THE DIFFUSION OF SMALL-SCALE RAINWATER HARVESTING TECHNOLOGIES IN THE ARID AND SEMI ARID AREAS OF KENYA: A CASE STUDY OF LARE DIVISION, NAKURU DISTRICT, KENYA

BY

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DECLARATION

This project is my original work and has not been presented for a degree in any other University.

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DEDICATION

To my late father Mwariri and my mother Wangechi. And to my wife Gladys and our children Wangechi, Mwariri and Macharia.

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ABSTRACT

This study focuses on how communication affects adoption and diffusion of agricultural technologies, especially the diffusion of rainwater harvesting technologies in Lare Division of Nakuru District, Kenya. Although there are other factors that influence diffusion of innovations, communication is singled out in this study as a major factor affecting diffusion. The communication strategies taken to introduce new technologies or popularize existing ones will lead to wider diffusion of the technologies. The target population may only require the requisite information in many instances, as some of the technologies require only labour input, which can be provided by the family unit for diffusion to take place. It is however acknowledged that many other factors including capital, knowledge, attitude and traditional practices also affect diffusion of technologies. The purpose of the study was to identify and assess the communication channels used in the diffusion of rainwater harvesting technologies and also establish the viability of water harvesting technologies in enhancing food production and improving people's livelihoods in the study area.
An analysis is made of the communication channels used by farmers as well as ownership and access to and usage of various communication channels.

The study is based on data collected between September and November 2003 from a sample of 125 small-scale farm households in Gichobo and Lare locations of Lare Division. The data were derived from primary as well as secondary sources. The primary sources included the survey technique where a questionnaire was administered to the respondents, key informant interviews with key players in the agricultural sector in the area including researchers, senior agricultural officers, extension agents and administrators, and focus group interviews. Secondary sources included library research and government statistical abstracts.

The study concludes that communication channels used to reach farmers are a major factor influencing diffusion of agricultural technologies. An integrated communication approach bringing together all the players, viz. farmers, extension agents, researchers and other stakeholders is recommended. This approach will ensure that the many research findings by research institutions reach the intended end user. Suggestions are made on how communication experts can be effectively involved in extension services so as to improve adoption of agricultural technologies in the rural areas.

LIST OF ABBREVIATIONS

ACK	-	Anglican Church of Kenya
ASAL	-	Arid and Semi-Arid Lands
BAC	-	Baraka Agricultural College
BC	-	Before Christ
CBOs	-	Community Based Organizations
FREGs	-	Farmer Research Extension Groups
FSK	-	Farming Systems of Kenya
FTCs	-	Farmers Training Centres
IDS	-	Institute of Development Studies
KARI	-	Kenya Agricultural Research Institute
km	-	Kilometre
MoALD	-	Ministry of Agriculture and Livestock Development
NGOs	-	Non-Governmental Organizations
NLO	-	Netherlands Liaison Office
SHDI	-	Self Help Development International
SPSS	-	Statistical Package for Social Sciences
SRDP	-	Special Rural Development Program
USA	-	United States of America
WWF	-	World Wide Fund for Nature

CHAPTER ONE

INTRODUCTION

1.1 Background

The Arid and Semi Arid Lands (ASALs) cover about 80 percent of the total land surface of Kenya. These areas support approximately 25 percent of the human population and over 50 percent of the country's livestock population (National Development Plan, 2002-2008). They are extremely varied in terms of environmental conditions with a generally fragile ecosystem.

The ASALs are typically characterized by low (100-1200 mm per annum) and erratic rainfall, high evapotranspiration rates, and are susceptible to frequent droughts. Farmers cannot therefore depend on rainfed agricultural activities as a meaningful way to meet their subsistence needs. ASALs also have poor road networks and experience acute water shortage and insecurity. Poverty is high and widespread.

For the survival of land and people in the ASALs where people still continue to settle, cheap, small-scale and decentralized rainwater harvesting systems must be employed to maximize the use of the little rain that falls. Many land users have improvised various indigenous runoff-farming systems, which could be improved through understanding and evaluating them. Thus different areas will have different techniques for harvesting and applying water. The communication strategies taken to introduce even new technologies will lead to wider diffusion of the technologies. As noted by Adaba (1988), 'For rural development to be successful, appropriate communication strategies (those that emphasize interpersonal rather than non-personal, horizontal rather than vertical) must be devised to obtain decisive results. Communication may be the means by which

the rural communities are energized to liberate themselves from the shackles of ignorance, poverty and backwardness'.

With increased population and pressure on arable land, the typical smallholder farmer under dryland conditions cannot even provide for his own family's subsistence. The major challenge is how to utilize the available water - the most limiting factor to economic activity in the dry areas. It is important to evaluate new technologies, land users innovations and traditional systems to determine their appropriateness in solving the recurrent food crisis in the ASALs, whose development represents the highest potential for further economic development in the country. Adoption of rainwater harvesting technologies on a larger scale has not materialized for many reasons including economic, technical, technological and social constraints. Some ethnic or tribal groups have reservations about rainwater. These are either psychological beliefs or may be deep rooted in their traditions and culture. Social conflicts sometimes arise over ownership of water harvesting systems that are commonly used. The country is littered with unsuccessful projects, the Bura irrigation scheme being a good example of a scheme that performed dismally and eventually collapsed. The pragmatic way forward is in the development of least-cost, small-scale rainwater harvesting technologies by the communities and the individuals who live within these areas.

In many areas of Kenya where rainwater harvesting is practiced, there is hardly ever enough water stored to see users through the dry season. Water often has to be carried over long distances, particularly during the dry periods. Despite the tremendous potential for developing new water supplies based on rainwater harvesting technology, the general adoption rate is low because of economic, technical, technological, and social constraints (Yu-Si Fok, 1993). Lack of understanding of the social structure within which the technology is to be implemented and maintained may pose

a major problem. Poor understanding of the technologies by the farmers and lack of proper information transfer to them are some of the factors that may be contributing to low adoption. There is need therefore for prior understanding of the peoples traditions and attitudes; their economic capability and the level of acceptability of the various new technologies before new technologies are introduced.

Some of the positive effects of rainwater harvesting on rural livelihoods can be categorized as improved food production and security, availability of water, improved environmental protection and conservation, improved health and nutrition, economic improvement and social integration. Perhaps the most important stimulus to growth in the use of appropriate water related approaches in the ASALs is a strong lead by the Kenya government in promoting and popularizing these approaches.

The study sought to investigate the role of communication in the diffusion of rainwater harvesting technologies in the Lare Division of Nakuru District. A key assumption was that communication plays a central role in the diffusion of rainwater harvesting innovations, and that the communication methods used to disseminate the technologies may make the difference between adoption and non-adoption. Lack of equitable systems for delivering innovation information, knowledge and skills reliably and efficiently to land users scattered through the extensive ASALs is a factor that lies within the domain of communication. The results may help in the development of strategies and recommendations for the wider adoption of the technologies in the ASALs of Kenya.

1.2 Problem Statement

This study sought to examine the role of communication in the adoption and diffusion of rainwater harvesting technologies in Lare Division, Nakuru District. The need to focus on the role of communication in the adoption of rainwater harvesting technologies arose from the fact that the rate of adoption of rainwater harvesting innovations by small-scale farmers in the ASALs of Kenya is quite low (Ngigi 2003). Many of these areas are newly settled with settlers originally from areas where the need to harvest rainwater may not have been as acute. Hence the communication methods used to disseminate such information are crucial for the adoption of the technologies. More so for those technologies that may require labour only, which the family can provide, or require minimal capital input. Some of the other factors that could be contributing to the low diffusion include: lack of capital, lack of appropriate technology, insufficient documentation and lack of fully comprehensive information packages, and lack of technical and managerial skills.

This has resulted in low food production in the ASALs, hence frequent food shortages, low farm incomes and the rapid migration of the youth to urban areas in search of better employment opportunities. The key to increasing food production in the ASALs has now been recognized by development planners as the harnessing of water resources in these areas (National Development Plan: 2002-2008 and National Water Policy). Though various rainwater harvesting technologies are being practiced in various parts of the ASALs, adoption levels need to be spurred. The concern here was that adoption levels of water harvesting technologies, hence increased agricultural production, was low despite the obvious benefits. The study sought to establish whether communication strategies adopted for the diffusion of the technologies were appropriate. It also

sought to establish whether change agents in the ASALs had considered attitudes, knowledge, value systems and beliefs of the communities they worked with. Certain socio-economic aspects like education, wealth and gender were also examined. How effective were the communication channels used by various change agents to disseminate the required information to small-scale farmers in the study area? Were rainwater harvesting technologies viable in enhancing food production and improving people's livelihoods? These are some of the factors that must be analyzed so as to come up with specific recommendations to spur diffusion of rainwater harvesting innovations among small-scale farmers in the ASALs.

1.3 Objectives of the study

The overall aim of the study was to examine the role of communication in the diffusion of rainwater harvesting technologies in Lare Division of Nakuru District.

The specific objectives were:

- To identify and assess the communication strategies applied in disseminating water-harvesting technologies in Lare;
- To examine the influence of peoples' knowledge, attitudes and practices in the adoption of rain water harvesting technologies in Lare;
- To establish the viability of rainwater harvesting technologies in enhancing food production and improving people's livelihoods in Lare; and
- To make recommendations on communication strategies based on empirical findings from the study.

1.4 Justification of the study

Kenya is an agricultural country whose development in other sectors is inextricably tied to agriculture. Eighty percent of the population live and work in the rural areas, the majority of them deriving their means of livelihood from agriculture. Seventy five percent of agricultural production in the country comes from small-scale farmers (National Development Plan 2003-2008). For decades the country has had to rely on food aid whenever there is prolonged drought. The semi-arid and arid areas of the country are usually the hardest hit. The rationale for studying the diffusion of rainwater harvesting technologies hinges on the fact that adoption of such technologies would not only contribute significantly towards food security but would also ultimately help the country achieve the elusive newly industrialized status (NIS) that the country aims to achieve.

No country the world over has become industrialized before managing to feed its populace. One of Kenya's development policies is to get industrialized by the year 2020, a goal that can be achieved only after the country is self-sufficient in food production. Since vast stretches of the country are semi arid or arid, it is justified to study how these areas could benefit from rainwater harvesting technologies, consequently contributing to the national wealth and ultimately industrialization.

The government needs to formulate viable policies that can help improve food production in the ASALs. This will in turn improve the standards of living of those who live in these areas. Studying the problems encountered in diffusing rain-water harvesting technologies in one specific community was a worthwhile venture since any workable solutions obtained in one community could be equally useful to planners in tackling problems of low adoption of rainwater harvesting technologies in the ASALs of Kenya. Women play a key role in the demand for and use of water for domestic purposes, especially in the rural areas. An examination of gender issues and

prevailing forms of gender division of labour may also shed some light on the low adoption rate of rainwater harvesting technologies.

The results may be useful to agricultural research scientists, extension agents and policy makers with regard to rainwater harvesting information packaging, dissemination and evaluation. The findings may be used to put in place communication policies that will improve adoption of rainwater harvesting technologies. The study may also generate interest for further research in the area of diffusion of rainwater harvesting technologies in Kenya.

1.5 Study Assumptions

The basic assumption of the study was that though communication plays a significant role in the diffusion of agricultural technologies, adequate attention has not been given to communication strategies used in the diffusion process. The study also assumed that professional communication specialists have to date not played a significant role in the diffusion of agricultural innovations in the country. It is the responsibility of the professional communicator to accept the responsibility of designing and directing the entire communication component in the diffusion of rainwater harvesting technologies. The study also assumed that knowledge, attitude and practice affect adoption of agricultural innovations.

1.6 Definition of key terms

Water harvesting

The practice of collecting and storing water from various sources for beneficial use such as production of crops, pasture or trees, for livestock or domestic water supply.

Diffusion

This is the process by which an innovation is communicated through certain channels over time among the members of a social system.

Innovation

An idea, practice, or object that is perceived as new by an individual or other unit of adoption.

Adoption

A decision to make continued use of an innovation as the best course of action available and excludes occasional use of the idea, object or practice. Adoption in this study means sustained use of rainwater harvesting and related technologies.

Innovators

These are the first 2.5 percent of the individuals in a system to adopt an innovation.

Early adopters

Adopt new ideas after the innovators and influence adoption by the late majority and laggards.

Late majority

Adopt new ideas just after the average member of a system.

Laggards

Are the last in a social system to adopt an innovation.

Communication

Refers to the process through which innovations or messages are transferred from the source (change agent) to the receiver (farmer).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter containing a review of the existing body of literature on rainwater harvesting technologies in Kenya. Descriptions and illustrations of the major rainwater harvesting technologies practiced in Kenya are also given. The chapter discusses in some detail the classical diffusion of innovations model and relevant parts of the social learning model. The classical model is particularly pertinent to this study because among the many studies under it are some on the diffusion of agricultural technologies, particularly the milestone study on the adoption of hybrid corn in Iowa, USA in the 1930s (Defleur, 1995). The nature of communication is also briefly outlined.

2.2 The status of rainwater harvesting in Kenya

Harvesting rainwater can alleviate water shortages in many parts of the world. Regardless of the ultimate water use, all water harvesting systems have two basic components - a catchment apron for collecting precipitation and some type of water storage facility. The collected water may be stored in a tank or reservoir, or in the soil profile for runoff farming. The criteria used to determine an appropriate harvesting method for a given location include: 1) the purpose for which the water is harvested; 2) land slope; 3) soil properties; 4) construction costs; 5) amounts, intensity and seasonal distribution of rainfall; and 6) social factors such as land tenure and traditional water use practices (Ngigi, 2003).

