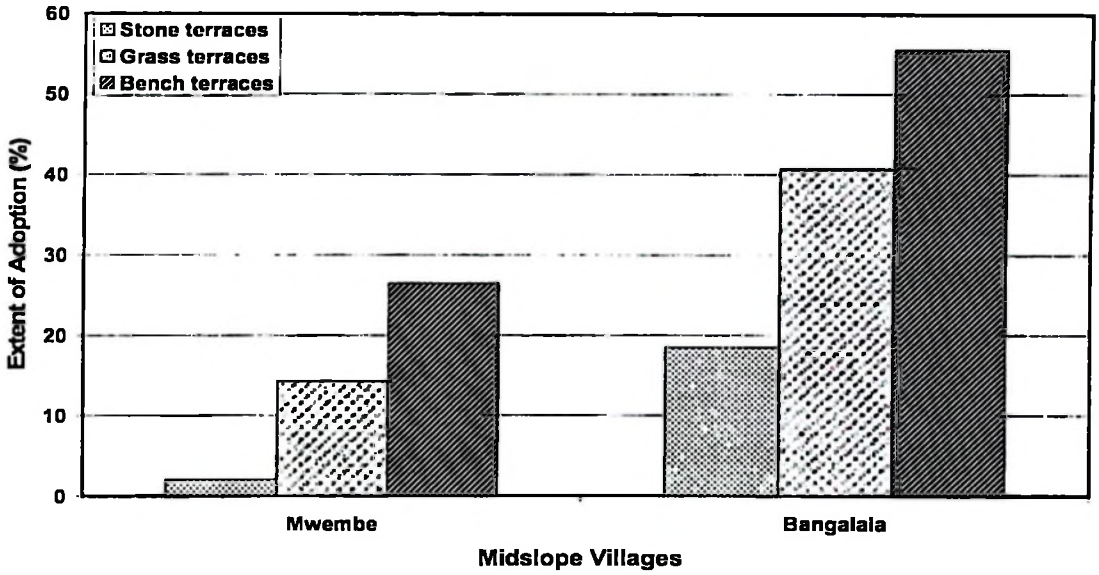

Figure 3: Type and extent of diffusion of terrace technology in the midland

The general observation made from the results in Figures 2 and 3, reveals that there were uneven diffusion of the technology (terraces) between the villages. During FGDs, farmers reported that some villages like Vudee and Chome in the uplands had much intervention and long ones, by NGOs like Same Agricultural Improvement Programme (SAIPRO) and Traditional Irrigation Programme (TIP) whereas in Suji there was none. This was referred to be one of the major reasons for uneven diffusion of the technology. The same reason was given to explain the case of midland villages, where Bangalala had higher diffusion of terraces than Mwembe.

4.1.2 Farmers' awareness knowledge on terraces

The results of farmers' knowledge and extent of use of terraces in the study area are presented in Table 1. The results show that stone and grass terraces portrayed similar general characteristics. Both indicate that many communities were highly knowledgeable but with low rate of practice, as follows:(Stone terrace: Chome- 85% awareness and 55% practice, Suji - 75% awareness and 17% practices. Vudee - 100% awareness and 64% practice. Grass terrace: Chome - 92% awareness and 71% practice, Suji - 81% awareness and practice 50%, Vudee - 100% awareness and 91 practices. This is explained by the 'time lag' between the moment at which a farmer learns about an innovation and the time when he or she adopts it. This argument has also been reported by de Buck *et al.* (2001).

In upland villages the results revealed that Vudee had the highest rate of awareness and practice for both stone and grass terrace. In the case of stone terraces, awareness was 100% while practice was 64.4%. In the case of grass terraces awareness was100% while practice was 91.1%. Although the results further indicated that Suji ward lagged behind in both awareness and practice, for both stone and grass terrace, it can be agreed that its awareness was fairly high (75% and 81%) respectively. The issue of poor practice while the community had fairly high knowledge on terraces suggests that farmers' abundant awareness and aknowledge on a particular technology could not be the only major factor for adoption of a new technology.

Table 1: Knowledge and practice of terraces technology (%)

Location	Village	Stone Terraces		Grass Terraces		Bench Terraces	
		Awareness	Practice	Awareness	Practice	Awareness	Practice
Upland	Vudee	100	64	100	91	24	20
	Chome	85	55	92	75	2	2
	Suji	75	17	81	50	17	17
Midslope	Bangalala	59	19	70	41	56	56
	Mwembe	8	2	14	14	22	27

Several studies have reported awareness as a factor to innovation adoption (Pannell *et al.*, 2005, TECA, 2005; SWMRG, 2004). According to Napier *et al.* (1991) farmers' exhibit reluctance to adopt technologies that expose the farm enterprise to greater risks. Furthermore, they must be convinced that the technology will indeed bring greater reward than the existing practices. This therefore necessitates need for building high the farmers' awareness on a new technology, before wider diffusion can realized.

In the case of midland villages, represented by Bangalala and Mwembe, the results indicate that there was higher percentage knowledge and practice of terraces in Bangalala than Mwembe for both stone and grass terraces. Poor community awareness of stone and grass terraces in Mwembe compared to Bangalala was the main reason for poor adoption of the technology in Mwembe. However, the fact that Mwembe village has a flatter terrain compared to Bangalala could cause the villages not suitable for stone and grass terraces. Nonetheless, midland villages had generally lower percentage awareness and practice for both stone and grass terraces as compared to upland villages.

Results in Figure 4 (c) indicate that there was generally lower awareness and practice of bench terraces in the uplands compared to the midlands. This is revealed by the fact that;

for upland villages, Vudee and Chome had awareness rating of 24.4% and 2.2% respectively, and practice rates of 20.0% and 2.2% respectively. On the other hand, Bangalala and Mwembe had awareness rating of 56% and 22% respectively and practice rating of 56% and 27% respectively.

The results further reveal that some communities were practicing bench terraces without being aware that they were practicing bench terrace technology. This was found in Mwembe, where practice and awareness were 27% and 22% respectively. Lack of respondents' adequate knowledge to differentiate between bench terrace and other WSIs, like *fanya juu* and *fanya chini*, probably could be the reason that can explain the phenomena.

Generally, it was observed that, the community in the study area had high rate of awareness with regard to terraces technology. During FGDs, it was revealed that colonial rulers introduced terraces technology in 1930s. Hatibu *et al.* (1999) also reported the same observations. However, it is reported by SWMRG (2004) that till 1980s the innovation was not widely adopted, regardless that long period of introduction.

The observations made during key informant discussions at Suji, revealed that terrace innovations, were introduced by colonial rulers. But since it was (sometime) used as means to punish criminals, especially people who failed to pay taxes (i.e. they were required to construct terraces in colonial fields), the community developed negative attitude towards it. That was also one of the reasons to explain why Suji had the lowest extent of terrace diffusion among upland villages.

From the findings made on knowledge and practice of terraces technologies in Makanya watershed, sufficient awareness on new technologies is one of the factor for its adoption and diffusion. Time is another factor that served to raise the communities' awareness. This finding concurs with Perret and Stevens (2003), who reported that farmers couldn't adopt technologies if they do not have all relevant information about the technology and what scope of returns could be expected after adoption.

4.2 Driving factors behind diffusion of terraces

This section explores factors behind increased adoption of terraces technology. It was hypothesized that the understanding of the factors behind increased diffusion of terraces could be important for developing framework for improved scaling up of WSIs at Makanya watershed.

4.2.1 The influence of change agents

Multiple responses Table 2 shows the results for the different change agents, which influenced diffusion of terraces in the study villages. Respondents were required to indicate the most common change agents for supporting or promoting adoption of terraces and rank them in order of effectiveness and usefulness in the adoption process.

Table 2: Change agents, which influenced diffusion of terraces in the study village

Agent	Wards					Average
	Vudee (N=45)	Chome (N=137)	Bangalala (N=27)	Suji (N=36)	Mwembe (N=49)	
NGOs	47	26	26	6	8	23
Neighbours	38	19	19	8	8	18
VEO	31	26	22	8	4	18
Inheritance	27	28	11	0	10	15
Government	22	5	4	0	0	6
Training of farmer	13	15	19	3	0	10
Kiwili(self help groups)	11	25	19	3	6	13
Relatives	2	17	7	0	0	5

VEO – Village Extension Officer

The general observation reveals that the results are divided into two major parts. The first part comprises change agents with relatively higher influences to adoption and diffusion of terraces. This referred to Vudee, Chome and Bangalala villages. The second part comprises change agents with relatively lower influences to adoption and diffusion of terraces. This referred to Suji and Mwembe villages. That observation probably explains the reason why there was lower adoption of terraces in Suji and Mwembe villages. Furthermore, the findings divulge that, there is direct relationship between the influences of change agents in facilitating adoption and extent of technology adoption i.e. where there is considerable diffusion of a technology there is also a substantial influence of change agents to facilitate disseminated technology.

The general observation from Table 2 further reveals that the change agents are categorized into two major parts; external agents and internal agents. External agents are those that do not originate from within the community itself, like; NGOs, VEO, and the government. Internal agents are those that are within the community itself and these include inheritance, self help group locally called *"kiwili,"* relatives, and neighbours.

The findings reveal that external agents were more effective change agents especially in villages with higher diffusion of terraces e.g. in the uplands: Vudee (NGOs lead by 47%) and in midland: Bangalala (NGOs lead by 26%). The findings for Chome shows that internal agents did well (Inheritance scored 28%), but external agents were still important (NGOs (26 %) and (VEO (26%). On the other hand the findings indicate that NGOs were less effective in Suji (6%) and Mwembe villages (8%).. This suggests that there was relatively lower degree of intervention by NGOs and development projects in Suji and Mwembe villages and higher degree of intervention in Vudee, Chome and Bangalala villages. On that basis therefore, it can be ascertained that external agents played bigger role in influencing diffusion of terraces more than the internal agents.

The difference in the degree of intervention by NGOs and development projects, between the two areas (Vudee, Chome and Bangalala on one side and Suji and Mwembe on the other side) might underline the reasons for the differences in the extent of diffusion of terraces observed earlier in Figure 2. Furthermore the findings indicate that government institutions as change agents were less effective especially in Suji and Mwembe villages (both with 0%). However it should be noted that where government involvement was relatively high, e.g. in Vudee, Chome and Bangalala (22%, 5 % and 4% respectively), the extent of diffusion of terrace was also high. This probably signifies the potential and importance of Government institutions as change agents for scaling up the innovations.

The results in Table 2 further show that training of farmers (TOF) in Bangalala (19 count) and Vudee (13 count) was among one of the effective change agents which influenced diffusion of terraces. However in Mwembe (0 count) and Suji (3 count) villages, where there was less diffusion of terraces, there was poor use of TOF. This can clearly signify the potential and necessity of TOF in influencing diffusion of WSIs.

The strong influence by NGOs and development projects on diffusion of terraces necessitated further investigation. The history of intervention by NGOs and other development projects in the area was investigated and the results are presented in Figure 4. It was not until the 1980s when the first NGO started working on soil and water conservation in the area. Interviews with key informants also confirmed that there were interventions by an NGO between 1980s and 2000, which promoted terraces. The promotion was successful because farmers had abundant awareness with the innovation, since it was introduced in the communities many years before.

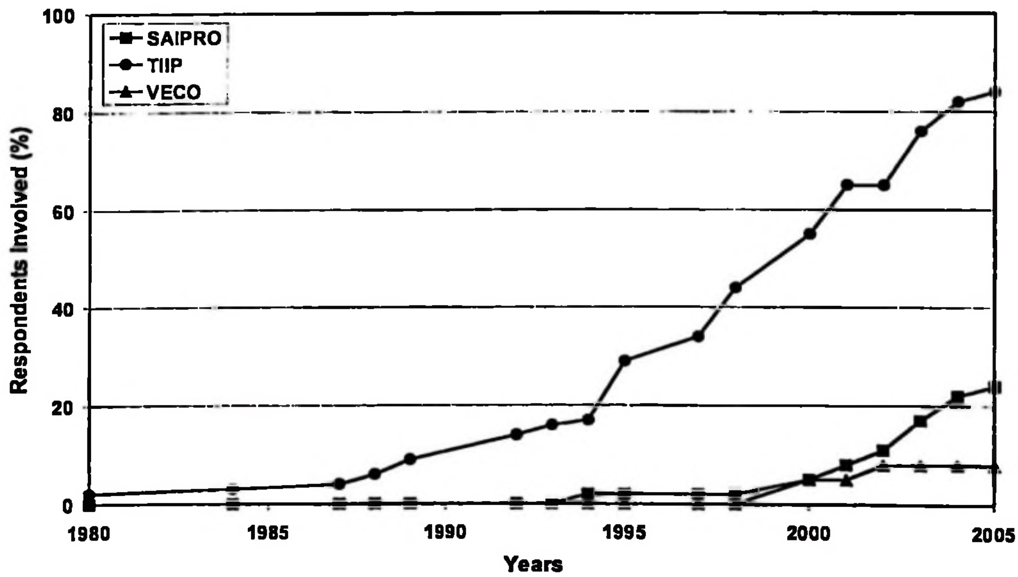

Figure 4: Involvement of the main NGOs in the Makanya watershed

In addition, farmers were assisted by NGOs, to construct or rehabilitate their water storage structure locally called "*ndivas*", but on condition that they should build terraces in their farms. An example was given during focus group discussions in Bangalala village, where farmers were given food aid by CARITAS (a new local NGO promoting agricultural conservation), but with the condition that they build stone terraces in their farms. Since there was severe food shortage, many farmers came out for that service. It can therefore be concluded that the reasons for the increased uptake of terraces innovation was due to the intervention of NGOs and other change agents.

4.2.2 Effectiveness of communication methods and media

Figures 5 and Figure 6 present the results for the effectiveness of different communication pathways in communicating information on terraces. Figure 5 presents the results for the uplands while Figure 6 presents the results for midland villages. The presented result ranks the percentage effectiveness of different communication methods in up scaling WSIs at watershed level. The findings provide understanding of the most effective communication pathways for scaling up innovation. According to Rogers (1995) choice of channels for communicating an innovation is a key to its successful diffusion.