The oldest and best-documented rainwater harvesting systems are found in the Negev Desert of Israel where 'runoff farming' was practiced 4000 years ago. Runoff farms have been found dating

back from the 10th to the 8th centuries BC. Ancient desert agriculture is also known from North Africa, Southern Arabia, North America and South America (Evenari 1961).

In Kenya, runoff and roof water harvesting is practiced mainly in the arid and semi-arid areas like Kitui, Machakos, Turkana, Baringo and Taita Taveta. These drylands are categorized as arid, semi-arid and dry sub-humid, depending on the level of rainfall in the area. A wide range of different ecosystems is to be found within these categories - savannas, open forests, even seasonal wetlands and rivers.

The harvested rainwater is used for domestic water supplies, crop production and livestock as well as wildlife watering. Rainwater runoff can be collected from seasonal watercourses, exposed rock surfaces, hillsides, land with sparse vegetation, roads and roofs on buildings. The potential impact of any water harvesting system depends on the end product resulting from the use of the harvested water.

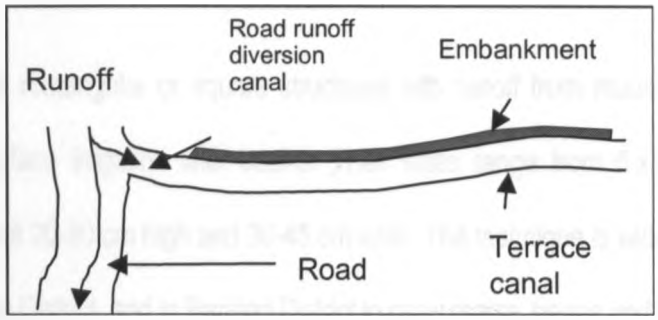
Scores of different projects on rainwater harvesting spread fast in Kenya in the late 1970s and 1980s using low-cost rainwater tank and rock catchment designs. Many involved implementation strategies base around the concept of community participation. Despite the success of some individual projects, however, the coverage of improved rural water supply remains low in Kenya.

The major rainwater harvesting technologies practiced in Kenya for crop production, domestic consumption and for livestock are as follows:

1. *Modified (enlarged) 'Fanya juu' terraces:*

The structure is called '*Fanya juu*' (*juu* is Swahili word for 'up') because during construction, the soil is thrown up-slope to make an embankment, which forms a runoff barrier leaving a trench (canal) which is used for retaining or collecting runoff. Crops such as bananas, pawpaws, citrus and guava are grown in the ditches. This technique is widely practised in Machakos and Kitui districts. It is effective and is recommended for water harvesting on slopes greater than 5 percent.

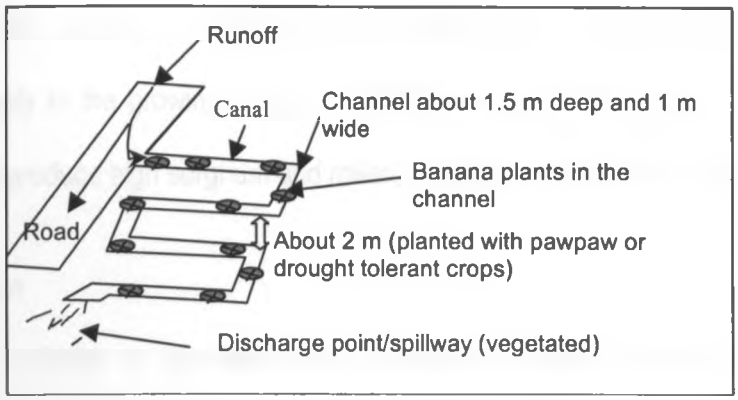
Fig. 1. Fanya juu terraces



2. *Runoff catchment with canals*

This technique involves diversion of runoff catchment into a canal network in the farm. The canal should be about 1.5 m deep and 1.0 m wide, and the distance between adjacent canals about 2 m. It is widely practised in areas with ground slopes of more than 5 percent, mainly in Kitui, Machakos and Mwingi districts. The technique is also rapidly gaining popularity in the study area after roof catchment and water pans. Bananas are planted in the canals, while fruit trees like pawpaws are planted between the canals together with food crops like beans in the rainy season. The technique is also called banana canal because bananas are invariably planted in the canal.

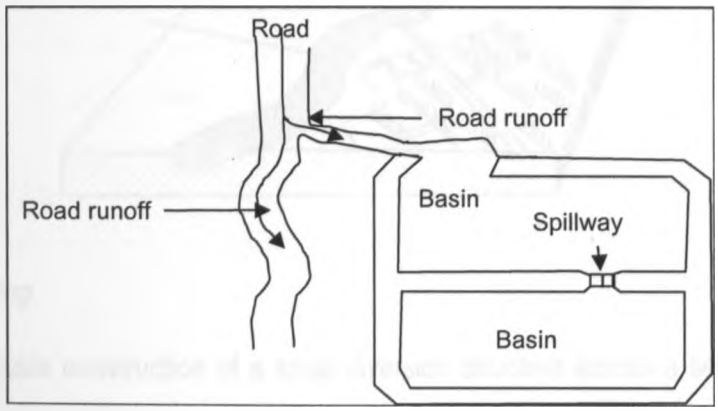
Fig. 2. Road runoff with canals



3. Basins

These are well-leveled rectangular or square structures with runoff from roads diverted into them, a principle similar to surface irrigation with basins. Their sizes range from 5 x 5 m to 5 x 12 m. The embankments are about 20-30 cm high and 30-45 cm wide. The technique is widely practised in Taveta Division of Taita-Taveta District, and in Baringo District to grow maize, beans and pigeon peas.

Fig. 3. Basins



4. Inundation

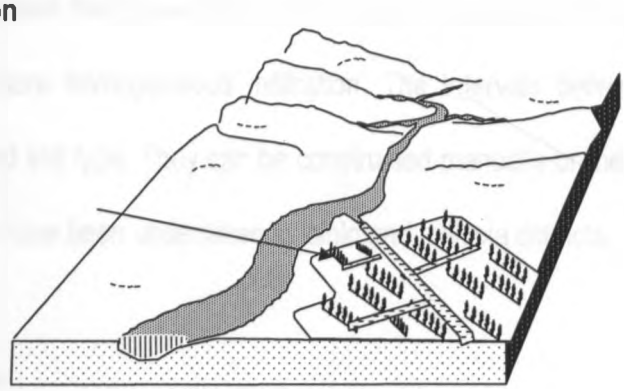
The technique involves runoff collection and storage behind a bund until planting time. The land is then drained of excess water just prior to planting. Crops grow to maturity using the reserved soil moisture. This technique also includes naturally occurring short-term flooding in plains and valleys. Sophisticated systems may include a series of bunds with sluice gates and spillways to create

several flood areas. This technique requires deep soils with a high water holding capacity to retain adequate water after flooding. The selection of suitable crops is important as the soils may be poorly aerated early in the growing period. The technique was introduced in Turkana District in 1951 and used to produce high sorghum and millet yields with a single flood from Turkwell River.

5. Flood diversion

This technique is similar to inundation but in addition involves diversion of the water with appropriate conveyance systems such as simple, open furrows or lined canals. Thus, flood diversion is a system of irrigation, but on a seasonal basis. The technology is used in Baringo and Turkana districts in the production of grain crops.

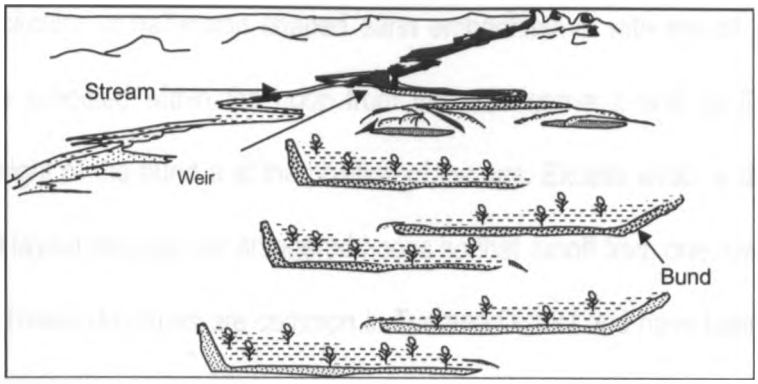
Fig. 4. Flood diversion



6. Water spreading

This technique entails construction of a small diversion structure across a seasonal watercourse and the use of short bunds to spread the flow without causing erosion. The technique is practised in Turkana District where alluvial and colluvial soil fans at the base of ridges, escarpments or piedmont plains, seasonal stream banks and natural depressions are used to grow sorghum and millet.

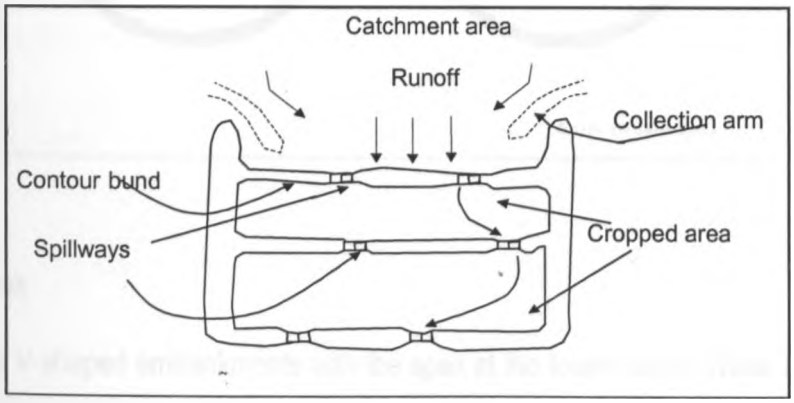
Fig. 5. Water spreading



7. Contour bunds

These are small earth or stone embankments constructed along a contour line. The embankments trap the water flowing down the slope and retain it behind the bunds. The area behind the bunds can be leveled to ensure homogeneous infiltration. The intervals between the contours vary depending on slope and soil type. They can be constructed manually or mechanically. Attempts to promote the technique have been undertaken in Isiolo and Laikipia districts.

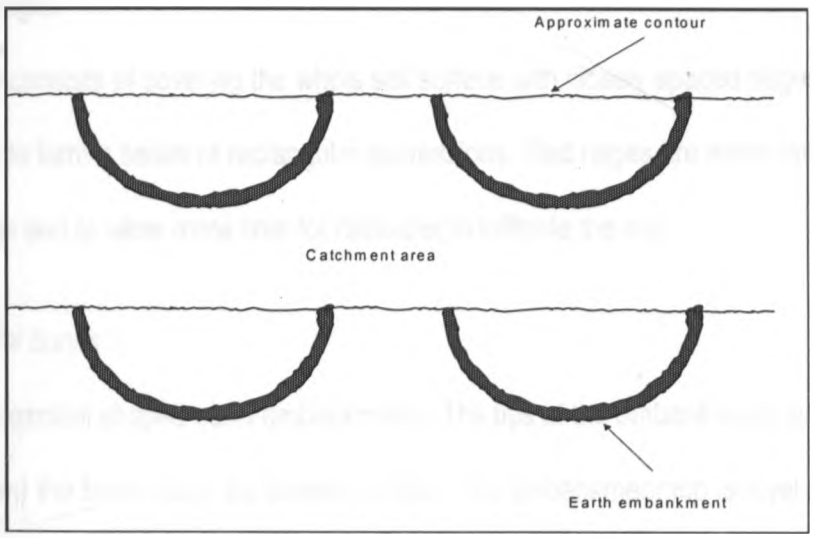
Fig. 6. Contour bunds



8. *Semi-circular bunds (hoops)*

These are semi-circular or half-moon shaped earth embankments with tips of the bunds on the contour. Water is collected within the hoop from the area above it and confined to the depth defined by the height of the bund and the position of the tips. Excess water is discharged around the tips. The field layout provides for staggered hoops so that runoff from one row is intercepted by the row below it. These structures are common in Turkana District and have been experimented in Baringo District. Experimental results showed that restoration of the productivity of the degraded grazing lands could be achieved within 3 seasons. The bunds are used for reseeding of grass, fodder shrubs and trees.

Fig. 7. Semi-circular bunds

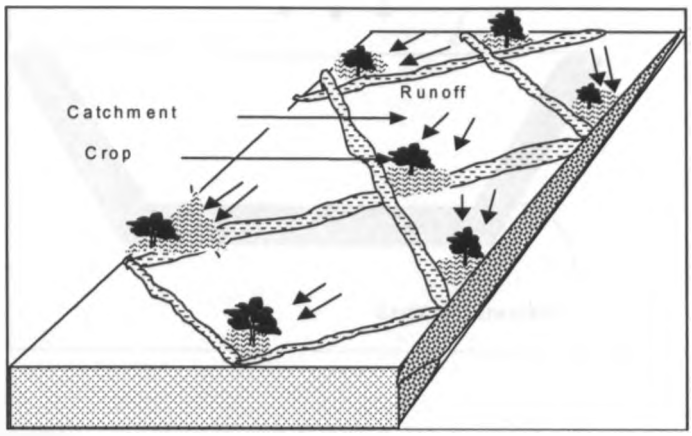


9. *Negarims*

These are small V-shaped embankments with the apex at the lowest point. Water is collected from the V-shaped basin and stored in the soil profile at the apex. This technique is best for the establishment of trees and shrubs. The technique has very little conveyance losses as water is used close to the source. The structures are also cheap to construct. The technique has been used

for establishing trees and for sorghum production in Turkana District. Some farmers also use the technique to grow fruit trees including mangoes and pawpaws in Kitui and Mwingi districts.