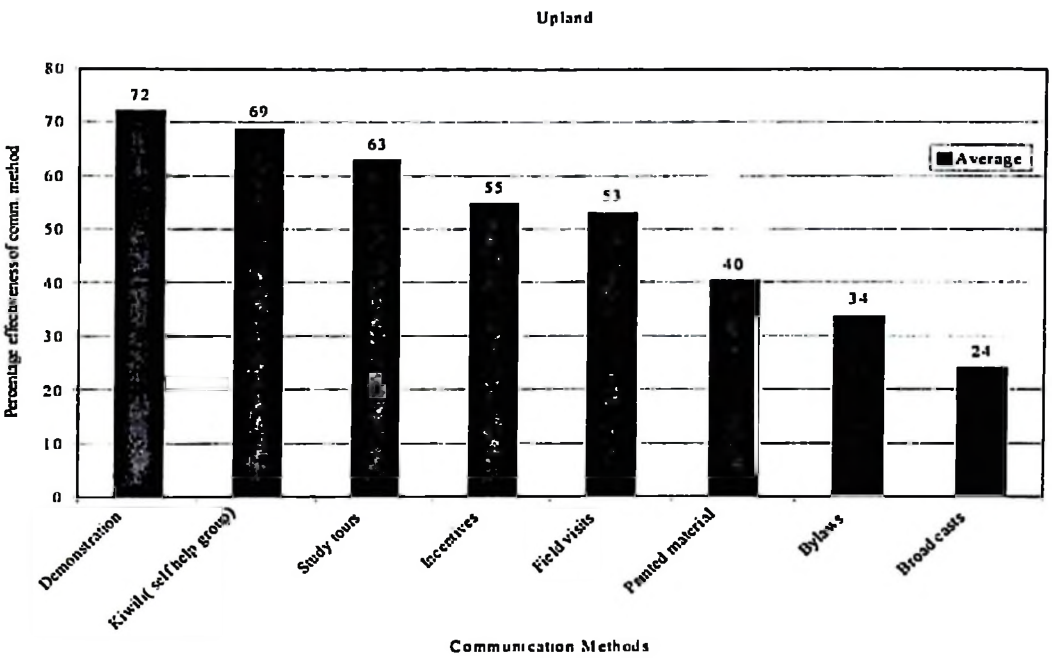

Figure 5: Effectiveness and adequacy of communication methods: Upland villages

The results in Figures 5 and 6 show that field demonstrations was ranked first in every area; upland (72%) and midland (68%), whereas broadcast was ranked last in every area: upland (24%) and midland (13%). This implies that field demonstration was the most effective method of communicating terraces at watershed level. In other words, practical and interactive communication techniques are more effective. Demonstration plots enabled farmers to see the results of new innovation, something that enabled them to determine if the innovation would have greater relative advantage, or if it is compatible with their existing values and if it lacks complexity. These are important prerequisites observed by Rogers (1995) for successful diffusion of new innovations.

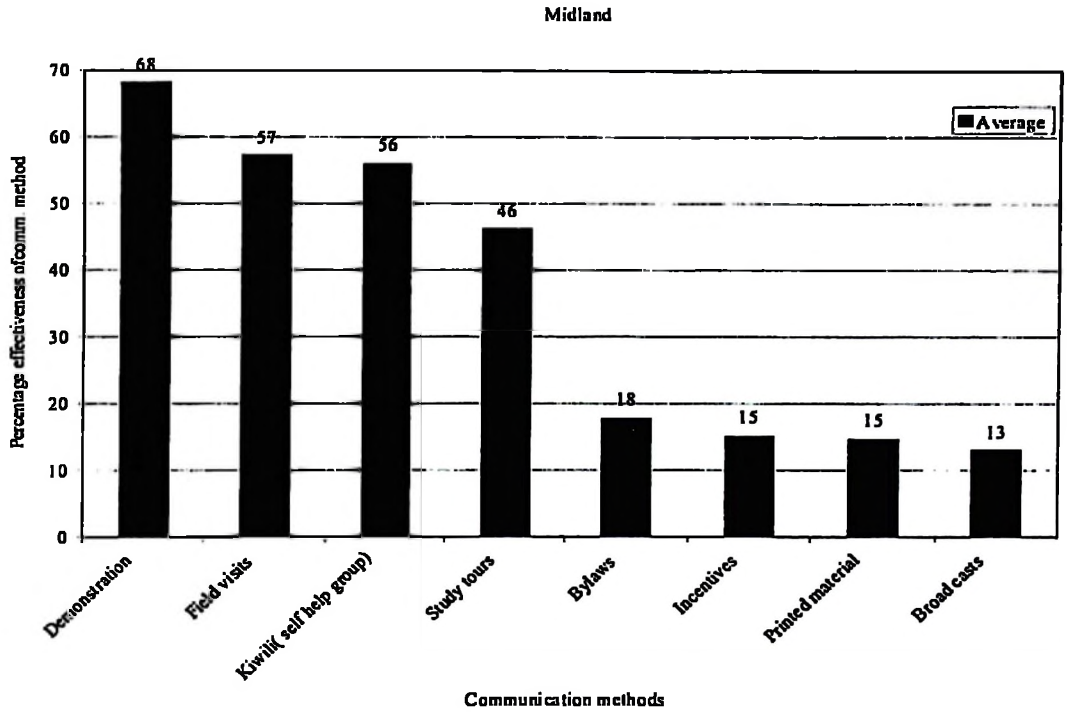

Figure 6: Effectiveness and adequacy of communication methods: Midland villages

4.2.3 The influence of membership in farmers' groups on adoption of WSIs

The results for the influence of membership in farmers' groups on adoptions of WSIs are presented in Table 3. It was hypothesized that membership in farmers' groups had positive influence on the practices of WSIs and therefore on the adoption of innovations. The results indicate that for upland villages, there were considerable variations from one village to another. For example, in Vudee, grass and stone terraces were the major WSIs practiced in the villages and percentage membership in groups were (78% and 61% respectively). This suggests that most respondents practicing the technologies were members of farmers' groups, and it also suggests that by virtue of membership, farmers were influenced to adopt the technologies. The adoption process was further enhanced through interaction and working in self-help groups (*kiwili*). Farmers could learn from each other about the new technology or could be forced to adopt new ideas because of social pressure. In conclusion, membership to farmers' groups was an important tool for adoption of innovations in Vudee.

Table 3: Membership in farmers' groups and practices of WSIs

Location	Villages	% farmers in groups and practicing WSIs (Respondents' Counts in brackets)		
		Grass terraces	Stone terraces	Bench terraces
Upland	Vudee	78(18)	61(13)	-
	Chome	46(52)	39(41)	0(2)
	Suji	0(8)	100(7)	0(2)
Midslope	Bangalala	89(9)	100(4)	83(6)
	Mwembe	67(6)	-	40(5)

In Chome, the situation was the opposite from Vudee. For the major WSIs practiced i.e. grass and stone terrace (46% and 39% respectively), each one had percentage less than (50%) of the respondents belonging to groups. This implies that in Chome, membership in a farmer's group was not as important to influence adoption of innovations as in Vudee. However, Vudee has higher level of diffusion of terraces than Chome, which might imply that membership in farmers' groups might be an important factor for wider adoption of innovations.

For the case of the midslopes; in Bangalala village, grass terraces had (89%) percentage membership and (100%) percentage membership for stone terraces, suggesting that most respondents were members of groups. Generally the findings show that farmers' groups were important in disseminating WSIs. Additionally, since in Bangalala there was strong group memberships and also higher extent of diffusion of terraces than Mwembe, therefore group's membership was therefore still important factor for scaling up innovation even in Mwembe.

Furthermore, the study investigated major mediators for initiation of farmers' groups and the results are presented in Figure 7. The results indicate that initiation of group formation was done mainly by farmers themselves and NGOs. Farmers' initiatives had the highest percentage (45%) followed by NGOs and other projects working in the area (41%). Though it seems that the two factors had almost the same percentage, but it should be remembered that not all farmers' groups had agenda in soil and water conservation. Farmers are faced with a variety of priorities, needs or problems, alternative choices of solution. Therefore they might form a group to solve different soil and water conservation problems. However all groups formed by NGOs, were on soil and water conservation as their main agenda. This suggests that groups formed by NGOs were important uptake pathway for WSIs.

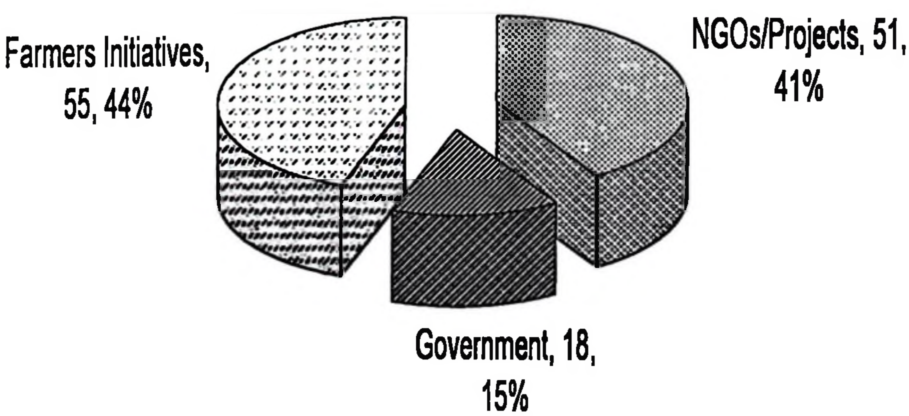

Figure 7: Initiation of group formation

4.2.4 Reasons for non-adoption of terraces

Investigation was also done to understand why some farmers could not adopt terraces. Figure 8 present the results for reasons that contributed to non-adoption of terraces in the Makanya watershed. The results indicate that lack of initial capital, which requires a farmer to own in order to invest into new technology, was ranked first, with 30 counts. The biophysical or terrain and lack of technical know how were ranked second and third with 28 total counts and 27 counts respectively. Labour, which is required for implementing the technology by a farmer, was ranked fourth with 16 counts. The study by SWMRG (2004) reported similar results although ranking was not done.