Fig. 8. Negarims



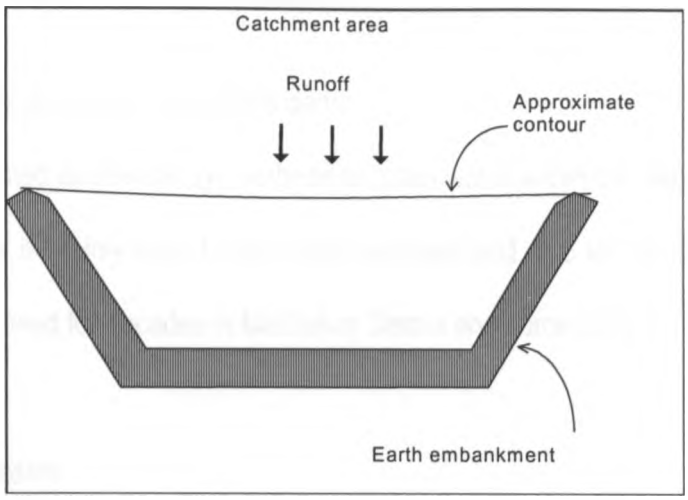
10. Tied ridges

The technique consists of covering the whole soil surface with closely spaced ridges in 2 directions at right angles to form a series of rectangular depressions. Tied ridges are made mainly to increase surface storage and to allow more time for rainwater to infiltrate the soil.

11. Trapezoidal bunds

These are trapezoidal shaped earth embankments. The tips of the embankments are placed on the contour line and the base along the lowest contour. The embankment top is level and higher than the ground level at the tips. Water flowing down-slope is trapped and retained behind the bund up to the level of the tips, and any excess overflows around the tips into other bunds in the system or natural drainage course. Finkel and Gainey developed the technology in Kenya in 1989 as a modification of rectangular pits. Although they were proven to be effective in improving crop yields in Turkana District , they have neither been widely tested nor adopted.

Fig. 9. Trapezoidal bunds



12. Microcatchments

The microcatchment technique involves spreading runoff from part of land on to an adjacent cultivated land without using any structures. The part from which runoff is obtained is weeded to reduce surface evaporation and may be compacted to reduce infiltration, thereby increasing runoff. The soil in the cultivated area is loosened to increase infiltration. Attempts have been made to promote the technology in Baringo and Turkana districts.

13. Zai pits

This technique is an indigenous method of water harvesting in Burkina Faso, and was recently introduced in Kenya. It involves digging small pits, about 30 cm in diameter and 15-20 cm deep and placing manure or compost at the bottom of the pit prior to planting. During digging, the soil is thrown down-slope to form a small embankment. The pits are also referred to as planting pits. Seeds are planted around the bottom of the pit. The technique has been tested in semi-arid

eastern Kenya and has shown improved yields. Adoption of the technique has been limited to a few farmers especially those growing vegetables.

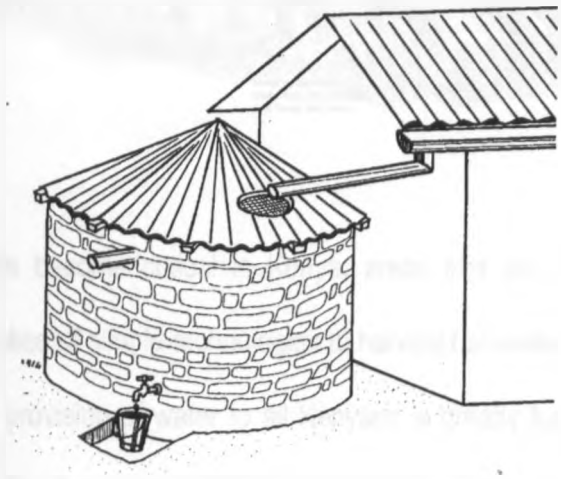
14. Sand storage dams and subsurface dams

Barriers are constructed across sandy riverbeds to retain water within the trapped sand upstream. The harvested water is mainly used for domestic purposes and also for smallscale irrigation. The technique has been used for decades in Machakos District and some parts of Kitui District.

15. Roof catchments

Tanks or other containers are used to store rainwater collected from tiled, iron sheet, thatched roofs or cow dung plastered roofs. Some roofing materials that are painted with lead-based products and asbestos materials are a health hazard for harvesting water.

Fig. 10. Roof water harvesting

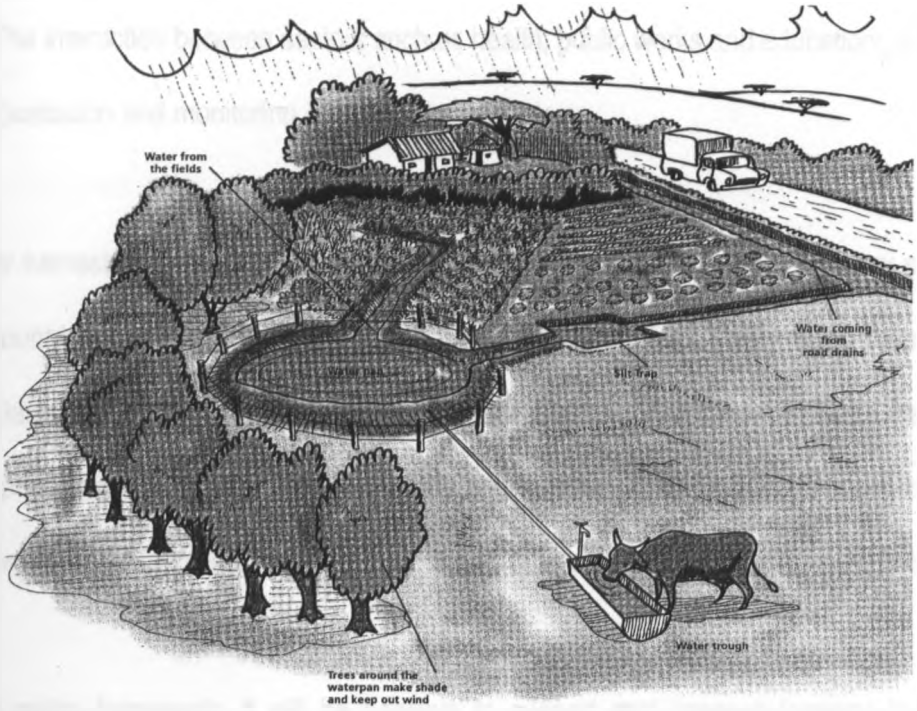


16. Runoff catchment pans

These are ponds for storing runoff water from roads and fields. They are usually built at the lowest point of the farm, near the road or field, on soils which hold water, such as clay soil. The pan bed

and walls can also be lined with heavy clay or plastic sheeting. Silt traps or check dams reduce siltation. Harvested water is used for livestock, domestic and small-scale irrigation. The method is very popular in Lare, second only to roof catchments

Fig. 11. Runoff catchment pan



As water needs become critical in Kenya, areas that are not necessarily semi-arid also find themselves in need of simple technologies to harvest rainwater in order to achieve a sufficient level of water. The provision of water to all Kenyans is greatly hampered by the financial constraints experienced in the economy. Although rainwater has proved to be a viable alternative source of water supply, the Kenya government has so far not formulated comprehensive policy guidelines to coordinate its practice and development. It is left to individuals, NGOs, and bilateral and multilateral organizations that are dealing with rural and community development (Ngigi, 2003).

A policy guideline would address issues such as:

- Financing policy such as the levels of community contribution, the mechanisms of donor financing and the operation and maintenance financing;
- The institutional framework of the sector, clarifying the roles of the central and local government;
- The interaction between sectors such as health, public works and education; and
- Evaluation and monitoring criteria and mechanisms.

Rainwater harvesting is not part of the national water management strategy in many sub-Saharan African countries. But the recently concluded (2000) National Water Policy recognizes the ASALs and stipulates several strategies to facilitate some measure of development in these areas. Though this is a positive development, it is not comprehensive enough, and rainwater harvesting is yet to be fully incorporated in the national water resources development and management policies.

Within a policy framework, it will be possible to support and improve farmers' initiatives and innovations. It would also be possible to initiate teamwork and collaboration from several sectors and departments. Institutional factors involving infrastructure, transportation and accessibility, government, development partners' programs operating in this sector, extension services, access to amenities, etceteras would be taken into consideration in policy formulation.

The best process for formulating national policy for rainwater catchment systems may be the consideration of cultural, social, environmental and economic aspects gathered from grass-root communities - the users. Water users should be motivated to contribute their own share of the cost and labour for the development and operation of their rainwater catchment system.

As more Kenyans settle in new dry lands, they have to provide for nearly all the essential necessities for human survival. This is the situation the people of Lare Division, Nakuru District, find themselves in. Lare experiences serious shortages of water affecting about 70 percent of all households. The majority of the households depend on water from roof catchments and water pans, or from seasonal rivers for their water needs.

A study carried out in the area between 1997-1998 (KARI-Njoro) had identified the community's technology needs where the farmers had prioritized them in the following order:

- Rainwater harvesting
- Improvement of roads in the division to enable marketing of produce
- Increased crop production through expansion of the cropping system
- Improvement of livestock production.

Water harvesting was top of the list and though adoption rate of the water harvesting technology has risen between the initiation of the project in 1998 and now, overall about 30 percent of the population in the division has yet to embrace the technology as the current study has shown.

The following methods were used in the dissemination of the technologies:

- Leaflets done in simple English presented to the farmers
- Training extension workers to equip them with details of each technology
- Farmer-research extension groups (FREGs) where farmers elected their leaders
- Demonstrations for farmers involving extension staff and researchers
- FREG meetings to determine relevance of technologies and further demands from farmers
- Stakeholders meetings to reassess the progress of the project.

While many technological and other innovations become available every year, only some are adopted and widely used by the public. Understanding the adoption of agricultural innovation and the role played by mass-mediated and interpersonal information is important in an agricultural society like Kenya whose economy largely depends on the levels of adoption of novel agricultural technologies. A study of the adoption of water harvesting technology and associated technologies in Lare may offer some factual knowledge of conditions attendant to the encouraging diffusion of the innovations in the area under study. This in turn may assist in enhanced adoption not only in Lare but also lead to widespread diffusion of this technology in the country.

2.3 Models of diffusion of innovations

This section looks at the classical model of diffusion of innovations in some detail and those areas of the social learning model that are relevant to the study.

2.3.1 The classical model of diffusion of innovations

Some innovations diffuse from first introduction to widespread use in a few years. Others are all but ignored. Rate of adoption is the relative speed with which an innovation is adopted by members of a social system, generally measured as the number of individuals who adopt a new idea in a specified period, such as each year.

The classical diffusion of innovations model is probably the most comprehensive diffusion model and is based on a large number of empirical studies from a wide variety of disciplines, including anthropology, sociology, agriculture, rural sociology, education, medical sociology, communication, and marketing. As described by Rogers with Shoemaker (1971), the classical diffusion model basically distinguishes four main elements in the diffusion process: (1) the **innovation,** (2) which

is **communicated** through certain channels, (3) **over time**, (4) among the members of a **social system**.

The **innovation** is defined as "an idea, practice, or object perceived as new by an individual or other relevant unit of adoption." Adoption might mean purchases of an advertised product, changes of beliefs advocated by an information campaign, modifications of attitudes brought about by persistent public relations efforts, or other changes in which mass communication played a role. The perceived attributes or characteristics of an innovation that determine its rate of adoption include: (a) the **relative advantage:** "the degree to which an innovation is perceived as better than the idea it supercedes:" (b) **compatibility:** "the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of the receiver"; (c) **complexity:** "the degree to which an innovation is perceived as relatively difficult to understand and use" (d) **trialability**: "the degree to which an innovation may be experimented with on a limited basis"; and (e) **observability**: "the degree to which the results of an innovation are visible to others".

Communication channels are the means by which a message goes from a source to a receiver. The essential elements in the communication process are the source, message, channels and receivers. According to the model, mass media channels are usually more effective in creating awareness of the innovations, whereas interpersonal channels are more affective in forming and changing attitudes towards the innovation. Most human communication also tends to take place between individuals who are homophilous, that is, individuals who are similar in certain attributes such as beliefs, values, socio-economic status, and the like, than between individuals who are heterophilous, that is, dissimilar in these attributes.

Time is involved in the diffusion progress in (1) the innovation decision process: "the mental process through which an individual passes from first knowledge of an innovation to a decision to adopt or reject, and to later confirmation of this decision". The innovative decision process is also a function of knowledge, persuasion and confirmation. (2) **Innovativeness**: "the degree to which an individual is relatively earlier in adopting new ideas than other members of his social system". The model classifies adopters into five categories: (a) innovators, (b) early adopters, (c) early majority, (d) late majority, and (e) laggards. This classification is based on the timing of adoption by various groups.

A **social system** is defined as a "collectivity of units which are functionally differentiated and engaged in joint problem solving with respect to a common goal". The social structure of a system, which consists of the status or positions and how they are arranged in the system, has an important influence on the speed of diffusion of new ideas. The social structure can impede or facilitate the rate of diffusion and adoption of innovations through system effects. Furthermore, the norms, social status, and hierarchy of a social system influence the behaviour of individual members and consequently their innovative behaviour.