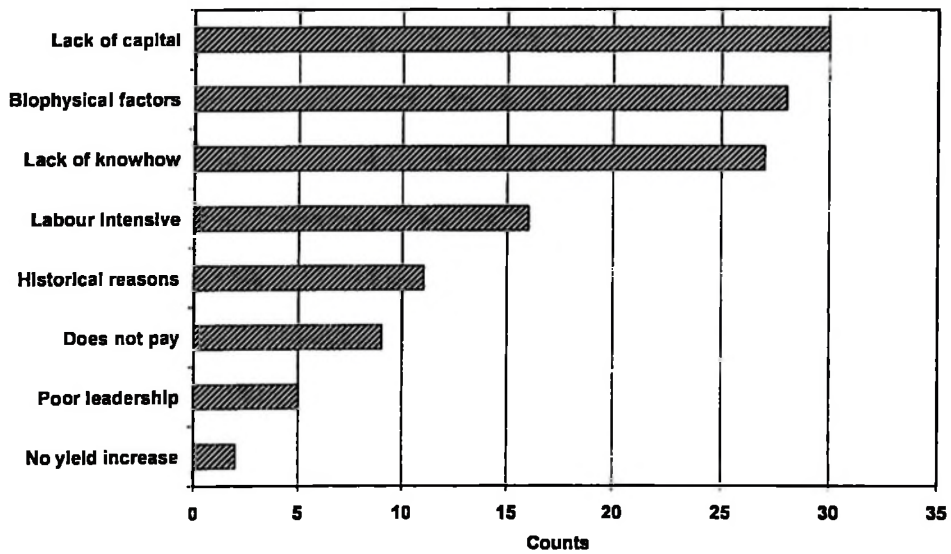

Figure 8: Reasons for non-adoption of WSIs

The perception that terraces do not increase yield as one of the reasons for non-adoption of WSIs were ranked last with 2 counts only. The underlying implication here is that the communities at watershed level accept terraces and understand what this technology can do to improve their production and livelihood in general. This provides an important opportunity for scaling up WSIs in the watershed.

A problem of non-adoption might also be attributed by other factors different from the yield performance of the innovation. Respondents revealed that poverty and food insecurity affected adoption of terraces in two main ways; firstly, due to food shortage, farmers were forced to spend much time in looking for and doing casual labour in order to get income to buy food and other families needs. As a result there was inadequate time for developing their farms. The second was the fact that construction of terraces requires resources, (in terms of labour, finance and time), also reported by (SWMRG 2004). Consequently, poor farmers could not get substantial capital for investing in construction of terraces.

Farmers' perception on technologies is one of the determinant factors of the technology sustainability (Sinukaban, 2001). Farmers' attitudes and perception are of crucial importance to successful research and development strategies. Many promising agricultural innovations and supporting policies failed because they were inappropriate to farmers' needs (Wossink and Boonsaeng, 2003). To prevent such failures, a good understanding of the behavioural and operational constraints at the farm level is required. The contribution of economic analysis in addressing this state of affairs is that it can identify the behavioural factors and farm level constraints determining adoption (Wossink *et al.,* 1997). Poor leadership toward diffusion of WSI had 5 counts while the factor that WSIs could not increase yield had 2 counts. These, two factors were ranked lowest, indicating that they were less important in hindering the adoption.

4.3 Factors for effective diffusion of WSIs

After the study covered the reasons for diffusion and non-diffusion of terraces, further investigation was carried to find out what were farmers' perceptions about factors that are important for promotion of up scaling of WSIs. The idea was to pay much consideration on these factors in developing the framework for promoting up scaling of WSIs. The investigation involved finding which preconditions are needed to be in place for wider adoption of innovations and also to establish effective uptake pathways that are needed. Relative importance was used in the ranking. A parameter with the highest relative importance means is more preferred. The results rank and indicate separately the parameters for areas with low adoption (Suji and Mwembe) and areas with high adoption (Chome, Vudee and Bangalala).

4.3.1 Preconditions for diffusion of WSIs

The results for preconditions of adopting new innovations at Makanya watershed are presented in Figure 9. Respondents were required to rank different preconditions for adoption of WSIs; this was done in accordance to their effectiveness, significances and suitability in the watershed.

The general observation reveals that preconditions for adopting WSIs were the same in areas with low adoption as well as in areas with high adoption rate. Similarity was also noticed in terms of ranking. The ranking was done according to the effectiveness and significances of the factors for precondition.

In both, high and low adoption areas, training on the new technologies was ranked as the first precondition for adoption of new innovation, (16.4%) and (16.8%) respectively. An innovation brought in without proper training will not easily be diffused. Technologies that conservation promoted followed with scores of 15.2% in low and 16.1% in high adoption areas. This probably indicates that for an innovation to be adopted and diffused it should clearly convince the communities that it is effective in conserving the soil and/or water resources.

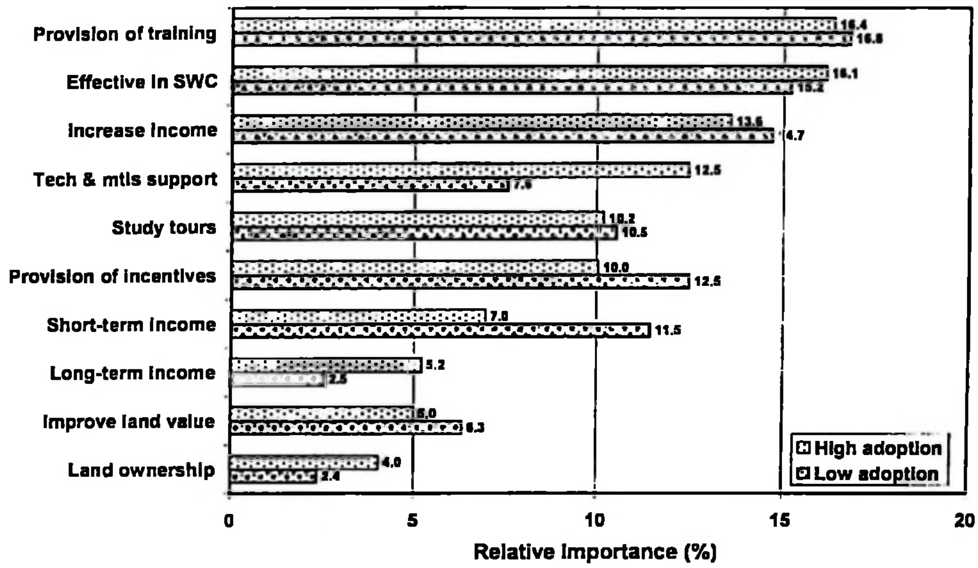

Figure 9: Preconditions for adoption of WSIs

Increase income was ranked third with 14.7% in low and 13.6% in high adoption area. This shows that in order for an innovation to be adopted it should convince farmers that it would improve their farm productivity and hence increase their income. In connection to that, in the low adoption areas, short-term income and provision of incentives were seen to be important while technical and material support was seen to be important in the high adoption area. The meaning of incentives and technical support could be the same with the high adoption area being more specific on the type of incentives. Provision of incentives in terms of material support was among the strategies used by NGOs in promoting adoption of terraces, especially rehabilitation and expansion of water storage systems in which NGOs provided cement and reinforcements.

4.3.2 Pathways for up scaling of WSIs

For research outputs to reach the targeted communities or end users, it is important to understand the effective uptake pathways of the innovations. The study therefore sought to investigate on the effective pathways for adoption of WSIs in the Makanya river watershed. The results are presented in Figure 10.

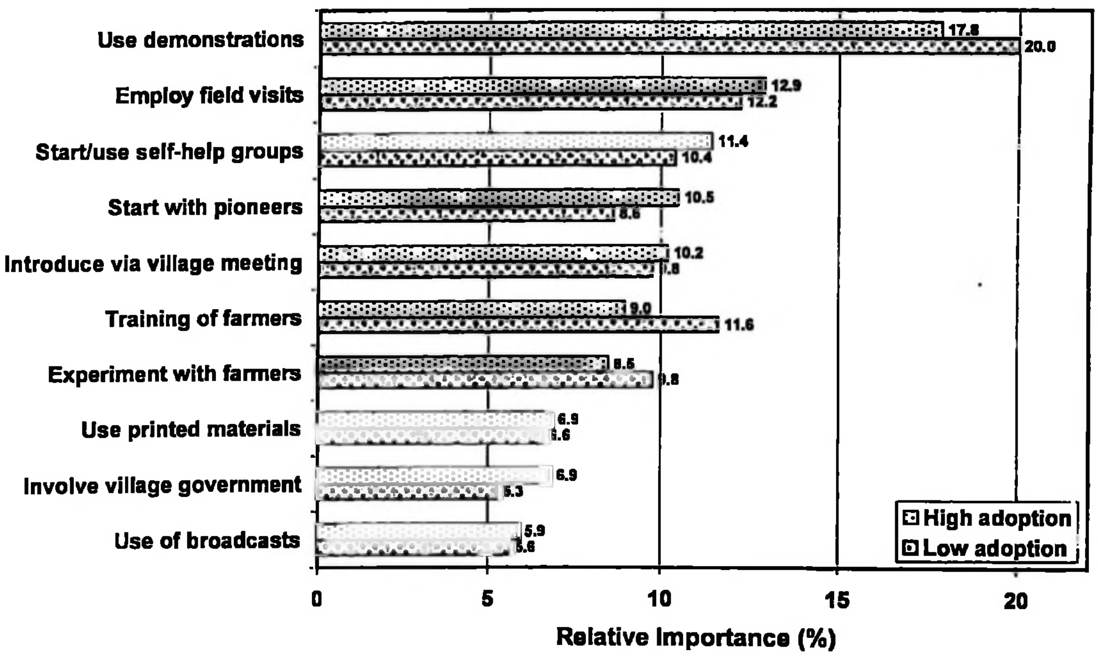

Figure 10: Suitable pathways for WSIs up scaling in the Makanya river catchments

Demonstration emerged to be the most preferred pathway for disseminating new technologies and ideas in both the high adoption (17.8%) and low adoption (20.0%) areas. This was followed by field visits with 12.9% and 12.2% and self-help groups with 11.4% and 10.4%, for high and low adoption areas, respectively. These results could suggest that farmers prefer pathways, which are interactive. These pathways could be the most suitable pathways for farmers who are old and to those with low literacy level, since such methods enable farmers to learn new ideas by seeing and doing.

Use of broadcast was the least preferred pathways with (5.9%) in the high adoption areas and (5.6%) in the low adoption areas. This was followed by involvement of village government and use of printed materials suggesting that the use of media in disseminating WSIs is less preferred. This is due to the fact that not all farmers had access to radio or could read the printed material. However, lack of reading habit and lack of time especially for women could also contribute to the reasons for their poor suitability. These findings concur with results reported by Lutkamu *et al.* (2005) who found that although printed materials were identified by farmers as source of information, their availability at village level and the level of literacy, especially among elderly farmers, were major limitation to their use. Also, farmers do not see the necessity of involving village government for them to adopt new innovations however; this does not mean the village government should not be involved completely.

Generally, the findings can be grouped into three major categories for both, upland and midland areas. The first category is pathways which show high suitability, this includes; demonstration, field visits and working in groups. The second category is pathways which show moderate suitability: this group include: starting with pioneers, village meeting, training of farmers and farmers experimentation, while the third category includes pathways which show less suitability, and this include; use of printed material and broadcast and involvement of the village government.

From these groups it can be summarized that pathways in category one, are the most suitable for disseminating WSIs. However, it should be remembered that there is no one best method for dissemination of innovations, rather a diversified use of different pathways is preferred by farmers and indeed is needed in order to reach different types and classes of farmers (Meinzen-Dick *et al.*, 2003). A similar opinion is also given by Masuki *et al.*, (2004) who asserted that the more alternative pathways the farmer has, the more the farmer intensifies adoption of WSIs. Therefore for successful dissemination of WSIs in the Makanya river watershed a combination of adoption pathways especially categories one and two above are greatly required.

4.4 Framework for improving scaling-up of WSIs

4.4.1 Introduction

This section presents and discusses a framework for improving scaling-up of WSIs at watershed level. The framework, Figure 11 is divided into three main phases: pre-implementation, intermediate and implementation phase. Pre-implementation phase is essentially for observing the beneficiaries prerequisites for innovation adoption and diffusion. The main activity includes validation of innovation to be scaled up. Validation is expected to be done by the innovation- introducing agent referred to as an external change agent. Intermediate phase is mainly for laying ground for popular participation in the scaling-up process and for influencing decision that can facilitate innovation uptake. It is also an important phase for laying ground for sustainability and horizontal scaling-up process. The third phase is implementation. Here is when all strategies and plans for uptake of innovation are put in practice. Subsequent sections provide details of the framework.