Finally, the diffusion model predicts that (1) the diffusion of an innovation in a social unit occurs primarily through communication and interaction between persons, and (2) an innovation is at first adopted only by a few. Others follow and more and more are converted in a snowballing effect. The speed of the innovation process increases, reaches a peak based on the number of members in the social unit, and then declines until finally the last ones are reached. The adopter distribution follows a bell-shaped curve over time and approaches normality. (3) Once a certain section of a social unit (innovators and part of early adopters) have adopted an innovation, it spreads automatically among other members of the system as long as the diffusion process is not

interrupted by intervening factors. Thus, the classical diffusion mode attaches special importance to persons through whom an innovation finds entry into a social system, particularly the "innovators" and the "early adopters".

According to Rogers and Shoemaker (1971), the innovators (the first 2.5 percent of the individuals adopting an innovation) are characterized by eagerness to try new ideas. This interest leads them out of local circles of peers and into more cosmopolitan social relationships. Communication patterns and friendships among a clique of innovators are common even though the geographical distance between the innovators may be great. Being an innovator also means having control of substantial financial resources to absorb the possible loss due to an unprofitable innovation and the ability to understand and apply complex technological knowledge.

On the other hand, early adopters are a more integrated part of the local social system than are innovators. Whereas innovators are cosmopolites, early adopters are localites. This group more than the others has the greatest degree of opinion leadership and peer respect in most social systems. Opinion leadership is defined as "the degree to which an individual is able to informally influence other individuals' attitudes or overt behaviour in a desired way with relative frequency". Thus, potential adopters look to early adopters for advice and information about the innovation. Furthermore, because early adopters are not too far ahead of the average individual in innovativeness, they serve as a role model for many other members of a social system. Communication behaviour of early adopters also entails significant contact with change agents, more extensive exposure to interpersonal communication channels, a propensity to seek information about innovation, and more contact with science.

Although the classical diffusion model is probably the most comprehensive diffusion model, it has several methodological, theoretical, and practical limitations. Among the methodological limitations, its inclusion of the time dimension leads to a dependence upon recall data (unless overcome by use of a "before-after" research design, which has been rare in diffusion studies) and to difficulties in determining the time-order of diffusion variables. Secondly, the source typology of adopters requires two assumptions: (1) that adoption decisions as a function of time are normally distributed, and (2) the diffusion process is relatively complete within the social system at the time of data collection. However, in reality, the normality assumption is rarely met, and diffusion researchers often want to study adopter types in social systems where adoption is significantly less than 100 percent or where the process has not reached equilibrium.

The first theoretical criticism of the classical diffusion model is over concern with the individual as the unit of analysis and decision-making. This has led to exclusion of group or collective influence including the impact of other forms of intervention, such as government incentives, and overemphasis on individual blame. The situational approach thus tends to emphasize the inherently relational nature of many important phenomena that impinge on the diffusion process. Thus, the manner and rate with which new technology is adopted cannot be interpreted independently from the social, economic, and political system where the technology is introduced.

The second criticism, according to Rogers (1989), is that most diffusion studies, at least until recent years, have taken a "pro-innovation" position, assuming that the innovation being studied should be adopted by individuals, hence, human communication was viewed mainly as a one-way linear process of persuasion. The individual was assumed to be a passive consumer rather than an active participant in decision-making. However, certain scholars are beginning to describe human

communication, including the diffusion of innovation, as information-exchange, a process more in line with a convergent model of communication.

Third, the diffusion model's estimation of the role of communication on the diffusion process has been questioned. The main criticism is that, although communication can change the individual's perception about his situation, by itself it cannot change that situation very much. In other words, other inputs, particularly resources, must accompany communication before adoption of most innovations occurs.

Finally, since the model attaches special importance to persons through whom an innovation finds entry into a social unit, change agents and policy makers have concentrated their activities on the wealthy (who are usually the innovators or early adopters), with the expectation that adoption of those innovations will trickle down to the majority of people. However, the "trickle-down" process has not functioned for most innovations, particularly those requiring substantial resources.

2.3.2 The social learning model

The basic argument of the theory is that, although people can learn through directly experiencing the consequences of their own behavior, most human behavior is learned observationally through modeling; from observing others, one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action.

The theory argues that most human behaviour is learned observationally through the informative function of modeling. Modeling in turn is governed by the ability to observe the modeled activities, code them for memory representation, retain them and match the modeled behaviour. Innovations

also face a situation where external reinforcement is minimal or lacking. In these cases, innovators have to sustain their efforts largely through self-encouragement and conviction of the worthiness of their innovative activities regardless of the opinion of others.

In summary, social learning theory postulates behaviour as being regulated by the interplay of self-generated and external sources of influence. The theory recognises that there is a continuous reciprocal interaction among a person's behaviour, events going on inside of the person (thoughts, emotional reactions, and expectations) and the environmental consequences of that behaviour.

In the case of innovative behavior, social learning theory distinguishes two processes in the diffusion of innovations: the acquisition of innovative behaviors, and their adoption in practice (Bandura, 1977). The following points can be drawn from the social learning perspective with regard to the process of acquisition.

(1) Acquisition of innovative behavior is achieved primarily through the informative function of modeling.

(2) Symbolic modeling, particularly from the mass media in the early stages of diffusion, functions as the principal conveyance of innovations. Early adopters, therefore, come from among those who have had greater exposure to mass media. Some of the variation in time of adoption partly results from differences in the time of first exposure to innovations.

(3) In later stages of diffusion, innovations tend to spread through direct modeling along existing networks of interpersonal communication. Furthermore, individuals are likely to acquire innovative behavior through their regular associates, either in

preference or imposition, because such associates are important determinants of the behavior that is repeatedly observed and hence most thoroughly learned.

(4) Innovators can sustain their innovative behavior despite possible failure, high risks, and lack of social support through self-reinforcement mechanisms, while the majority of the adopters depend on vicarious reinforcement (seeing the advantages gained by early adopters) before embarking on innovative behavior. Thus, modeled benefits tend to accelerate diffusion by weakening the restraints of the more cautious potential adopters.

(5) (a) Early adopters are likely to be effective models if they possess prestige, power, competence, expertise, and high socio-economic status. (b) Adoption can be significantly influenced by real or assumed similarity between early adopters and potential adopters.

The apparent contradiction between (5a) and (5b) can be reconciled by the fact that individuals have a strong need to achieve cognitive consistency in their self-concept. Therefore, when a person perceives himself or herself as having some characteristics similar to a model, he or she will usually interject other attributes of the model in order to maintain cognitive or perceptual consistency. In other words, although early adopters usually have more prestigious social psychological variables than later adopters, a single similarity in other characteristics, such as ethnic origin, neighborhood, language, or religion, is sufficient to evoke a generalized similarity. This introjection phenomena also explains in part why diffusion takes place between "model-observer", "change agent-client" or "opinion leader-follower" despite their apparent dissimilarity.

From the social learning perspective, acquisition of innovations is necessary but not sufficient for adoption in practice. The theory also recognizes a number of factors that determine whether people will enact what they have learned. The major factors advocated by the theory are concerned with the attributes of the innovation, stimulus inducements, and resource necessary for adoption of many innovations. Social learning theory generates the following points regarding the practical adoption of innovations:

(1) Innovations that are highly visible (observability), easy to match (complexity), and perceived to pose less harm or loss (risk) are likely to diffuse more rapidly.

(2) Stimulus inducements associated with the innovation, such as anticipated satisfaction, observed or perceived benefits, functional value, and social approval act as motivation to adopt. Positive and pervasive stimulus inducements increase the likelihood of the learned innovations being tried or adopted.

(3) Direct incentives or tangible advantages have greater motivation than vicarious ones, particularly for sustaining the adopted innovation. Therefore, innovations with long-run advantages but without immediate tangible advantages, such as many health related innovations, are slow in diffusing.

If people lack the money, skills, or needed accessory resources, they will not adopt even innovations favourable to themselves.

2.4 The role of communication in diffusion of agricultural technologies

Experts in various fields have defined communication in many ways. Wilbur Schramm (McQuail, 1986), a pioneer in mass communication research, offered this definition: " When we communicate we are trying to share information, an idea, or an attitude. Communication always requires at least three elements – the source, the message, and the destination."

Harold Lasswell (McQuail, 1986) defines communication as "A convenient way to describe the art of communication is to answer the following questions: Who Says What In Which Channel To Whom With What Effects." Lasswell identifies the necessary components in communication as source, message, channel, receiver, and effect.

Although these definitions vary in the number and kinds of behaviours that would be included in the study of communication, they share a concern with effect or response: communication occurs only if the organism reacts to the message or stimulus in some way. Communication then can be looked at as a system made up of various components (source, message, channel) and behaviours (encoding, decoding, formulating objectives); communication is also purposive, deliberately initiated by a source to achieve some effect (purpose) in a receiver. Communication can also be said to be a transaction, and it is also subjective. Perceptions of the objects in our environment and encoding and decoding of messages are all influenced by advances of communication technology in recent times, communication research has so far failed to come up with systems and strategies for diffusing needed innovations across preliterate traditional social systems reliably, efficiently and equitably. Studies consistently show that the patterned flow of communication is linked to the adoption and diffusion of new ideas.

Studies of diffusion of innovations in the west produced a lot of general information to explain the process and it appeared as if the tradition of diffusion of innovations would bring about a breakthrough in the area of mass and interpersonal communication strategies in the Third World. But when similar studies were repeated in third world countries, a perplexing phenomenon was encountered. The S-shaped curve denoting complete adoption of an innovation was seldom

found, particularly within subsistence communities. Adoption rates were generally low, that they produced curves truncated to considerably less than the totals.

This can be explained by the fact that pre-occupation with already diffused innovations provided researchers with few insights about strategies for 'pushing' the process, for causing it to recur more rapidly, reliably, efficiently and completely.

Diffusion researchers have steered largely clear of field experimentation. Applied diffusion therefore is still in the hands of other professionals such as agronomists, economists and nutritionists. Not trained in the area of diffusion communication campaigns, their efforts have produced for the most part the minimal effects observed by the diffusion researchers. They were largely ignorant of the body of diffusion knowledge growing around them. Such knowledge had explanations of why their diffusion efforts met with so little success in peasant social systems. But they found little of use to help them remove or overcome obstacles impeding the process.

The Kenya government made an effort to correct this situation when in 1970 a multidisciplinary team of researchers was formed to evaluate Kenya's Special Rural Development program (SRDP). It was located at the Institute of Development Studies (IDS), University of Nairobi.

The SRDPs ultimate goal was raising the quality of rural life through increased rural productivity via the diffusion of agricultural innovation such as high yielding seed varieties, improved cultivation techniques, use of chemical fertilizers and pesticides, and artificial insemination for upgrading livestock. The whole SRDP idea was, of course, to come up with strategies that impaled widespread adoption of these productivity-increasing innovations.

The SRDP team also attempted a communication experiment which was evaluated alongside other experiments in 1972, two years into the experiments. While most of the other experiments were found to be failing, the communication experiment showed quite remarkable success. Of 217 small-scale farmers in the study, virtually all had adopted hybrid maize. Moreover, each claimed to have influenced the adoption behavior of at least two others outside the sample. Quite clearly, what these peasants lacked was not empathy or innovativeness or need achievements. They lacked information, knowledge, skills and materials to effectuate adoption decisions.

Five major obstacles to adoption and diffusion of agricultural technologies that the team found are highlighted below.

1) Farmers may have simply been unaware of productivity increasing innovations available to them. Even if they were, they may have nevertheless lacked the requisite knowledge and skills to make adoption feasible. Preventing them from acquiring this information and training was a system of delivering cognitive inputs which itself was lacking in knowledge and skills of effective, reliable mass and interpersonal communication strategies, and too underpowered in terms of numbers and creativity to reach more than just a handful of peasants with its managers.
2) Farmers lacked the necessary material and financial resources in invest-adopting innovations. The system of distributing loans, credit and form inputs was unresponsive to the small-scale, unbusinesslike needs of preliterate subsistence cultivators.
3) Farmers may have found themselves too remotely situated from market places or too ignorant of marketing policy, or without feeder roads or public transportation linking them to markets, or without granaries or warehouses for surplus storage.

4) Farmers have been systematically excluded from effective participation in reviewing available innovation alternatives, evaluating them in terms of their own perceived needs and adapting them to their own way of life.

5) Farmers finding themselves underemployed on their small holdings or unemployed in the dry season, had few additional, off-seasonal opportunities for income generating occupation in the rural areas because of a lack of rural public works such as labor-intensive road-building or self-employment cottage industries or small-scale irrigation schemes for dry-season farming.

The SRDP findings offered new explanations of why innovations spread so poorly in Third World countries. Factors beyond the control of the peasants were acting in concert to shut the majority of them off from adopting productivity-increasing innovations. Lack of equitable systems for delivering innovation information, knowledge and skills reliably and efficiently to peasant masses scattered through the rural areas was a factor that lay clearly within the domain of communication. The professional communication specialist therefore has a role, though little recognized, in the process of rural development.

The SRDP study and findings are relevant to the current study as there are many parallels with the study area. It is noteworthy that the study also rates provision of innovation information, knowledge and skills, as one within the domain of communication, an aspect which the present study considers a key limiting factor in the adoption and diffusion of rainwater harvesting technologies. Higher adoption rates of the rainwater harvesting technologies in Lare may also have been spurred by the fact that farmers participated in the review of available innovation alternatives and also of their evaluation in terms of their own perceived needs and adapting to their own way of life. Lack of such participation is highlighted as a major constraint in the adoption of innovation in

the SRDP study. Due to the confidence built in farmers, incidences of farmer innovation were evident in the study site, principal among them a modification of the Banana canal which the local farmers have named after the farmer innovator.

As Bandura (1977) postulates, early adopters are likely to be effective models if they possess prestige, power, competence, expertise, and a high economic status. The study affirmed this to be largely true as some key informants resident in the study area showed. Even FREG group leaders and other well-to-do farmers affirmed this as neighbours admitted to looking up to them for guidance or as sources of information leading to adoption of innovations.

It is noteworthy that according to the ICRA report (1997), there were about 500 water pans in the study area in 1997. These had grown to about 2000 water pans by 1999, which goes to support the definition of an innovation as an idea, practice, or object perceived as new by an individual or other unit of adoption. Water pans were not new in Lare but were taken as a new innovation as a result of the communication strategies that were used to popularise them. The use of appropriate communication strategies and channels may therefore have been the single most important factor in the diffusion of rainwater harvesting technologies in the study site.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This study was conducted in Lare Division of Nakuru District, Rift Valley Province. Although the level of adoption of the rainwater harvesting technologies is quite high, it is lower than would be expected, especially considering what appeared to be obvious benefits to those who had adopted. The fact that various stakeholders have put a lot of effort in the diffusion of the technologies is significant and consistent with adoption levels. Diffusion is quite high, a factor that has encouraged farmers groups from other parts of the country to visit the area to see the gradual transformation that is taking place as a result and also adopt the technologies. A higher rate of diffusion would quickly transform the area into a showpiece of the success of the diffusion of technologies likely to make a major impact in the vast ASALs of the country. Like many other marginal parts of the country, Lare is a 'newly' settled area and it would therefore be interesting to establish if the varied backgrounds of the 'settlers' has had an impact on the adoption of the innovations.

3.2 Site selection and description

Lare Division of Nakuru District, is a semi-arid, 'newly-settled' region that is rich in ethnic diversity, comprising of the Kikuyu (who are the dominant group), Kalenjin, Kisii, Luo and Luhya. The ethnicity difference brings about different socio-cultural aspects in the farming systems. The division experiences serious shortage of water during the dry season. The average annual rainfall ranges between 600-1000 mm spread out between March and December. But it is erratic, unevenly distributed and varies from one year to another. There is drought after every 3-4 years.

Lare Division covers an area of about 134 km². It was hived off the expansive Njoro Division in 1998. The division has four administrative locations viz.: Gichobo, Pwani/Naishi Game, Lare and Bagaria. Naishi is the commercial and administrative centre for the division and is linked by road to Nakuru and the Mau-Narok tarmac road. The roads are not easily passable during the rainy season.

The 1999 National Census gives the population for Lare as 27,727, which is a decline from the 1996 estimate of 43,976. The estimate for 2003 is 33,702 calculated at an annual growth rate of 5 percent.

Table 3.1–Population statistics for Lare division

Year	Male	Female	Total	percent population change/year	Density persons/km²
1989	15,156	16,157	31,313		234
1995	20,446	21,448	41,894	56 percent	313
1996	21,462	22,514	43,976	4.7 percent	328
1999	13,211	14,516	27,727		
2003	16,058	17,644	33,702		

Source for 1989-1996: NARP II report; 1999- National Census report

2003- Estimated at 5 percent growth

The significance of the population statistics is the steady rise between 1989 and 1996 in comparison to the decline in 1999 as shown by the figures from the 1999 population census. The decline is explained by the occurrence of tribal clashes in 1998 which led to the displacement of a lot of people from the division and the death of a few hundred people according to local sources. Such a big displacement of people has certainly affected general development of the area, including diffusion of agricultural innovations such as rainwater harvesting.

Land is privately owned. The household farm sizes vary from 2.5 to 10 acres though this continues to decrease as land is further subdivided among families or sold. Farmers mainly grow maize and beans in an intercrop system and also keep dairy cattle, sheep and goats. Recent years have seen the adoption of more crops, more especially security food crops and small-scale irrigation of horticultural crops. With the assistance of the ACK Church, a long dormant tap water supply project covering parts of Gichobo and Lare locations is being revived and extended to cover a wider area. In fact some households had started receiving piped water at the time of the study.

Except for this piped water project and another small one in Gichobo Location, Lare does not have tap water supply system. The community depends on borehole, roof water catchment, water pans, dams and seasonal rivers (Naishi and Bagaria) for both livestock and domestic use. There are primary and secondary schools, a health clinic and daily market. However, Lare has no electricity and the fixed line telephone supply system is very limited.

3.3 Sample design and procedure

The researcher realized that simple random sampling would be an added constraint to the study. First the entire population was too large and the time allocated to the study was limited. Studying the entire population would also be very costly. In addition, many local people are suspicious of strangers, the area having been hit by the infamous tribal clashes. It is also prone to persistent cattle theft and general crime rate is rather high according to the local people. On the advice of key informants, the snowball sampling procedure was finally adopted. Samples were drawn from the two locations of Lare and Gichobo.

A total of 125 farmers from the two locations were interviewed. 39 of these were from the smaller Gichobo Location with a total population of about 5,000 people and 940 households, while 86 were from the bigger Lare Location with a population of about 11,000 people and 2,368 households. As earlier, stated the snowball method was used. The researcher was initially introduced to some farmers by the coordinator of the Mt Clara Farmer Training Centre. These in turn introduced the researcher to other farmers. Care was taken to ensure that as representative a sample as possible was interviewed by covering all corners of the two locations. The total sample interviewed represents 3.8 percent of the total population of the two locations.

3.4 Data collection methods and techniques

As has been pointed out, this study sought to examine those communication and socio-cultural factors that may have impeded the rate of diffusion of smallscale rainwater harvesting technologies in the ASALs. The following methods of data collection were used to obtain the required data.

3.4.1 Library research

Library research was a major source of data at the proposal writing stage where literature concerning the status of rainwater harvesting in the ASALs was reviewed. Apart from providing a lot of background information on the study, the literature review also enabled the extraction of a few research assumptions as clues to the issues to be investigated.

3.4.2 The survey method

The survey method using the interview schedule was the key research method used to extract data from the respondents. Primary data was derived from survey interviews with both adopters and non-adopters. Both structured and non-structured interviews were

conducted. In the structured interviews, a prepared questionnaire was used and questions asked as worded and in the order in which they were written to allow for a comparison of answers from respondents to facilitate the computation of summary statistics. Often after going through the structured questionnaire, the author engaged in conversation with the respondents about the subject matter using unstructured questionnaires to elicit further information. It was therefore important to establish good rapport with the respondents which consequently often led to spontaneous answers on the subject under discussion. Some literate respondents, especially primary school teachers, insisted on filling the structured questionnaire on their own, thereby denying the author the opportunity for the unstructured interview. To make up for this, the author requested such respondents to note on the questionnaire issues that were relevant to the subject. Some obliged and interesting remarks were made on some of the questionnaires. The questionnaires had been pre-tested with 15 farmers from Kihingo Location of the adjacent Njoro Division.

More data was sourced from the local extension officers and key informants including leaders of community based organizations (CBOs), farmer-research-extension-group (FREG) leaders, other local opinion leaders, and local administration officers.

3.4.3 Interview of extension staff

The 9 government extension agents in Lare Division and 3 from the Mt. Clara Farmer Training Centre were interviewed. Three students on extension attachment at the Centre from Baraka Agricultural College, Molo, were also interviewed. Locating the government extension agents was tricky since they meet at the Divisional Extension Coordinator's office only on Mondays and even then not all attend the weekly meeting. But the author managed to interview all eventually.

3.4.4 Focus group discussions

Focus group discussions were conducted with the MUSEFA Tree Nursery Self-Help group. This is a highly homogenous group of farmers which has established a commercial tree nursery hosted by one of the members. Membership is essentially on family basis as any mature member of a member family is allowed to participate in the group's weekly activities. The level of integration among the members was very high, transcending gender and age barriers. The host member has a water pan since water is a must for the project.

3.4.5 Key informant interviews

Key informant interviews were also utilized to obtain data. Farmer Research Extension group leaders were interviewed with the aim of obtaining information on the effectiveness of the FREG system. Contact farmers (with KARI-Njoro) were also interviewed to obtain information about farmer-researcher contact. Other key informants were the District Agricultural Officer, the District Agricultural Liaison Officer (formerly Division Extension Coordinator, Lare), the Baraka Agricultural College Extension Manager, the Coordinator, Mt. Clara Farmer Training Centre, Lare, and research scientists from the nearby Plant Breeding Research Centre, Njoro.

3.5 Data analysis

The data was analyzed objectively using the Statistical Programme for Social Sciences (SPSS), a recognized scientific and statistical method. Statistical methods of organizing data for ease of understanding and interpretation have also been employed. Statistical inferences have also been used.

3.6 Limitations of study

- The lack of up-to-date data on the adoption levels of rainwater harvesting technologies was a limitation that affected sampling. The most recent records had been compiled in 2000 and a lot of change had since taken place.
- Limited funding was a problem and the author had to personally carry out the entire survey, there being no financial provision to hire enumerators. Transport was also limited to a little allowance for public transport. Long distances were covered on foot as the author had no vehicle and public service vehicles are very few and serve only a small area of the study site.
- Time allocated for the study did not allow for an in-depth study.
- The poor infrastructure in the area – poor roads, lack of electricity and poor telecommunication facilities – made the study more difficult. Persistent rains at the beginning of the study rendered movement virtually impossible because of the poor state of the roads and much valuable time was lost.
- Above normal rains during the year and therefore indications of a bumper harvest may have influenced respondents to give biased responses.
- Finally, since most of the questions were recalled, the possibility that respondents may have given inaccurate responses cannot be ruled out.

CHAPTER FOUR

DIFFUSION OF SMALLSCALE RAINWATER HARVESTING TECHNOLOGIES IN LARE DIVISION

DISCUSSION OF EMPIRICAL FINDINGS

4.0 Introduction

This chapter presents the results of the study in relation to the objectives. The main purpose of this study was to identify and assess the communication strategies applied in disseminating water harvesting technologies in Lare Division of Nakuru District in Kenya and also to establish the viability of water harvesting technologies in enhancing food production and improving people's livelihoods in Lare. People's knowledge, attitude, and practice were briefly analyzed. A substantial amount of information was generated and is presented in this chapter.

A 1997 study showed that there was a serious water shortage for both human and livestock consumption in Lare affecting about 70 percent of homesteads. (ICRA Report, 1997). The majority of the households depend on roof catchment and water pans or seasonal rivers for their water supply needs. The roof catchment water tanks projects had been started way back 1985/88 by the Church Province of Kenya (CPK) church working mainly through self-help women groups. A study in 1997/1998 (KARI, Njoro) had revealed that most of the water tanks had been poorly constructed and were prone to leakage. The 15,000 litre storage tanks were also small and did not satisfy household needs. Related to this was the high incidence of water borne diseases, especially typhoid and amoebic dysentery.

A collaborative project by several stakeholders already actively involved in the community or being interested parties was started in the division in 1998. Among the stakeholders were: KARI Njoro, Egerton University, the Netherlands Liaison Office (NLO), the Ministry of Agriculture and Livestock Development (MoALD), the Catholic Diocese of Nakuru, Self-Help Development International (SHDI), Baraka Agricultural College (BAC), Farming Systems of Kenya(FSK), World Wildlife Fund for Nature (WWF), the Anglican Church of Kenya (ACK), and Mtakatifu Clara Mwangaza Centre, Lare. Several technologies were introduced to the people of Lare, among them rainwater harvesting technologies. Through a demand-driven approach to identification of relevant technologies, Lare farmers rated rainwater harvesting as their top priority (1998).

Lare relies on relief food supplies during extended dry periods. But wider adoption of the rainwater harvesting technologies would in fact reduce or eliminate the need for such food aid. Adoption of the rainwater harvesting technologies has led to a diversification of the crops grown in the area. In addition to the traditional maize and beans, some farmers have now adopted other crops including bananas, sweet potatoes, cassava, green grams, sorghum and millet.

The study focused on the diffusion of rainwater harvesting technologies and related technologies such as new crops in Lare Division and aimed to investigate why the technologies had not been as widely adopted as would be expected. The dissemination methods used were: leaflets in English, field extension workers, farmer-research-extension-groups(FREGs), field demonstrations and meetings .

The study attempted to examine the role of communication in the diffusion of the technologies. It attempted to find out the literacy level of the farmers and whether they understood the contents of

the leaflets. It also attempted to find out whether the field extension workers, the farmer-research-extension groups, demonstrations and the meetings were effective in conveying the information to the farmers. Farmers were also asked the communication methods they preferred. Intentions to carry out a KAP survey were not quite fulfilled though some useful information was gleaned in the course of the study.

4.1 Biodata

125 respondents were interviewed in both Gichobo and Lare locations of Lare Division. 39 or 31.2 percent were from the smaller Gichobo Location with a population of 4331 persons. 86 respondents representing 68.8 percent were from the bigger Lare Location with a population of 10,995 persons (1999 census).