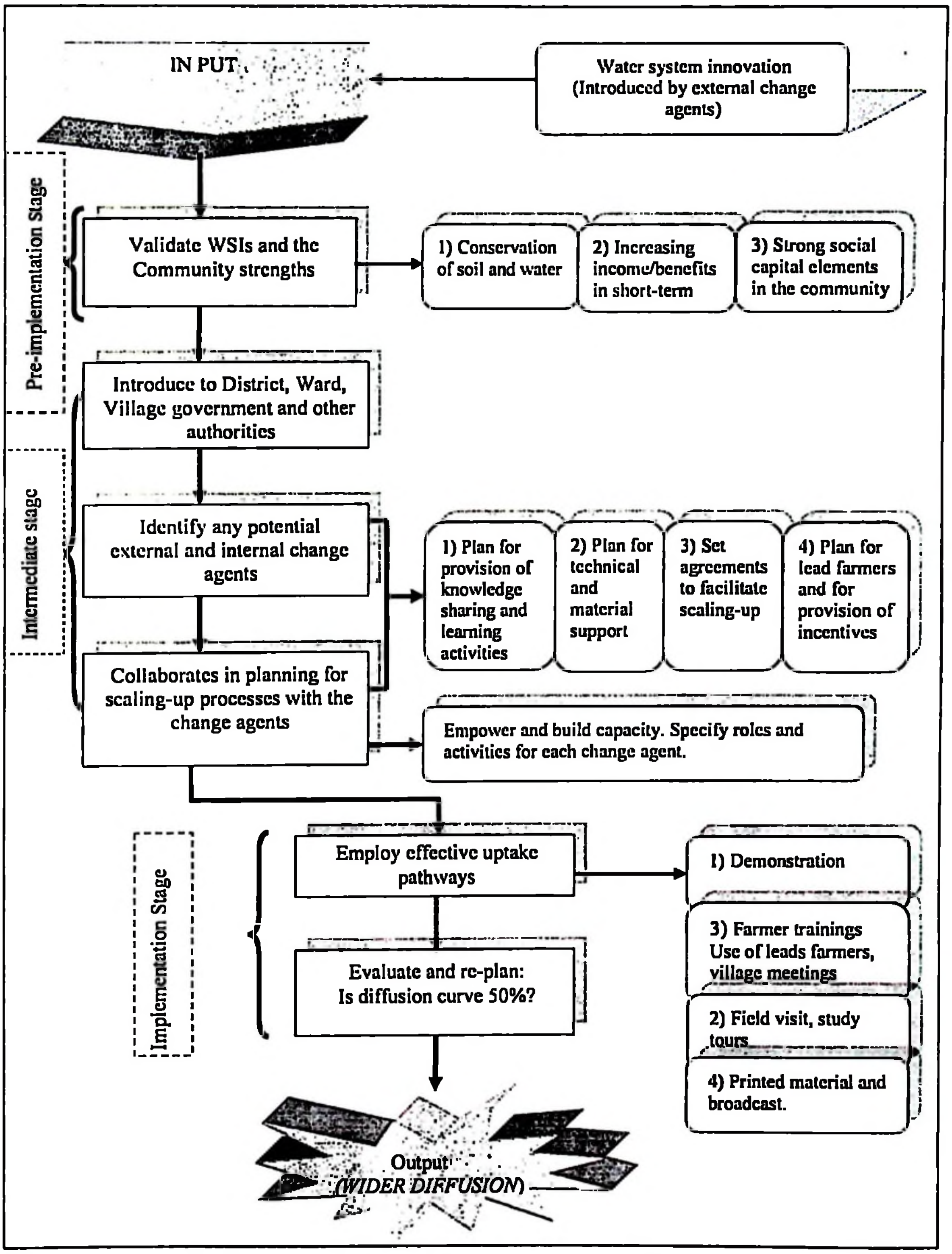

Figure 11: Proposed framework for guiding scaling-up of WSI at watershed level

4.4.2 Pre-implementation phase

The external change agents like, NGOs, development projects, and Government institutions are expected to be the main triggers and facilitators of the scaling-up process. In that case they are supposed to prove beyond doubt that the innovation (s) at hand will be useful and that the technologies will effectively and efficiently bear benefits anticipated by the beneficiaries but also the community has strong social capital which will be used as a foundation.

Validation should consider the characteristics of the innovation and the environments of diffusion at the community or watershed level. From the findings, an innovation should have a strong property of effectively conserving soil and water, which farmers should be able to observe over time during implementation stage. These means therefore that the innovations to be scaled up should clearly prove and convince communities at watershed level that they are effective in the conservation of soil and water resources. Increased farmers' income or benefits was also one of the highest parameters in the pre-conditions for adoption. This again shows that farmers prefer to adopt technologies that give quick return of their investment either in monetary or labour-saving terms. This is probably due to the fact that the cost of adopting WSIs is high and while most farmers are poor. In communities where social capital is very low especially trust followed by groups and networks, it is difficult to successfully promote innovations. In such cases, the change agent will have to find strategies to build trust among farmers and between farmers and local change agents while promoting the innovations.

4.4.3 The intermediate phase

(I) Introducing to government authorities

Introducing to authorities is a first step of the intermediate phase. Here the external change agent will have to contact the respective authorities in the watershed from the district to the village level and when applicable to tradition leaders. The purpose is to introduce the idea of scaling-up and possibly develop a multi-agency involvement in planning for scaling-up at the local level.

(ii) Identifying Potential external and internal change agents

The general observation made in the previous studies revealed that there were two major categories change agents: external and internal or local. External agents were those that did not originate from within the community itself, such as NGOs, Village Extension Officers, and government institutions. Internal agents were those, which originated within the community itself. These included farmers groups, pioneers, neighbours and relatives. In both cases, it was observed that the external and internal change agents were important in the diffusion of terraces. For example, in the case of groups, farmer could learn from each other about the innovation or they could be forced to adopt the innovation because of social pressure. According to Perret and Stevens (2003), farmers' organizations should be recognized as the main vehicles for conveying farmers' needs and for technology development and diffusion. There is a need therefore to exploit the potential of other external organizations and farmers' groups, in scaling-up of WSIs in the watersheds.

(iii) Establishment of local change agents

Establishment of local change agents can be done through building the capacity of local change agent. Capacity building will encompass organizing training and workshop aimed at promoting human resources, use of available physical facilities, and providing technical know-how. After building the capacity and possibly empowering the local change agents then there could be effective collaboration between the two agents. This could strengthen local ownership of the scaling-up process and thus sustainable scaling-up of WSIs.

During the intermediate phase, after covering the three steps under it that is introduction to authorities, identifying potential local change agents and establishing them, then the main activity will be planning for the scaling-up process. The core group of the main change agent, identified change agents to work with, lead farmers will have to work together to plan for provision of knowledge sharing and learning activities; plan for sustainable accessibility of technical and material support; set bylaws that will facilitate the scaling-up process also set scaling-up goals; and lastly plan for lead farmers and for provision of incentives.

During focus group discussion it was noticed that use of lead farmers was significant in diffusion of technologies. However, it was further noticed that effectiveness could increase if individuals are carefully selected with much consideration of individuals' social acceptability. According to EPA, (2000) personal relationships foster direct interest and enthusiasm, increasing the chances of institutionalization and spread of ideas. The selection should therefore ensure appropriate interactions between the selected farmers and the community at local level and those who have influence on a larger scale. Most individuals evaluate an innovation on the basis of the experience of peers who have adopted it or people perceived to be influential and not on the basis of scientific research by experts (EPA, 2000).

It was also found in this study that for effective diffusion of WSIs, there is a need for provision of incentives. Even though not very appropriate, the local NGOs called CARITAS provided food aid in return to building terraces in Bangalala village, because the area was frequently hit by food shortage. Normally farmers respond positively to short-term needs.

Incentives can also be in the form of support to the activities undertaken by the self-help groups such as *kiwili*. This is not permanent group, because it is formed when individual farmer wants to do something which is labour intensive. The lost call other farmers to come and help him or her and provide them with tea or local brew. Such opportunities can be used by change agents to support construction of WSIs.

Agreements are aimed at facilitating the scaling-up process. In order to make sure that they are effective and efficient it is advised that there should be binding agreements which will enforce farmers who are selected to participate in the study tours to practice the new technology or demonstrate them to other, on their return, to enable others farmers to learn.

4.4.4 Implementation phase

(i) Employ appropriate diffusion pathways

Generally the findings indicate that uptake pathways are divided into two main groups: interactive and none or less interactive ones. Interactive pathways are mostly preferred compared to none or less interactive ones. Interactive communication pathways includes: demonstration, field visits, study tours, farmers training, working in groups (farmers group), and working initially with lead farmers. Non-interactive category include; use of printed material and broadcast. In the framework these factors for innovation uptake pathways are arranged chronologically in respects to respondents' prioritization and perception on their effectiveness.

For successful scaling-up of WSIs it is recommended that there should be a combination of these uptake pathways. Mixing these pathways will serve to reach all classes of people in the communities, especially the less privileged class: poor, old, young, and women. Using different uptake pathways will also serve to accommodate different levels of literacy in the community.

By employing different uptake pathways it is expected that that the community knowledge and awareness on WSIs will increase and therefore improve uptake pathways. Findings on awareness knowledge and practice of terraces technology showed that communities with higher awareness knowledge also had higher adoption of terraces technology. Building and raising abundant awareness and knowledge on WSIs will be of great importance for successful scaling-up of WSIs.

This concurs with Perret and Stevens (2003), who said farmers couldn't adopt technologies if they do not have all relevant information about the technology and what scope of returns could be expected after adoption. Change agents will therefore be required to aim at raising the communities' awareness and knowledge on WSIs, through the discussed communication methods and adoption pathways before remarkable scaling-up can be noticed.

(ii) Evaluate the scaling-up process

Establishment of orderly monitoring and evaluation systems will be important for tracking the implementation performance of scaling-up. This will give a picture of extent to which scaling-up outputs are being achieved in accordance to the time frame. Evaluation could lead into better decision-making on the need for adjustment of implementation strategies or on the need for re-planning.