Table 4.1–Distribution of respondents by sex

Sex	Percent
Male	60.8
Female	39.2
Total	**100**

76 respondents were male, accounting for 60.8% of the total, while 49 were female, representing 39.2% of total respondents. While a high level of partnership between men and women in the performance of farming activities was evident, when asked who made decisions on whether or not to adopt new technologies, most respondents said that it was the man who made such decisions.

Table 4.2–Age distribution of respondents

Age bracket in years	Percent
20-30	13.6
31-40	36.8
41-50	28.8
51-60	12.1
61-70	6.4
Total	**100**

The age of the respondents ranged between 20 and above 71 years. The 31-40 years bracket formed the majority of respondents at 36.8 percent while the 41-50 years bracket comprised 28.8 percent.

Table 4.3-Marital status of respondents

Marriage characteristics	Percent
Married	84.7
Single	7.3
Widowed	4
Divorced/Separated	-
Total	**100**

Marital status and level of education of respondents

A significant proportion (84.7%) of respondents were married, 7.3% were single, 4.0% were widowed, while none were divorced or separated. Marital status may determine family size, hence have implication for adoption, though this is not decisive.

Educational level of respondents is important based on the premise that educated farmers adopt new and better farming methods. This is because they understand the new technologies by either reading material such as leaflets, books and newspapers and also learn better in FTCs. In other words, educated farmers are more likely to benefit more from most communication channels used to disseminate material on agricultural innovations. Majority, comprising 33.9 percent, had primary education.

Language spoken by respondents

This is important because of the key role of communication in the adoption and diffusion of innovations. Farmers who speak the language of the extension workers have an advantage. Though Kiswahili is widely spoken in the study area, some technical terms may pose a problem for extension officers who do not speak the local ethnic language and therefore may not be able to explain the message. All the farmer respondents in this study were of the Kikuyu ethnic community, as were most of the extension agents.

4.1.1 Communication methods and adoption rates

The communication methods used in the dissemination of information on rainwater harvesting were extension leaflets in simple English with illustrations, extension agents, farmer-research-extension groups, field demonstrations and meetings. 68 percent of the respondents were male and females

were 39.2 percent. Of the respondents, 75 percent were farmers, 22.6 percent were teachers, artisans at 1.6 percent, while social workers were 0.8 percent.

Most of the farmers are in dairy keeping and crop farming. 84.6 percent have iron-sheet roofed houses, while 15.4 percent of the houses are either thatched, tiled or have asbestos roofs. Considering the importance of roof runoff harvesting in the area, the high percentage of iron-sheet roofed houses is clearly significant. A lot more water can be collected from an iron-sheet roof than from a thatched one. 74.4 percent of the total sample of 125 had adopted roof runoff harvesting, 65 percent had adopted road runoff catchment harvesting, and 55.2 percent had adopted the banana canals. The rather high adoption levels may be explained by the fact that the decision to adopt is essentially optional to the individual farmer. As Rogers (1995) puts it, optional decisions can usually be made more rapidly than collective decisions. So, as many respondents put it, once they had realized the importance of the rainwater harvesting technologies, they just went ahead and started with the technology they could most easily adopt. Diffusion was also spurred by the credible source of the information in form of extension agents (who had been trained by researchers), researchers themselves, and neighbours who had adopted and were enjoying the benefits of having adopted. Of course as the diffusion theory shows, adoption is never uniform across a social system but rather adoption is explained on the basis of adopter categories.

In the case of the study area, it should be noted that adoption of the different rainwater harvesting technologies was not mutually exclusive. A farmer would have adopted all the three technologies or one only. The level of demand for water in a household was a key determinant of adoption, especially in the adoption of water pans. As one key informant put it, if a farmer did not have livestock, especially cattle, or a large family, he might not feel compelled to invest in the labour and time-consuming water harvesting projects. Some farmers who had invested heavily either in

terms of labour, money or both to dig water pans had seen their pans lose water through seepage or faults in the earth. The author saw a big, empty water pan in Gichobo Location which had served the owner and neighbours since 1989 but had lost water through a fault that had suddenly appeared in year 2000. Another farmer in the same area had managed to have a water pan after two attempts. His first water pan had lost water through slow seepage as the soil could not hold water. A fault had appeared in the second one through which all the water had disappeared.

4.1.2 *Barazas* – a channel for creating awareness

Of the total respondents, 85.4 percent of those who attended *Barazas* had adopted at least one of the three major rainwater harvesting technologies introduced in the area. These are roof runoff harvesting, runoff catchment harvesting and the runoff catchment with canals popularly known as banana canals.

Kiswahili is the language used at *Barazas*. Some respondents admitted that they used the vernacular, in this case Kikuyu, in group meetings where all the members were Kikuyu. The major issues that were discussed in *Barazas* were those to do with development of the area, security matters, self-help activities and agriculture, particularly on food security.

Table 4.4–Sources of rainwater harvesting information

Source	Source %
KARI Leaflets	25.6
Lare Farmers Magazine	21.6
Farmer Training Centres	48.0
Extension Officer	57.6
Research Officer	26.4
Community Leader	29.6
Neighbour	27.2

4.1.3 Farmer-researcher contact

The author considers the 26.4 percent respondents who had learnt of the technologies from research officers rather high. But this is explained by the existence of the Farmer-Research-Extension Groups (FREGs) in the study area which were meant to link the three categories of players. Many farmers had encountered researchers for the first time through these groups. If the FREG system was encouraged, it would also address the problem of limited diffusion and utilization of research findings among change agents. Many research findings end up in files in research institutions due to the poor linkages between researchers and change agents in the field (Bangura, 1985). The proximity of the KARI-Njoro research centre to the study area also made it easier for researchers to frequent the area, especially during the multi-stakeholder activities of 1998-2000. Research officers from the centre also work with several contact farmers in the area.

4.1.4 Role of community leaders and neighbours

Community leaders and neighbours were also a significant source of information. A few respondents admitted that though they never went to FTCs or attended demonstrations, they nevertheless observed what their neighbours did and copied from them. A farmer in Lare Location who had never attended a field demonstration or gone to a FTC was credited with a modification of the banana canals, through what neighbours referred to as 'Githua' technology. Githua is the farmer's name.

4.1.5 Extension material as a communication channel

Sixty nine point two percent of the sample had read some material on rainwater harvesting while 30.8 percent had never read anything on rainwater harvesting. Of those who had attended demonstrations on the rainwater harvesting technologies, 40 percent had adopted at least one

technology. Most respondents had not seen or read KARI leaflets on rainwater harvesting. The simple illustrations of the technologies in the leaflets would have enabled even illiterate farmers get an idea of the technology. In any case illiterate farmers have either educated children, neighbours, or extension agents who can assist them to understand reading material. The author has assumed that the rather low percentage of respondents who read the KARI leaflets may be as a result of low distribution of the leaflets among farmers.

4.1.6 Extension agents as a communication channel

69 percent of respondents who had had contact with extension officers had adopted. Such contact was at the farmer's home, the local Farmer Training Centre (Mt. Clara), during field days or at a neighbour's during some field activity. Clearly then farmer-extension contact has contributed significantly to the diffusion of the rainwater harvesting technologies. This is also supported by key informants and focus group discussions. This also supports the diffusion model which stipulates that interpersonal channels such as extension play a significant role in the diffusion of innovations. Extension agents, especially those from Mt. Clara FTC, were rated highly and their advice was likely to be accepted by the farmers. The varied venues of farmer-extension contact also increased chances of influencing change.

4.1.7 Mass media channels and diffusion

The study analyzed ownership and/or access of the mass media channels of radio, television and newspaper readership. Though this may not have directly influenced the diffusion of the technologies, such access may have led to higher levels of awareness, hence possible adoption, especially among innovators and early adopters. This is consistent with what Lowery and DeFluer (1995) conclude that the adoption of innovation depends on some combination of well established

interpersonal ties and habitual exposure to mass communication. According to the diffusion model, mass media channels are more effective in creating awareness of the innovations, whereas interpersonal channels are more effective in forming and changing attitudes towards the innovation. Whereas it is a fact that there is very little use of the mass media in the dissemination of agricultural innovations in the country today, it is nonetheless highly probable that exposure to mass media does influence adoption of innovation. People exposed to mass media will be more receptive to new ideas even when these come from other sources such as interpersonal. Radio ownership is very high in the study area and television set ownership is also reasonably high. This implies that Lare farmers would benefit if more use was made of these channels to disseminate information.

4.1.7.1 Television

Television set ownership was found to be unusually high for a rural area with no electricity and which also experienced frequent droughts, hence high poverty levels. 52 percent of respondents own television sets, which are powered by car batteries and solar panels in a few homesteads. 56 percent of respondents said that they watch television. Car batteries are a very common sight on bicycle carriers as local people go to or come from Store Mbili, the nearest shopping centre with electricity power supply, or Nakuru. They are also a common luggage on the few ramshackle public service vehicles to and from Nakuru and Store Mbili.

4.1.7.2 The Radio

Radio ownership is high at 98.1 percent of the respondents. Listenership is high as evidenced by 82.2 percent of respondents who listen daily. The common sight of radios as people go about their

daily chores in the fields or in the homestead is further evidence that the channel is very popular in the area.

4.1.7.3 Newspapers

Newspaper readership, either of the English dailies or the "Taifa Leo" is not very high. Only 5.3 percent of respondents read newspapers daily. Thirty five point one percent said they read newspapers a few times a month. Literacy levels, financial ability, availability and interest influence newspaper readership. In addition, the nearest major shopping centres where daily newspapers may be available may be several kilometres from the homes of many of the farmers in the division. Not many farmers can afford newspapers and many of those who read them do so at the shopping centre. Though readership is low at only 5.3 percent of respondents, some said that they had learnt of some agricultural innovation from newspapers. Since literacy level is high in Lare, more farmers would benefit if newspapers were more affordable or accessible.

4.1.8 Farmers' groups as a communication channel

Groups are another method of dissemination of information to farmers. The various types of groups in the study area include self-help groups (which incorporate both men and women), women groups, youth groups and men only groups which are very few. Women groups are the majority, constituting approximately 80 percent of all groups in the area (records at Mt. Clara FTC) with self-help groups standing at 17 percent. Other groups are church groups and the Farmer-Research-Extension-Groups (FREGs). The FREGs are not active now though some farmers, especially the leaders, still exploit the contacts they made during the life of the project when they were created (1998-2000). As mentioned earlier, the FREG system should be studied with a view to incorporating it in the national agricultural extension system.

Group activities include income generating activities engaged in activities such as horticultural crop production, doper sheep rearing, poultry production and tree seedlings raising and distribution; social activities such as weddings and funerals; development activities such as water tank purchase or construction, land buying and purchase of household items.

Group sizes vary from 10 to 50 members, against the minimum stipulation of 25 members for a group to be registered with the Ministry of Social Services. Having realized the importance of groups, all the groups in the division have formed an umbrella group to coordinate the activities of all the groups in the area.

61 percent of respondents belong to church groups. Though church groups are not used as a channel for dissemination of agricultural information, many farmers said such groups and church congregations as well as the local primary schools, were useful avenues for various announcements of community activities, including *Barazas*, field days or other community activities. It is important to also note that group membership is not exclusive and the same farmer could belong to more than one group.

Group activities in the study area appear to be effective channels of communication. In many instances a couple will belong to more than one group. Where the wife is a member of a women group, the man may be a member of a farmers' group. Some groups that are involved in commercial activities allow both the husband and wife to participate in the group's activities. Such is the case with the MUSEFA Tree Nursery Self-Help Group, which allows family members including children to participate in the group's activities. The advantage here is that any useful

information gathered is shared for the benefit of the family. It is also easier for such groups to invite experts in various fields, including extension officers, to give them advice on issues affecting their groups. In other words, groups with the same interest can be reached more easily with information. It could be concluded that there is great potential in using groups as a channel of communication of information, including agricultural innovations.

Table 4.5–Group membership in Lare Division

Group type	Count	percent
Farmers Groups	44	35.2
Farmer Research Extension Groups	17	13.6
Church Groups	77	61.6

87 percent of women respondents belong to women groups. This tallies with the figures provided by Mt. Clara FTC showing that women groups constitute 80 percent of all the groups in the division.

It is also significant that the respondents do not have a problem with women of any category, young, old or officials, addressing them or attending meetings.

Even more significant is the fact that one of the major activities of the women groups has been the construction of stone water tanks. The ACK Church was actively involved in the formation of women groups with the major aim of constructing water tanks in the mid-eighties. The initial zeal was such that the women were themselves involved in the construction work. No wonder most of the water tanks built during the mid-eighties and early nineties are no longer in use due to cracks

and other structural weaknesses. These first generation tanks were also rather small with an average capacity of 15,000 litres.

The newly built tanks and the ones under construction are better having been professionally done from this unfortunate experience. To build bigger tanks so as to meet increased needs, members are supplementing the group funds with their own resources. This also means that the tanks are no longer uniform sized. It is easy to understand the leading role women are playing in roof rainwater harvesting especially for domestic purposes since they play a key role in the demand for and use of water in the rural areas.

Another factor that could explain why women are involved in various group activities is the intense attention which has been directed towards development programmes targeting women by both government and other development partners such as NGOs and churches. Development planners have realized that to incorporate women in development programmes is to improve the overall economic development of the country.

4.1.9 Farmer Training Centres

69 percent of farmers who had attended Farmers' Training Centres had adopted rainwater harvesting technologies. Among other reasons to explain this rather high attendance is the location of the Mt. Clara Farmer Training Centre situated at Naishi, the divisional headquarters of Lare. Farmers can get to the centre on foot from almost every corner of the division. The centre is an offshoot of the popular Baraka Agricultural College in Molo also not too far way, that many local farmers have also attended. The Mt. Clara FTC extension agents also seemed very popular with

many of the farmers interviewed who knew them by name, a factor that would spur attendance. Many respondents had made more than one visit to Mt. Clara, Baraka or both.

At 48 percent of the respondents who had attended one or both institutions, the two were serving the local community well. Demonstrations of the various rainwater harvesting technologies and other agricultural technologies were carried out at the FTCs and this may further explain the rather high level of contact with farmers. This links well with the extension source which would be at the FTCs, demonstrations on farmers' plots and also visits to individual farmers. More enterprising farmers sought the extension agents either at their offices or visited them at their homes. A close rapport existed between many respondent farmers and the extension agents from the Mt. Clara FTC.

Attendance was not limited to men only as many women had also been to the Farmer Training Centres. A high percentage of respondents (83.2 percent) affirmed that women should attend FTCs. Ninety two point two percent of respondents said that they had learnt something helpful at the Farmer Training Centres.

Table 4.6–Farmer Attendance in FTCs

Year	No.	percent
2003	30	44.1
2002	14	20.6
2001	6	8.8
2000 and below	17	25
Did not attend	57	
Total	**125**	**100**

4.1.10 Security issues

As earlier mentioned, the issue of security is of particular concern to the local people. Tribal clashes had hit the area in 1998 leading to the virtual displacement of the second biggest ethnic group in the area, the Kalenjin. Locals pointed out a mass grave for clash victims at the divisional headquarters which is a grim reminder of the ill-advised clashes. It is undeniable that the clashes had a negative impact on the diffusion of agricultural innovations in the study area. Many farms are uncultivated while many homes stand desolate in those parts of the division that were previously occupied by the displaced people, their former occupants reportedly living as squatters or in shanty villages in Molo and Elburgon. The pattern of settlement in the division is largely ethnic based since land allottees would be in batches, usually from the same area of origin.

4.2 Viability of water harvesting technologies and enhanced food production

The major economic activities in the study area are crop production and livestock keeping. Some of the production from both crop and livestock farming is for domestic consumption, while the surplus is sold to meet various household expenses.

4.2.1 Crop farming

The main crops grown in the area are maize and beans. Other crops grown include Irish potatoes, sweet potatoes, wheat, French beans, sorghum, peas, vegetables such as kales, cabbages and onions, the oilseed crops of sunflower, rapeseed and sunflower, bananas and oranges. A few farmers had planted sweet corn on arrangement with the Njoro Canning Factory during the main rain season of 2003. Returns were so encouraging that all interviewed farmers who had planted the crop planned to increase acreage under the crop the following planting season. Of course this would largely depend on demand by the canning factory or alternative markets being found.

Some of the crops, especially the vegetables, are grown for domestic consumption using small-scale irrigation from the water pans, though surplus produce is sold locally. Of note is the increasingly popular planting of bananas in banana canals. Sugarcane is also planted in the banana canals as are pumpkins and sweet potatoes. Through farmer innovations, spacing between banana plants is increased to allow for sugarcane in between. According to farmers who have planted sugarcane, local demand is hard to satisfy. This means that even as more farmers continue to adopt the banana canals, demand for the produce raised using the technology is assured. According to records available at the Nakuru District Agricultural Office, length of the banana canals in the division has increased from about 40,000 metres in 2001 to approximately 60,000 metres in 2003.

Security food crops in the study area have gained fairly rapid diffusion. These are cassava, cow peas, dolichos, bulrush millet, finger millet, sorghum, sweet potatoes, pumpkins, pigeon peas and bananas. Initial multiplication of planting material for many of these crops was and still is inextricably tied to rainwater harvesting. Most of the material was originally acquired in small quantities during a farmers' field trip to Embu and Mbeere. Though the farmers contributed money to buy more planting material after the trip, it still had to be deliberately multiplied so as to reach as many farmers as possible. Those farmers that had adopted water-harvesting technologies, especially those with water pans, inevitably did the multiplication.

The impact of the visit on the study area mainly in terms of crop diversity and area under production is significant. Diffusion of the technologies has been steady and there is now some planting material for dissemination to local farmers. Maybe the impact is best exemplified by a key

contact farmer who at the time of the study had approximately three acres under sweet potatoes. What this has proved is that little communication by members of a social system with outsiders inhibits diffusion of technologies (Adaba, 1988).

That farmer visits are increasingly being acknowledged as a diffusion channel is not in doubt. What may not be known is the degree of impact of such visits. The study site itself has been the destination of visitors from many parts of the country. Word spread fast of the transformation taking place in the area as a result of the diffusion of agricultural technologies, more so the rainwater harvesting technologies. A television documentary mainly featuring rainwater harvesting technologies in the area whose production the researcher was involved in, went a long way in creating awareness about the study area far and wide. Many farmer groups continue to visit as more awareness is created of the improved situation in Lare.

Between 1999 and 2003, farmers' groups from the following districts had visited the study area:

Kiambu	Kilifi
Nakuru	Taita Taveta
Bondo	Meru
Siaya	Embu
Baringo	Laikipia
Bomet	Kericho
Koibatek	Gucha
Narok	Kisumu
Nyandarua	Thika
Makueni	Kirinyaga
Maragua	Busia
Muranga	Rachuonyo
Mombasa	West Pokot

Other visitors included participants in an International Course in Water Harvesting hosted by the Ministry of Agriculture and Rural Development, a group from Northern Uganda, the Regional

Coordinator (East and Central Africa) ICRAF, a team of extension agents from Ethiopia, and a team of research scientists and extension agents from Rwanda.

As illustrated by the Lare farmers visit to Embu/Mbeere, visiting farmers and their communities do gain from such visits by acquiring and adopting some of the technologies they are exposed to on their visits. But such visits need to be planned carefully and with clearly stated objectives.

4.2.2 Livestock farming

Livestock keeping in the study area is virtually directly linked to rainwater harvesting. Dairy cattle rank first in terms of providing cash to the farmers and almost all farmers own at least one dairy cow. Farmers also keep poultry, sheep and goats, and some have donkeys, which are used for transport. The cattle breeds kept in the area are mainly crosses of Guernsey, Ayrshire and Friesian. Very few farmers keep pure breeds and virtually none has a typical local zebu cow. The animals therefore have a fairly high genetic potential for milk production under good feeding regime and good husbandry practices. Dairy farming and adoption of rainwater harvesting technologies seem to be closely linked (Table 4.7).

Table 4.7–Dairy farming and adoption of rainwater harvesting technologies

	Adopted RWH Technology (%)	Adopted roof runoff harvesting (%)	Adopted runoff catchment (%)	Adopted banana canals (%)
Dairy farming	60	54	46	42

Many of the farmers interviewed said that they had dug water pans mainly to harvest water for their dairy animals. Some told sad stories of how their livestock had perished in times of drought and the harrowing experiences of trying to find water for their animals during such times. Upon realizing the usefulness of the water pans, many have enlarged their pans so as to harvest more water, more so if the same water is used for small-scale irrigation of the vegetable gardens evident

adjacent to the water pans in many homesteads. Also consistent with this is the construction of larger water tanks to harvest roof runoff water both for domestic purposes and for livestock. It is a common sight in Lare to see a huge stone water tank mismatched with a small iron-sheet roofed, mud-walled house! Unfortunately many farmers do not know the volume of water they can harvest either in their water pans or the water pans. All they say is that the harvested water takes them to the following rainy season or to just a week or so before the onset of the rains.

Lare dairy farmers have also realized the value of the banana canals as a source of supplementary feed for their animals in form of the banana stems. Some also plant fodder crops in the banana canals as well planting napier grass between the banana canals. This realization has spurred diffusion of banana canals in the area.

For those farmers who own livestock and either have not harvested enough rainwater or have none at all, fetching water for the animals is a hard, time-consuming activity. Ironically some buy or borrow water from neighbours who have water pans or fetch it from the community dams in the area. Donkeys and bicycles are used to fetch the water while women and girls carry it in jars on their back. Young boys and sometimes adult men will be seen carrying water jars in wheel burrows. A major threat to this significant economic activity for the community in the study area is rampant cattle theft. In the course of the study, the researcher heard of several incidents of cattle theft and robberies in people's homes. Cattle owners have therefore been forced to incur expenses reinforcing their cattle sheds, almost invariably erected adjacent to the living house in the homestead. No wonder 48.8 percent of respondents cited security as one of the key subjects discussed during *Barazas* by the Provincial Administration staff.

4.3 A brief analysis of extension service in the study area

Most of the extension staff in the study area, that is 73.3 percent, are of the Kikuyu ethnic group, which also is the overwhelmingly predominant group in the area. 78.6 percent are male with the rest, 21.4 percent female. 26.7 percent of the extension agents have a minimum of secondary 'O' level education while 66.7 percent have advanced 'A' level education. Only 6.7 percent have university education. A majority (60 percent) have undertaken two years agricultural training, 33.5 percent more than two years, and only 6.7 percent have undertaken one year training.

The two main methods of contacting farmers are field visits and demonstrations. Although the two methods are not mutually exclusive, 93.3 percent of the extension workers said they visit farmers in their homes; 86.7 percent organize demonstrations; 46.7 percent participate in Farmer Training Centre activities and 73.3 percent said that they are visited by farmers. Many of the extension agents (71.4 percent), cited lack of follow-up as the major reason why farmers fail to follow recommendations given to them. They gave as reasons for the lack of follow-up the small number of extension staff and lack of transport to the farms. Only 15.4 percent said that farmers fail to adopt recommendations because of lack of money, while 7.7 percent cited illiteracy as the reason for failure to adopt.

Between 1996-2003, 26.7 percent of the extension workers had not received any job related training while 54 percent had received some training in 2003. The most prevalent training was a seminar of one week or less. Most of the training for extension staff is to improve skills so as to serve farmers better.

Most of the extension agents in the study area have a much higher level of education than a majority of the farmers. They have attained 'A' level education and most have acquired agricultural training for at least two years. Many of the educated farmers have attained only primary school level education. Being better educated and also professionally trained, the extension agents are in a good position to provide the requisite services to the farmers. The fact that many of them also speak Kikuyu, the predominant local language, should be considered an advantage given the propensity of people to use their ethnic language.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of research findings

It was evident from the study that diffusion of rainwater harvesting technologies in the study area is quite high. Communication has evidently contributed to this rate of diffusion as acknowledged by many respondents. The various communication channels of extension agents, leaflets, field demonstrations, farmer-research-extension groups and meetings each contributed to the diffusion of the technologies. The contribution of communication to diffusion is deemed significant because adoption of some of the technologies does not require huge capital outlays. For instance, digging a water pan essentially requires labour, which in many cases is provided by family members. Of course respondents who could afford it used hired labour or tractors. But most respondents, and because of the information received, had started with a small water pan dug by family members, in many cases just the man and his wife, which was gradually enlarged to cater for increased needs.

The results of the study indicate that communication has played a major role in the diffusion of rainwater harvesting technologies. Adoption was low before the intervention by external players whose involvement through several communication strategies spurred diffusion to the current levels. Whereas communication is only one factor affecting or influencing diffusion of technologies, it may be the single most important factor especially for technologies that may require labour only, which is abundant in many rural areas.

Through activities of women groups, most homesteads in the study area have stone water tanks. Communication equally played a key role in the adoption of this technology. One respondent could recall a meeting in the mid eighties where an official of the ACK church had remarked that people in Lare lacked water because they did not wish to harvest it since they received adequate annual rainfall. Women worked hard and hand in hand with men to build the first generation water tanks. An added bonus from this experience could be the reduced gender bias in the carrying out of some tasks as noted in some group activities where men and women worked together comfortably. Mixed men and women groups seemed to be performing quite well.

The other major water harvesting technology of the banana canals, just like the water pans, though labour intensive, can be acquired using family labour. Many respondents said they had gradually been increasing their banana canals using family labour. The rapid diffusion of the technology from 40,000 metres in 2000 to 60,000 metres in 2003 can be attributed to acquisition of information and of course, the utility of the technology in that it is possible to grow other crops alongside the bananas in the trenches. Some farmers grow other crops without planting bananas in the canals. New technologies in form of new crops have been introduced in the area, the cultivation of many of them directly linked to rainwater harvesting. Small-scale irrigation has rapidly gained popularity. The initial priming of the local people for the diffusion of rainwater harvesting technologies has aided in the adoption of security food crops and other crops. Many farmers plant two or more varieties of maize in a planting season an effort to ensure food security. Dairy farming has improved alongside increased diffusion of rainwater harvesting technologies to become a key income earner for the local people. Using the snowball sampling method, a sample of 125 farmers were interviewed using a questionnaire schedule and the probing method. Data was also collected

from key informant interviews and during focus group discussions and was analysed using the SPSS and qualitative analysis.

5.2 Conclusion

In terms of usefulness as channels for communicating rainwater harvesting technologies and other agricultural innovations, the respondents rated channel usefulness as depicted in table 5.1 below:

Table 5.1–Respondents rating of communication channel

Communication Channel	Rating by percent respondents
Daily Newspapers	32.9
Barazas	36.8
Farmers Groups	77.8
Church	32.6
Radio	37.1
Television	40.0
Neighbours	59.8
Extension agents	62.5

The data shows a clear preference for farmers groups, extension agents and neighbours as the preferred channels of communication. There are many farmers groups that are specialized in activities such as dairy farming, horticulture, commercial tree nurseries and growing oil crops. Farmers seem to have realized the advantages of such groups since they are able to access credit, professional advice and even markets more easily. Being in a group also means spreading risk, meaning that individual farmers are likely to suffer less loss in the event things go wrong.