Furthermore, from the findings, it was observed that time frame for widespread diffusion is normally long ranging between 10 and 20 years. It was noted that when the extent of adoption reaches about 50% and therefore the early majority have already adopted the innovations and the remaining group is only the late majority. Therefore, continuous monitoring on the extent of adoption by plotting the diffusion curve will be important.

It is proposed to document and analyze the circumstances in cases where certain innovations, did not spread or did not have the positive effects envisioned. "Failure stories" would be complementary to "success stories," as they can yield important information about the necessary conditions for and constraints to scaling-up. Agricultural development is largely based on trial and error; it is healthy to recognize the errors in order to avoid excessive optimism and to counteract the "postcard syndrome." If these non-successful cases are regarded as sources of learning, this could help to modify the technology or avoid the repetition of mistakes.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

5.1.1 Diffusion of terraces in the Makanya watershed

The study examined measures that promoted diffusion/scaling-up of terraces in the Makanya river watershed. The study examined the extent of awareness and knowledge and adoption of terrace in areas with and without diffusion of terraces. Five villages were used of which three were with diffusion of terraces (Vudee, Chome and Bangalala) and two without diffusion (Suji and Mwembe). Furthermore, three villages were in the upland (Vudee, Chome and Suji) while the other two were in the midslope areas. The study investigated the driving factors behind the diffusion of terraces and reasons for lack of adoption in the other areas.

The findings show that Vudee has a higher level of diffusion followed by Chome and Bangalala. For example for grass terraces, the extent of adoption was 91%, 75% and 41% for Vudee, Chome and Bangalala, respectively. The higher level of diffusion were attributed to interventions by external agents (especially NGOs), which increased awareness and how-to knowledge on terraces, employment of interactive communication pathways (demonstrations, study tours, field visits) and use of self-help groups. Another important reason was the continuous active presence of NGOs, which allowed more people to be involved in the programme activities. In this study it was found that some respondents were involved since 1980 and 1994 with TIP and SAIPRO, respectively. Even though the NGOs were the most important change agent but the significant support of other change agents made a difference in some villages. For example, neighbours, village extension officers, inheritance, training of farmers were also important. The Government's role is also very important as it was seen in Vudee village where its role in diffusion was more significant than of self-help groups, training of farmers and relatives.

For the villages without diffusion, which are Mwembe and Suji, it was found that lack of or minimum external interventions was one of the reasons for poor diffusion of terraces. In general, even the role of the other change agents was insignificant and the role of the Government was completely zero. Posthumus (2005) noted that external interventions stimulate initial adoption of SWC practices by also bringing in incentives to give a boost to the initial adoption. Similarly, most of the adopters of terraces did not belong to self-help groups, which is another means for communicating information about terraces. The level of awareness and knowledge was also low compared to areas with higher extent of adoption. The most important reasons provided for non-adoption were lack of capital, biophysical factors, and lack of knowhow. Other minor reasons included labour, historical reasons and the belief that terraces do not pay. Posthumus (2005) noted that there is no financial benefit from terraces for farm households if there are no markets for the increased yield, the improved land, or the saved labour. In this study, it was noted that promotion of terraces was linked with rehabilitation of water storage reservoirs (*ndivas*) and development of markets. The water storage reservoirs were used to supply water to terraces so that high value crops could be grown.

The study therefore, argues that scaling-up initiatives for conservation-based WSIs should consider and effectively use the Government, village extension officers, local change agents and self-help groups. For sustainability of the initiatives, continuous promotion and involvement of more farmers over time should be built into the programme. Moreover markets should also be developed. In the process, the programme should use more interactive communication pathways and just supplement with non-interactive ones such as printed materials and broadcasts.

5.1.2 Framework for improving scaling-up of WSIs

The framework for scaling-up water systems innovations aims at increasing communities' awareness and knowledge on WSIs before scaling-up could take place. It also aims at decentralizing control of the scaling-up process and develops a multi-agency involvement in planning at the watershed level. These are expected to bring about a sustainable scaling-up process and more involvement of communities.

The framework is not cast on concrete but can be used as a guide for review during scaling-up process. A study by Guendel *at el.* (2000) revealed that not all enabling and constraining factors can be identified at the outset. So, the scaling-up activities will need to build in a mechanism to review new issues and plan around them or with them.

Desired outcomes and impacts of scaling-up can be quite different from one place to another, not withstanding outward similarities. Furthermore, different stakeholders might have different perspectives on what they consider success (World Bank 2003). In that respect it might be necessary to consider or assess the outcomes, impacts, or costs of scaling-up activities of WSIs. The U.N. Millennium Development Goals provide a common reference point that can be helpful in identifying measures of success in scaling-up WSIs. From this perspective what could be considered successful scaling-up of WSIs is when there are two things: when extreme poverty and hunger is eradicated, and when environmental sustainability in the watershed areas ensured.

5.2 Recommendations

(i) Further researches should be done to discover appropriate WSIs for steeper areas. The study found that some communities staying in very steep areas could not practice terraces mainly because it was difficult and uneconomical to construct them. This was unveiled during key informant discussion in Suji, the village believes to have most of areas steeper than other villages in the upland.

(ii) Since lack of capital required for adopting or implementing the technologies was ranked as the first reason for non adoption and since this reflected the effects of poverty in diffusion of WSIs, it is therefore recommended that further studies should be done to examine how the implementation of the National Strategy for Growth and Reduction of Poverty (NSGRP) can effectively contribute on diffusion of WSIs. The study believes that the improved up scaling of WSIs, will ensure sustainable livelihood of the communities in the study area.

(iii) Since it was pointed out that there was poor communication between village leaders and change agents, it is recommended that there should be regular quarterly village meetings, whereby experts can give reports on the dissemination process and the leaders together with villagers gets to discuss on difficulties arising and their possible solutions. These kind of meetings can be important for further creation of awareness about the technologies and change agents getting feedback from the community, which can help them to adjust their dissemination strategies. In addition this can also serve as tool for doing evaluation and monitoring of the scaling up process.

(iv) Since there are incessant food shortages and in some areas this happens almost every year and since the communities have to be supported with food aid from NGOs and the Government, it is recommended that food aid should be provided in condition that the families or individuals would practice WSIs. This needs to be a general condition by all food aid providers.

(v) Since it was found that there was insufficient involvement by the Government in dissemination process of WSIs, it is recommended that the government should increase its involvement. This can be done in many ways, most importantly through putting bylaws, which will enforce adoption of WSIs and close cooperation with NGOs and development project working in the area.

(vi) Since the findings showed that there difference in the extent of diffusion of terraces along the topography, it is recommended that, in order to bring equitable and smooth scaling up of WSIs, that there should be stakeholders' networking, with the responsibilities of facilitating and coordinating the scaling up process. Furthermore it should ensure smooth networking within the identified stakeholders and popular participation.

(vii) Lastly it is recommended that there should be documentation and evaluation of circumstances in cases where certain innovation, did not spread or did not have the positive effects envisioned. "Failure stories" would be complementary to "success stories", as they can yield important information about the necessary conditions for and constraints to scaling up. Agricultural development is largely based on trial and error; it is healthy to recognize the errors in order to avoid excessive optimism and to counteract the "postcard syndrome". If these non-successful cases are regarded as sources of learning, this could help to do modification of the technology or avoid the repetition of mistakes.

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APPENDICES

Appendix 1: Checklist

History of terraces in the area

- When terraces were introduced in the area?
- Who introduced terraces in the area?
- What other innovations were introduced?
- What strategies were used for dissemination of terraces?

Wide diffusion of terraces

- What factor influenced wider diffusion of Terraces?
- What commutations methods were used?
- What change gents were more effective in dissemination of terraces?

Non-adopter of terraces

- What reasons underlined non-adoption of terraces?
- What should be done to solve the hindrances?

Scaling up WSIs

- What are the general perceptions of the communities about WSLs
- What are the effective pre conditions for adoption and diffusion of WSIs?
- What are the effective pathways for adoption and diffusion of WSIs?