Many respondents expressed a preference for practical demonstrations, which is linked to extension agents, hence the high rating for extension agents. Such may be explained by the relatively low level of literacy, education, and understanding of the scientific method. Of course the

interactive nature of engagement with extension agents is a point in their favour. Television is also rated quite high because respondents preferred visual channels where they could 'see' things. Churches and church groups are preferred as a channel through which announcements for various community activities are made.

More use of mass media channels of radio and television would create more awareness among rural farmers. Diffusion of innovation would then be enhanced through the use of interpersonal channels of communication.

5.3 Recommendations

Communication plays a key role in the diffusion of technologies. But it is also acknowledged that other factors affect diffusion of technologies. The use of multiple communication channels should be encouraged as each channel has its strengths and weaknesses. Success would be enhanced by the participation of professional communications personnel in all dissemination campaigns. The following recommendations have been made from the findings of the study.

- The Farmer-Research-Extension Group (FREG) system should be studied further with a view to incorporating it in the extension service. Through it, the 'ivory tower' perception of researchers and research institutions by field extension workers and farmers would be reduced. Farmers would be encouraged to seek assistance directly from research institutions through sustained contact with researchers in the field. The FREG system also enhances farmer to farmer exchange of information. This ensures sustainability after project life. It also provides for organised farming communities, hence a foundation for demand-driven research/extension services that can also form the basis for the privatization of such services.

In addition, the system ensures training of front-line extension workers so as to equip them with the necessary information and knowledge that is relevant to the technologies in question.

- Farmers prefer communication channels that demonstrate things practically such as field demonstrations. Such channels should be used as far as possible, especially in view of the widespread illiteracy in the country. Leaflets where used should be widely distributed. Attempts should be made to produce leaflets in Kiswahili, or in the case of a target area with one ethnic group, in the vernacular.
- A multi-channel approach ensures more farmers are reached with information. Planners should therefore try to use as many channels as possible in dissemination campaigns. Alongside this, mobilisation of as many stakeholders as possible in the dissemination of agricultural information appears to be the most effective approach to technology transfer and adoption. Duplication would also be avoided if a team approach was used by all stakeholders involved in a project.
- Radio and television channels should be utilised more in the dissemination of agricultural information. Communication experts, who should also be involved in communication research, should be actively involved in the process of diffusion of agricultural innovations.
- Groups have clearly emerged as a channel of communication with unique advantages that can be exploited to reach many people with information. The diverse nature of group types and activities makes it imperative to carefully study groups and find out how best to use them in the diffusion of agricultural innovations.
- Farmers group visits are another emerging channel that may need to be studied further so as to make full use of them. Factors such as place to be visited, choice of farmers to make the group visit and a cost-benefit analysis should be considered.

- Security is crucial if development is to take place in the rural areas. Government should ensure that calamities such as the tribal clashes never occur again. Cattle theft and general insecurity also deter diffusion of agricultural innovations and should be stamped out.

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APPENDIX 1

Questionnaire Schedule

Name of farmer: _____

i Questionnaire number: _____

ii Sub-location: _____

iii Location: _____

iv Village: _____

Background Information

1. Sex: Male ☐ Female ☐

2. In which of the following age brackets do you fall?

i. 20-30 years ii. 31-40 years iii. 41-50 years

iv. 51-60 years v. 61-70 years vi. Over 70 years

3. Marital status:

i. Married (Monogamous) ii Married (Polygamous)

iii. Single iv. Widowed

v. Divorced/Separated

4. How many children do you have?_____

5. Educational status

i. Illiterate ii. Adult literacy (Can read and write)

iii. Primary iv. Secondary

v. Post Secondary

6. Are you able to speak, read and write any of the following languages? (Tick)

Language	Speak	Read	Write
Kikuyu			
Kalenjin			
Luhya			
Kisii			
Swahili			
English			

Socio-economic variables

7. What is your main occupation?

_____

8. If retired please state the type of work you used to do.

_____

9. How would you rank your other occupations/activities in terms of the most financially rewarding?
   1. _____
   2. _____
   3. _____

10. Tick if your house is made of the following:

ROOF				FLOOR		WALLS			
Tiles	Asbestos	Thatched	Sheets	Cement	Earth	Stone	Bricks	Mud	Timber

12. Tell me how many types of animals you have of the following:
    a. Cattle
    b. Sheep and goats
    c. Poultry
    d. Donkeys

Questionnaire to establish communication channels used by farmers

13. (a) Do you own a radio?

Yes ☐ **No** ☐

(b) If no, please explain your answer.

1. _____
2. _____
3. _____

14. (a) Do you own a television?

Yes ☐ **No** ☐

(b) If no, please explain your answer.

1. _____
2. _____
3. _____

15.

No	How often do you	Daily	A few times a week	A few times a month	Seldom	Never
		4	3	2	1	0
1.	Read Daily Newspapers					
2.	Listen to Radio					
3.	Watch Television					

16. (a) Have you ever read anything concerning rainwater harvesting?

Yes ☐ **No** ☐

(b) If yes from what source?

1. _____
2. _____
3. _____

17. Did you understand the content?

Yes ☐ **No** ☐

18. Which was your other source of information concerning rainwater harvesting techniques?
    1. Extension officer
    2. Agricultural research officer
    3. Community development leader
    4. Neighbour

Level of attendance in *Barazas*

19. Do you attend *Barazas*?

Yes ☐ **No** ☐

20. If you do not, please explain why?
    1. _____
    2. _____
    3. _____

21. Which language is normally used in these meetings?

_____

22. How frequently do you attend these meetings?

Attendance			
Every time there is a meeting	**Quite often**	**Seldom**	**Never**
4	3	2	1

23. What issues are discussed in the *Barazas*?

1. _____
2. _____
3. _____

24. How often do they attend? (Tick where appropriate)

Every time there is a meeting	Frequently	Occasionally	Never
4	3	2	1

25. (a) Do they ever address people in these meetings?

Yes ☐ **No** ☐

(b) If yes, what do they usually talk about?

1. _____
2. _____
3. _____

26. (a) Do women also attend these meetings?

Yes ☐ **No** ☐

(b) If no, why don't they?

1. _____
2. _____
3. _____
4. _____

(c) If yes, do they ever talk in these meetings?

Yes ☐ **No** ☐

27. What sort of women talk in these meetings?
    1. Young women
    2. Only women with official status
    3. Old women

28. How do you feel about women attending *Barazas*?

_____

_____

_____

The role of community groups as a communication channel

29. Are you a member of any of the following groups

    1. A farmers' group in the area
    2. Church group
    3. Women group
    4. Farmer Research Extension Group

30. Do extension officers attend these group meetings?

Yes ☐ **No** ☐

31. (a) Are you able to practice what they advise you to do?

Yes ☐ **No** ☐

(b) If no, please explain why?

1. _____
2. _____
3. _____

Questionnaire to establish frequency of contact between farmers and extension officers

32. Are there Government or other agricultural extension agents who work in this sub-location?
Yes ☐ **No** ☐

33. (a) Have you met them?
Yes ☐ **No** ☐

(b) If yes, please indicate where

_____

(c) Do you know his/her name? **Yes** ☐ **No** ☐

34. When did you last talk to an agricultural extension agent?
1. A week ago
2. Two weeks ago
3. A month ago
4. Several months ago
5. Never

35. Do they work with most farmers in this sub-location?
Yes ☐ **No** ☐

36. Have you ever attended a course in a Farmer Training Centre?
Y☐ ☐ **No**

37. What type of courses were they? (Tick)
1. General agriculture (cultivating many crops)
2. Animal husbandry
3. Rain water harvesting
4. Bee-keeping

38. How many times have you attended these courses?
1. Never 2. Once 3. Twice
4. Three times 5. Four times

39. When did you last attend a course? Year .....

40. (a) Did you learn anything in the Farmer Training Centre which was helpful to you?

Yes ☐ **No** ☐

(b) If yes, please state

1. _____
2. _____

41. What are your feelings about the Farmer Training Centres?

1. _____
2. _____
3. _____

42. (a) Do you think women should attend these training centres?

☐ **Yes** ☐ **No**

43. Have you ever attended demonstrations by the Ministry of Agriculture or other institution about rain-water harvesting?

Yes ☐ **No** ☐

44. How many times have you gone to a demonstration on rainwater harvesting in the last twelve months?

1. Once
2. Twice
3. Three times
4. None

45. What types of rain-water harvesting demonstrations have you attended? (Please tick)

Type of demonstration

(1) Roof runoff harvesting
(2) Road runoff (water pan)
(3) Banana canals harvesting

45. In the table below, please rate the communication channels in terms of importance as dissemination tools for rainwater harvesting technologies and other agricultural technologies.

Channel	High	Low	Poor
Radio			
Television			
Daily Newspapers			
Barazas			
Farmers Groups			
Church			
Neighbours			

(b) Please explain your answer.

47. Tell me your opinion of the local agricultural extension officer

Extension Officer	Usually available	Gives good advice	Never available	I do not know
	4	3	2	1

Questionnaire on farmers' socio-cultural values and attitudes toward adoption of innovations

48. Tell me:
    a) Who owns the land in this homestead?

_____

_____

49. Where do you obtain labour for farm activities? _____

_____

50. How many hectares/acres of land do you have? _____

51. What type of crops do you plant? _____

52. (a) Have you adopted rainwater harvesting technologies on your farm?
Yes ☐ **No** ☐

(b) If yes, which? (tick)

1. Roof runoff harvesting
2. Runoff catchment(Water pan)
3. Banana canals

53. What types of crops do you plant using rainwater harvesting technologies?

_____

_____

54. From whom do you learn new farming methods?

1. Extension officers
2. Research Officers
3. Neighbours
4. Visits to other areas

55. Have you ever adopted the following (please tick)

1. Improved crop varieties (Hybrid maize, etc)
2. Improved farming practices (Crop rotation, control of soil erosion, etc)
3. Growing tomatoes, cabbages, onions, carrots etc (Horticulture)
4. Rainwater farming techniques

56. If you haven't adopted, please indicate why?

1. _____
2. _____
3. _____

Questionnaire for Extension Staff

Official grade/title _____
Age _____
Tribe _____

57. Sex : Male ☐ Female ☐
(a) Do you live in the sub-location ? Yes ☐ No ☐
(b) If not state where _____

58. (a) Do you speak any of the local languages? Yes ☐ No ☐
(b) If yes, state which _____

59. How many years of schooling did you complete? (Tick where appropriate)

Primary	Secondary	Tertiary
☐	☐	☐

60. How many years of agricultural training did you receive?
1. One year
2. Two years
3. Three years
4. More than three years

61. How many farmers are there in the area for which you are responsible? _____
_____

62. How do you contact them?
1. Field visits
2. By organizing group demonstrations
3. In farmer training centers
4. All the above

63. How frequently do you visit farmers?
1. Once weekly
2. Once monthly
3. Once in two months
4. 3 times a week.

64. Estimate as accurately as possible how often you did the following in this sub-location during the past six months:

(A) Organized a demonstration

1. Never
2. Once
3. Twice
4. Three times

(B) Organized a meeting to discuss agricultural issues.

1. Never
2. Once
3. Twice
4. Three times

(C) Attended a meeting organized by someone else and gave agricultural advice. Such meetings could be

1. Church groups
2. Co-operative
3. *Barazas*
4. Women groups
5. Others

(Tick where appropriate)

1. Never
2. Once
3. Twice
4. More than twice

(D) Distributed written extension materials

(a)		(b)	
1.	Never		In what language
2.	Once		1. English
3.	Twice		2. Kiswahili
4.	Three times		3. Other (specify)_____
5.	More than three times		

65. It is known that farmers sometimes do not adopt farming practices recommended to them. What do you think are some of the important reasons why they sometimes fail to follow recommendations?

1. _____
2. _____
3. _____

66. What action do you take to make sure that they practice what you advise?

_____

_____

67. Are you usually successful?

Yes ☐ No ☐

If not, please explain why?

1. _____
2. _____
3. _____

68. Please comment on the Farmer Research Extension Groups.

_____

_____

69. What are the biggest problems you face as an extension agent?

1. _____
2. _____
3. _____
4. _____

70. When was the last time you received a job related training? Year.....

What type of training was it?

(1) A seminar of one week or less
(2) A seminar of more than one week
(3) A short course

71. How many times have you received this type of training?

(1) Once
(2) Twice
(3) Three times

72. What benefits do you obtain from this training?

(1) _____
(2) _____
(3) _____

73. What criteria do you use to choose farmers who should attend farmer training centres?

(1) _____
(2) _____
(3) _____

74. How often do you choose them?

1) _____
(2) _____
(3) _____

75. What problems do you encounter while organizing trips to FTC's for farmers?

(1) _____
(2) _____
(3) _____

76. In the columns below please rate farmers' characteristics in your area of operation.

No	Characteristics	Good	Fair	Poor	Don't know
1.	Farming reputation				
2	Rate of adoption of agricultural innovation				
3.	Consultation with extension agent				
4.	Flexibility to change				
5.	Desire for agricultural training				
6.	Attendance of agricultural meetings				
7.	General cooperation with extension agents				