Appendix 2: List of participants of FGD

Village	Name	Title
Mwembe	Athmani Mkubwa	Village Extension Officer
Mwembe	Wilson Mbwambo	Village chairperson
Mwembe	Walter Mjema	Village
Mwembe	Issa Ramadhani	Villager
Mwembe	Halima Said	Villager
Mwembe	Mariam Said	Villager
Mwembe	Mwanaidi Hussea	Villager
Mwembe	Hussein Ramadhani	Villager
Mwembe	Omary Alli	Villager
Mwembe	Juma Mkumbwa	Villager
Mwembe	Sofia Hussein	Villager
Mwembe	Elinata Mfinanga	Villager
Bangalala	Joyce Chediel	Villager
Bangalala	Betrice Alli	Villager
Bangalala	Mlindoka Alli	Villager
Bangalala	Godfrey Joel	Villager
Bangalala	Wilfona Amina	Villager
Bangalala	Bakari Joel	Villager
Bangalala	Simon Charles	Villager
Bangalala	Msafiri Wilson	Villager
Bangalala	Emmanuel Joel	Villager
Bangalala	Elizabeth Mdee	Villager
Bangalala	Kapombe Mshana	Village
Bangalala	Athman Mkumbwa	Village
Bangalala	Juma Shaban	Villager
Bangalala	Ester Mtai	Village
Vudee	Nuru Mzava	Ward executive officer
Vudee	Christopher Mtei	Village executive officer
Vudee	Wedieli Eliwangu	Villager Chairperson
Vudee	Godrich Richard	Villager
Vudee	Neheman John	Villager
Vudee	Mrs. C. Mchome	Villager
Vudee	Naze Neheman	Villager
Vudee	Magai Mdeme	Villager
Vudee	Doris Jafet	Villager
Vudee	Engiaedi Nakasa	Villager
Vudee	Mzee Elibariki Enioye	Villager
Chome	Joel Richard	Villager
Chome	Nehemia Mgoda	Village Ext. Officer (TIP)
Chome	Mrs. Janeth Omari	Village Ext. Officer
Chome	Jasper Mtundu	Village Ext. Officer
Suji	Elisafi Mhando	Villager
Suji	Benjamini Frank	Villager
Suji	Sara Mkitunda	Villager
Suji	Marentu Amani	Villager
Suji	Mwalimu Mkitunda	Villager
Suji	Tachare Emmanueli	Villager Ext. Officer
Suji	Mkitunda Mdengula	Villager
Suji	Abdu Edward	Villager

Appendix 3: Questionnaire

Study on diffusion of water system innovation in Makanya watershed

1. Background information

1.1 Interviewer

Name of Interviewer...

Date of Interview..

1.2 Village

Name...

Sub-Village Name..

Location on toposequence..

1.3 Respondent

Name...

Sex Male......................... Female....................................

Age..

Status in the HH...

Relation with HHH..

1.4 Household Head

Name...

Sex:

Male.............................. Female...

Age...

HH Size...

Education...

Livelihood: Agriculture....... ....Livestock............... Business.........................

Employment..

Other...

2 Awareness-knowledge

Type of Terrace	Knowledge	Practiced in the Village	When brought	Who brought	Do you practice
Stone					
Grass					
Fanya juu					
Fanya chini					
Other					

3 Soil-water conservation measures in relation to slope and source of water

Crop Field 1, Distance from home:							
Crop	Acreage	Season	Source of water	slope	practice	When started practice	Reason for delay

Key:

Crop	1-Maize 2 – Beans 3 – Onions 4 – Lablab 5 – Irish potatoes 6 – Cabbage 7 – Tomatoes 8 – S/potatoes 9 – Cassava 10 – Others:
Season	1 – Vuli 2 – Masika 3 – Kiangazi
Water source	1 – Ndiva 2 – Rainfall 3 – Diversion canals 4 – Ndiva + Diversion
Slope	1 – Steep slope 2 – Mild slope 3 – Flat
Practice	1- Stone terraces 2 – Grass terraces 3 – Bench terraces 4 – Fanya juu 5 – Fanya chini 6 – Contour terraces 7 – Borders 8 – Crop cover 9 – Flat cultivation

Crop Field 2, Distance from home:							
Crop	Acreage	Season	Source of water	slope	practice	When started practice	Reason for delay

Crop Field 3, Distance from home:							
Crop	Acreage	Season	Source of water	slope	practice	When started practice	Reason for delay

Crop Field 4, Distance from home:							
Crop	Acreage	Season	Source of water	slope	practice	When started practice	Reason for delay

Crop Field 5, Distance from home:							
Crop	Acreage	Season	Source of water	slope	practice	When started practice	Reason for delay

4 Criteria/Reasons for adoption

Terrace Type 1:				
Reason	Very Important	Important	Less Important	Not Important
Improve Income				
Improve Yield				
Follow Fashion				
Food Security				
Soil/Water Conservation				
Inadequate water				
Steep slopes				
Self-help Groups				
Abide to Conditions/Bylaws				
Terrace Type 2:				

Reason	Very Important	Important	Less Important	Not Important
Improve Income				
Improve Yield				
Follow Fashion				
Food Security				
Soil/Water Conservation				
Inadequate water				
Steep slopes				
Self-help Groups				
Abide to Conditions/Bylaws				

Terrace Type 3: ______				
Reason	Very Important	Important	Less Important	Not Important
Improve Income				
Improve Yield				
Follow Fashion				
Food Security				
Soil/Water Conservation				
Inadequate water				
Steep slopes				
Self-help Groups				
Abide to Conditions/Bylaws				

5 To what extent the following source of knowledge helped you to adopt?

Terrace Type 1: ______					
Source	Very much helped	Much helped	Little help	Very Little	Not helped
Inheritance					
Taught by VEO					
Forced by the Govt.					
Taught by NGO/Project					
Self-help Group (Kiwili)					
Neighbour(s)					
Other farmers (TOF)					
Relative					
Other: ______					
Terrace Type 2: ______					

Source	Very much helped	Much helped	Little help	Very Little	Not helped
Inheritance					
Taught by VEO					
Forced by the Govt.					
Taught by NGO/Project					
Self-help Group (Kiwili)					
Neighbour(s)					
Other farmers (TOF)					
Relative					
Other: ______					

Terrace Type 3: ______					
Source	Very much helped	Much helped	Little help	Very Little	Not helped
Inheritance					
Taught by VEO					
Forced by the Govt.					
Taught by NGO/Project					
Self-help Group (Kiwili)					
Neighbour(s)					
Other farmers (TOF)					
Relative					
Other: ______					

6 Effectiveness and adequacy of communication methods

Method		Effectiveness		Adequacy of methods	
Very Effective	Effective	Not Effective	Adequate	Inadequate	None
Self-help groups					
Demonstrations					
Study tours					
Field visits					
Printed materials					
Broadcasts					
Bylaws					
Incentives					
Other methods					

7 Non-Adopters of terraces
7.1 Reasons for non-adoption

Reason	Stone	Grass	Bench	F/Juu	F/Chini	Other
Labour intensive						
Lack of know-how						
Lack of capital						
Terrain/Biophysical (flat area)						
Absence of self-help groups						
Historical/traditional reasons						
Poor approaches of change agents						
Poor leadership						
Negative attitude of opinion leaders						
Other: ____________						

8 Adoption pathways

Pathways	Highly suitable	Suitable	Moderately suitable	Less suitable	Not suitable
Introduced to Village Govt.					
Introduced to Village Meeting					
Demonstrations					
Field visits					
Farmers' experimentation					
Work with groups					
Start with pioneers					
Use printed materials					
Use broadcasts					
Train local person for backstopping					
Other: ______					

9 Pre-conditions for adoption

Pre-conditions	Highly necessary	Necessary	Moderately necessary	Less necessary	Not necessary
Convincing income in the short-term					
Convincing income in the long-term					
Increased crop yield					
Improved soil conservation					
Improved land value					
Ownership of land					
Study tours					
Incentives					
Technical/Material Support					
Training - know how					